AIS in The Currents of Sea and Thought

D-uppsats skriven av

Olle Blomberg

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An Ethnographic Study of Mariners' Use of The Automatic Identification System

Olle Blomberg
Abstract
An ethnographic study loosely informed by the theoretical framework of distributed cognition was carried out in order to describe how mariners have adopted the Automatic Identification System (AIS) in their work practice, or “made the technology their own”. AIS is a transponder-based identification and communication system that allows ships to automatically identify and track each other. In addition to facilitating the identification and tracking of ships, objectives behind the introduction of AIS are to “simplify informational exchange”, and “provide additional information to assist situation awareness”. Participant observation and interviews were made at four different ships, as well as at two shore stations. A focus group was also held at a maritime conference. The study gave some interesting results. For example, a Problem of Public Information Loss was identified. It is tentatively suggested that this problem has been overlooked partly because of a widespread but impoverished model of communication which does not account for the role of side-participants in a conversation. It is concluded that more research needs to be done on maritime work and the use of new bridge technology.
Extended abstract

This thesis documents an exploratory ethnographic study of mariners' use of the Automatic Identification System (AIS). AIS is a transponder-based identification and communication system that allows ships to automatically identify and track each other. Without AIS, mariners must address each other by referring to their position (i.e. “ship at position X Y”) when trying to make radio contact. This way of addressing ships often does not yield an answer at all, or even worse, it does yield an answer, but from the wrong ship. Apart from providing a solution to this problem, other objectives behind the introduction of AIS are to “assist in target tracking”, “simplify informational exchange”, and “provide additional information to assist situation awareness”.

An ethnographic study loosely informed by the theoretical framework of distributed cognition was made in order to describe how mariners have adopted AIS technology in their work practice, or “made the technology their own”. Participant observation and interviews were made at four different ships, as well as at two shore stations. A focus group was also held at a maritime conference.

The study gave some interesting results. For example, a Problem of Public Information Loss was identified. As long as some ships do not have access to the information provided by AIS, there is a danger that those ships will experience a loss of information and, with it, situation awareness. It is tentatively suggested that this problem has been overlooked partly because of a widespread but impoverished model of communication which does not account for the role of side-participants in a conversation. An unanticipated use of AIS was also discovered. The nationality of other ships is a highly meaningful category for mariners, since it (correctly or not) tells them something about the communicative and navigational skills the crew of those ships possess, thus helping them to plan their own navigation. While not explicitly broadcasted by AIS, nationality is read off from a ship's call sign.

It is concluded that more research needs to be done on maritime work in general and on the use of new, presently developing, bridge technology in particular.
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1.0 Introduction

This thesis is an ethnography of the reception and use of new technology in maritime navigation. While it is not uncommon for a thesis in cognitive science to focus on technology use, it is less common that it does so ethnographically, and it is even less common that it is concerned with technology use in maritime navigation.

I chose to study the use of a new technology in maritime work (more specifically, navigation work on the bridge) for several reasons. First, compared to other domains such as aviation, research on the effects of new technology has been scant in the maritime world. This is despite the fact that accidents and incidents in the worldwide maritime transportation system is alarmingly frequent, endangering both human lives and the environment, as well as resulting in the loss of huge amounts of money (Perrow, 1999, chapter 6). Furthermore, like in many other work places where complex and dynamic processes are being controlled, bridges, where the navigation work is carried out, has become increasingly automated over the years.

While new technology and automation often bring benefits, there are a number of known problems connected with automation (Dekker, 2002). For example, many accidents are the result of so called “automation surprises”. Because of inadequate communication between automation technology and human operators, the automatic system's model of the world and the human operator's model of the world can start to diverge and continue to increasingly do so under a long time, possible with disastrous consequences (see Lützhöft and Dekker (2002) for a detailed account of such a scenario within the maritime domain).

More specifically, the use of radar technology in maritime navigation has led to so called “radar assisted collisions”. This was initially used to describe a problem frequent during the early days of radar technology after World War II (Perrow, 1999, p. 203-4), at which time only a small portion of ships carried radar. Radar undoubtedly gave the OOW a whole new awareness of the traffic situation at night or in heavy fog. In addition, when only a very few merchant ships had radar technology, having radar gave a competitive advantage (at night or in heavy fog) since ships without radar had keep low speed and were unlikely to alter their course quickly (since they could not see anything). The radar however allowed the OOW to maintain full speed and manoeuvrability. “Radar assisted collisions” started to occur when more and more OOWs got this new sight organ, and they were all following the logic outlined above, assuming that others did not have radar technology. Even today, when virtually all ships have radar, collisions properly labelled “radar assisted” can occur. In some modern radars (so called ARPA radar), safety zones can be displayed around targets, showing where it one can safely navigate and where not. If two ships are on collision course, due to intuitive perceptual judgements, the displayed safety zone of a target might seem to suggest an obvious solution (Lee and Sanquist, 2000, p. 279). However, this solution might contravene the so called Rules of the Road, which among other things regulate how two ships should behave if they are on collision course. So if one of the OOWs trusts his perceptual judgement induced by the ARPA
radars graphical characteristics and the other sticks to the Rules of the Road, a collision might result.

This is merely an example of how new technology on the bridge might have unanticipated, and in this case undesirable, consequences. When I started working on this thesis, in the end of August 2003, quite many ocean-going vessels had just become required, by international regulations issued by the International Maritime Organisation (IMO), to carry a new type of navigation and collision avoidance aid called the Automatic Identification System (AIS). (At that time, approximately 18% of all vessels, international as well as domestic, were subject to this requirement according to Pettersson (p.c.)). It seemed then, that the timing was ideal for a cognitive science student with an interest in the role of technology in work practices to go to sea.

AIS is a transponder-based identification and communication system that allows ships to automatically identify and track each other. Without AIS, mariners must address each other by referring to their position (i.e. “ship at position X Y”) when trying to make radio contact. This way of addressing ships often does not yield an answer at all, or even worse, it does yield an answer, but from the wrong ship. Apart from providing a solution to this problem, other objectives behind the introduction of AIS are to “assist in target tracking”, “simplify informational exchange”, and “provide additional information to assist situation awareness” (IMO, 2001).

Because of the lack of research and knowledge of the use of AIS, this thesis is largely exploratory. I have employed an ethnographic approach, loosely informed by the theoretical framework of distributed cognition. The focus has been the use of AIS on the bridge by mariners (rather than say, staff working at shore stations equipped with AIS). Four different ships provided my primary field sites, although I also visited two shore stations (responsible for traffic information and for the arrangement of pilots for ships enter and leaving harbour). Additionally, with the help of my supervisor, I arranged and moderated a focus group where mariners discussed AIS and its introduction and use in their day-to-day work.

In the rest of this introduction chapter, I give some background about maritime navigation (in 1.1), with a particular focus on some of the technology available on the bridge, and then introduce the characteristics of AIS (1.2). In section 1.3 I give some examples of previous research on new technology in maritime work, as well as in other domains of work. Finally, I (re)state my research aims/questions in section 1.4.

Chapter 2, “The natural history of my research” contains sections about my chosen theoretical perspective (distributed cognition), and methodology (participant observation, interviews, and a focus group). Theory and methodology are usually contained in separate chapters in a thesis, but since in this case, theory and methodology are tightly intertwined, they fit comfortably together. Both the discussion of the theoretical framework and methodology is contextualised with some biographical details about the emergence of this ethnography.
Chapter 3, “The bridge as ‘the field’” contains narratives from my visits at bridges and shore stations, and from the staging of the focus group. This chapter has two functions, it presents some of the “results” of my ethnographic study, and it describes my method in more detail, and hopefully, gives a sense of what is involved in collecting “data” as a participant observer.

Chapter 4, “Analysis, interpretation, and discussion” contains much more of my results, but this time, in thematically under the headings AIS and VHF-communication, AIS and information needs, and Trust and presentation of AIS information. I discuss my findings and try to relate them to my chosen theoretical perspective.

Chapter 5, “Conclusions”, quickly sums up my main findings, and presents some broader reflections on the thesis.

1.1 Maritime navigation

The work of navigating a ship is carried out on the bridge, or the ‘wheel house’. Nowadays, ‘bridge’ is perhaps a better word since on modern ships, there is no literal wheel with which to steer the ship, only a small joystick. Traditionally, before the advent of the advanced technologies interwoven in bridges today, navigation was the work of a whole bridge team, with a radio officer, a lookout, a helmsman, as well as the navigator (also called the watch keeper, or the Officer of the Watch (OOW)).

To navigate a ship successfully, the position of the ship must first be estimated, and secondly, a course must be set in order to navigate according the planned route. Since estimating the position of a ship is computationally quite an intensive task, the presence of a team on the bridge with strict division of labour has certainly been justified (for a both excellent and brief account of how a bridge team estimates the position of a ship in piloting waters, see (Hutchins, 1990)). In choosing which course to set or maintain a host of different factors are important: the presence and behaviour of other vessels, the geography of the surroundings (both above and below water level), the requirements set by international regulations, the ultimate destination of the ship, the manoeuvring capability of the ship, the weather, et cetera.

However, the various tasks and activities performed by the members of the bridge team in order to estimate positions have plan courses are today being performed by a host of technological systems. The systems allow a ship to be navigated, most of the time, by a single OOW. (This was the case on all the ships I visited, although, there where always at least one other person present ready to assist the OOW should he or she so require.) I will here briefly describe some of the most important tools used by the OOW to estimate the position of the ship and to plan its course.

The Collision Regulations (COLREGS, or “the Rules of the Road”)

While a set of internationally agreed upon regulations are not the first thing that strikes one's mind when thinking of technologies for navigation and collision avoidance, the COLREGS are a kind of technology, although of a much “softer” sort than the electronics and hardware found on bridges. There are much debate about the utility (or not) of the COLREGS and whether they are only applicable in hindsight, as rules for determining
irresponsibility for incidents and accidents, or if they are also able to serve as rules giving guidance to the OOW during the course of making decisions. Anyway, the rules are only straightforwardly applicable in situations with two vessels. As an example, here is rule number 15 (there are 38 rules all in all):

**Rule 15**  
**Crossing Situations**

When two power driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

(This rule, by the way, is very similar to the “right hand rule” governing road traffic in Sweden.) It is evident from the above quote that the rules are not always straightforwardly applicable but are defeasible (“if the circumstances of the case admit”) and requires good judgement (see Belcher, 2002, Cannell, 1981, Taylor, 1993, for discussion). Moreover, the rules are quite frequently broken, even when they seem to be straightforwardly applicable (Syms, 2003).

*The gyrocompass*

The gyrocompass gives the heading of the ship relative the direction of the North Pole. The heading can also be referred to as the “course over water” (COW), as opposed to “course over ground” (COG). COG is the direction in which the ship moves relative to the ground, and since the water can be moving relative to the ground, this is not necessarily the same as heading/COW.

*The log*

The log delivers the speed of the boat by making calculations on the echoes returned by a sonic depth finder. There are two kinds of speed measurements, “speed over ground” (SOG), which is speed measured relative to the ground (i.e. the bottom of the sea), and “speed over water” (SOW), which is speed measured relative to the body of water under the boat. Whether the log delivers SOG or SOW depends on the depth of the water. SOG is measured in shallow waters, SOW in deeper waters. With the help of a speed measurement, the heading from the gyrocompass, and a previous reliable position estimation, a new position estimation can be fixed. This way of estimating the position of the ship is known as ded reckoning (its estimates the position deductively), or in Swedish, “död räkning”. On modern ships, ded reckoning is only used if a ship's GPS is not working properly.

*The radar*

There are two major kinds of radar: relative motion radar, and true motion radar. Relative motion radar, which is a much older technology than true motion radar, provides a radar image of the situation around the ship from purely egocentric perspective, without any connection to a fixed coordinate system such as that constituted by the longitude and latitude frame of reference. True motion radar on the other hand represents the surroundings of the ship in a fixed coordinate system (longitude, latitude, and nautical miles). True motion radar, which emerged in the 70s when information from the radar,
the gyrocompass and the log could be integrated, always has a relative motion optional mode.

Since the 70s, radars have developed into what is known as ARPA radars, radars with Automatic Radar Plotting Aid (Peiponen, 2001). ARPA radars have quite sophisticated computational functions embedded. For example, ARPA radars can automatically plot targets (other vessels are referred to as 'targets'), giving their heading (presented as a vector from the target echo), speed (length of the vector), closest time and point of approach between the own ship and target (abbreviated CTA and CPA). The modern ARPA radar is also an autopilot. The captain can enter the planned route for the voyage, and the autopilot automatically enters the route track (outlined on the radar screen). When the ship arrives at a track-point where the ship, according to the planned route, is about to steer into a new course, an alarm goes off which alerts the OOW. The OOW can then either confirm the new course by pressing a button or not do so, in which case the ship continues in the course held before the arrival to the track-point.

The Electronic Chart Display and Information System (ECDIS)
Traditional paper charts have on many ships been replaced by Electronic Chart Display and Information Systems (ECDIS), although paper charts are still used for backup purposes. The usual chart information can in an ECDIS be integrated with information from the gyro, the ARPA radar, GPS, planned routes etcetera, all displayed on a single monitor.

Very High Frequency (VHF) radio
VHF-radio units facilitate both ship-to-ship and ship-to-shore communication. Other ships are called on a specific public channel (channel number 73) and when contact and identity has been established, conversations can be carried further on other private channels. Sometimes shore stations, for example so called Vessel Traffic Services (similar to air traffic control towers, only they often solely have advisory authority, i.e. they are in the business of traffic information, not traffic management), have their own semi-public channels where ship-to-shore communication is conducted. In situation where no ships do not have AIS technology, ships are usually called upon by issuing the position of the ship (information gained from the radar, or from visual contact), either in longitude-latitude coordinates or relative to some landmark, for example, “northbound ship south of buoy 41” (or possibly, although hopefully not, relative to their own ship, i.e. “northbound ship on my port bow”).

The Global Positioning System
Most ships of today have at least one GPS receiver which continuously computes a position estimation with the help of a system of satellites orbiting planet Earth. Thus with the introduction of GPS, the position information provided by the log is only used for backup purposes, or as a potentially useful redundant information source (as an indication that the GPS receiver is not working properly for example).

This is some of the technology available both on ships with and without AIS. While this technology certainly provide the OOW with information and opportunities useful for
navigation and collision avoidance, there are a number of problems, some of which AIS is supposed to address:

- While there is advanced technology available to compute the position, heading and speed of the own ship (GPS, gyrocompass, and log), this does not help with establishing the position, heading or speed of other ships. While an ARPA radar can give approximate information about these, there is a two minute up-date delay, which can cause problems when other ships start changing direction, especially if the own and other ship are both travelling fast in converging directions (Perrow, 1999, p. 205).
- Unless one has clear visual contact (so that one can read the name of the ship off its hull), there is no way of addressing other ships over VHF-radio, except by using position information. This often does not yield any answer at all from the ship addressed, or even worse, it does yield an answer, but from the wrong ship (Perrow, 1999, p. 206).
- While advanced ARPA radar systems is sometimes referred to specifically as collision avoidance systems (for example, National Research Council, 1994, p. 49), they still suffer some problems inherent in radar technology which might lead to collisions rather than help avoid them. Apart from the two minute delay already mentioned, target tracking by radar can suffer from so called “target swaps”. Target swaps can occur if two echoes, of which one is the plotted target, are very close to each other, causing the ARPA radar to misidentify the target as the other echo (another vessel, rain clutter, a buoy), causing erroneous plotting.
- Because of the short wave length of radar beams, they are easily stopped by obstacles which create (possibly large) areas in 'radar shadow' (TRB, 2003, p. 20). Obstacles might for example consist of other ships or landmasses. Basically, the radar can only “see” what is in the line of “sight”.

### 1.2 The Automatic Identification System (AIS)

AIS is a type of transponder system. If a ship is equipped with AIS it is fitted with an electronic device, the transponder, which transmits signals to, and receives signals from, all other AIS-equipped ships within a certain range\(^1\). The transponder consists of a GPS receiver, a computer and a radio unit. The GPS receiver is fed with data about the ships position and navigational status. This data is sent to the computer, which processes it along with other data provided by ship's integrated bridge system (for example vessel speed, name, heading, COG). The radio unit then broadcasts all information to other AIS-equipped ships or shore-based AIS stations within range.

Requirements on ships to carry AIS technology went in force on the first of July 2002, since when all new large ocean-going ships have to be equipped with AIS (IMO, 2001). One year later, all old large ocean-going ships classified as passenger and tanker ships had to have AIS units installed, and by the first of July of 2004 all ships of over 300 gross tons were required to carry AIS. By the first of July 2008 all domestic ships (as opposed

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\(^1\)The range depends on the type of antenna used and on the amount of AIS messages being broadcasted in the surrounding area. If there is a lot of AIS messages sent, the range will automatically shrink to avoid overloading the network (TRB, 2003, p. 20). Usually, VHF range is around 20 nm (nautical miles), or 37 kilometres.
to international ocean-going ones) of over 500 gross tons will be required to have AIS onboard. By then, approximately 80% of vessels in traffic will carry AIS (Pettersson, p.c.). For such a major new technological system, including not only the individual units onboard ships, but also infrastructural support, the schedule of introduction is very tight indeed.

The AIS system is autonomous in the sense that it does not depend on central external sources of information for normal functioning (input from Vessel Traffic Services for example). Although, it does depend on the functioning of the AIS units of other ships, and the various sensors feeding into their units (in this sense, AIS is not as autonomous as radar technology).

Messages are continuously sent from the AIS system with a frequency determined by the current speed of the ship itself. Fast-moving ships transmit with a high frequency while ships at anchor only transmit now and then. A message contains the following information (IMO, 2001)\(^2\):

1. Name
2. Call sign\(^3\)
3. Length and beam
4. Type of ship
5. Position
6. Speed over ground (SOG)
7. Course over ground (COG)
8. Heading (gyro course)
9. Rate of turn
10. Destination (optional)
11. Estimated time of arrival (optional)
12. Ship’s draught (optional)
13. Type of cargo (optional)
14. Number of persons on board (optional)

The information entries 1-4 are static information, and is entered when the AIS unit is installed. Static information is only transmitted once every six minutes. The information entries 5-9 on the other hand are transmitted more frequently, depending on the speed and whether the ship is changing course, and are called dynamic information. For example, if a ship is at anchor, dynamic information is transmitted once every three minutes. If they are doing 0-14 knots without changing course, the information is transmitted once every twelve seconds, but if the ship is doing the same speed while altering its course, the information is sent out once every four seconds. Entries 10-14 are called voyage related

\(^2\)I have excluded some entries in of the AIS message for ease of presentation (IMO number, MMSI number and the location of the GPS antenna for example).

\(^3\)A ship’s call sign change with ownership and is assigned by a national agency. For example, ships under Swedish ownership are assigned call signs by the Swedish Maritime Administration. Swedish ships are assigned a four letter call sign, always with the first two letters ranging from SB to SM (Web page about the Swedish Register of Ships. Available on http://www.klubbmaritim.com/Sidor/skeppsreg.html (September 7, 2004)). Other countries have other ranges of letter combinations at their disposal.
information and are transmitted once every six minutes and can be entered (it is optional) at the start of a voyage and updated as required.

What then are the objectives of introducing AIS in the world of maritime transportation? This is what IMO (2001) has to say under the heading “OBJECTIVES OF AIS”:

“AIS is intended to enhance: safety of life at sea; the safety and efficiency of navigation; and the protection of the maritime environment. SOLAS regulation V/19 requires that AIS exchange data ship-to-ship and with shore-based facilities. Therefore, the purpose of AIS is to help identify vessels; assist in target tracking; simplify information exchange (e.g., reduce verbal mandatory ship reporting); and provide additional information to assist situation awareness. In general, data received via AIS will improve the quality of the information available to the OOW, whether at a shore surveillance station or on board a ship. AIS should become a useful source of supplementary information to that derived from navigational systems (including radar) and therefore an important ‘tool’ in enhancing situation awareness to traffic confronting users.” (IMO, 2001)

While AIS is supposed to function not only in a ship-to-ship mode, but also in a ship-to-shore mode, as a tool for Vessel Traffic Services (VTS) and for coastal surveillance by various agencies (various port authorities, the Coast Guard, and the police for example), I will here focus my presentation on AIS in the ship-to-ship mode, and AIS as a new technology on the bridge. It is clear this is the primary mode of operation in the eyes of IMO as well. Some of the objectives in the ship-to-ship mode then, is “to help identify vessels; assist in target tracking; simplify informational exchange […]; and provide additional information to assist situation awareness”. That this is at least possible effects of a working AIS system can be seen if we reflect on what AIS can do to help us deal with the problems highlighted at the end of the last section (1.1). There is no two minute update delay on the heading, speed and position information sent from other ships. Dynamic information is updated quickly and continuously (at a rate depending on the speed of the broadcasting ship). The identity of other AIS-fitted ships (name and call sign) will be readily available to the OOW (although she might have to wait six minutes before receiving that information). There are no target swaps between AIS targets and others, and finally, because of the longer wavelength of the radio communication, AIS makes it possible to “see around bends and behind islands”, which was not possible with radar technology (TRB, 2003, p. 20).

For AIS data broadcasted from ships to become information relevant for the OOWs on other ships however, it must be presented somehow. This have been done in several ways (TRB, 2003, p. 28-30).

- On a laptop computer
- On a Minimum Keyboard Display (MKD). This is the absolute minimum display requirement outlined in (IMO, 2001). The display should consist of “no less than

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4A VTS is the maritime equivalent of an air traffic control tower in the aviation transport system. Usually, VTS stations only have informational responsibility and authority though, they do not direct and control traffic. VTS stations are often located in ports where ships are required to report to VTS stations (via VHF radio) as they reach certain VTS reporting points. See section 3.2 and 3.7 for more information about VTS stations.
three lines of data consisting of bearing, range and name of a selected ship”. Ships are selected by scrolling a list.

- On an iconic display. This display provides a graphical representation of nearby AIS targets on, typically, a low-resolution monochrome display, as well as data alphanumerically for a specific ship icon.
- Integrated in an ECDIS display. AIS targets are displayed as triangles overlaid on the ECDIS chart.
- Integrated on a radar screen. AIS information can be toggled forth on top of the ARPA radar information. The AIS targets are displayed as triangles on top of/alongside the radar echoes (on top of, hopefully).

While the IMO naturally emphasises the advantages brought about by the introduction of AIS they do list some problems and limitations of the system in (IMO, 2001). For example:

- The OOW must be aware of the fact that other ships might lack AIS technology (for example leisure craft, fishing boats and warships), and that ships fitted with AIS might have their AIS unit turned off. AIS does not therefore necessarily give a complete picture of the traffic situation.
- Poorly calibrated or malfunctioning ship sensors (gyro, GPS, log) will cause misleading or erroneous information about the ship (heading, position, speed) to be transmitted and displayed on the bridges of other ships.

1.3 Some previous research on maritime work (but none on AIS)

No systematic study of AIS usage from human factors perspective (broadly construed) has been carried out so far. The most comprehensive overview of AIS and human factors considerations, Shipboard Automatic Identification System Displays: Meeting the Needs of Mariners (TRB, 2003), which focuses on requirements for display design states that while research on collision avoidance, information needs and the effects of new bridge technology have been carried out, no research has specifically targeted the use of AIS (TRB, p. 105).

Furthermore, most of the research on maritime work and technology have been carried out in the narrow trenches of human factors research concerned with quantitative measurements and modelling (I am basing this on my own reading as well as Grabowski and Sanborn's (2003) more thorough review of previous research). The focus is on measuring – for example – mental workload, navigational accuracy, or the number of rudder or engine commands, and relating these measurements to specific task analysis tools or cognitive models (Grabowski and Sanborn, 2003, p. 642). Empirical data is usually collected during sessions in navigation simulators. Now, I am not dismissing this work as irrelevant, but it has some inherent weaknesses and needs to be complemented with more naturalistic open-ended studies of maritime work.

In order to give a taste of the flavour of this major stream of research, as well as convey some of the conclusions drawn from it, I will present two snapshots from this tradition of research. I will then relate this work to what has become known as workplace studies,
which has grown out partly from a critique of the narrow factors-and-variables approach to human-machine interaction which the snapshots represent, and show why a workplace study approach to AIS use is needed.

Maritime navigation and technology
Most research on maritime navigation and technology has been concerned with the effects of automation. A relatively early study of automation on the bridge which is concerned with how tasks ought to be distributed between human operators and automation technology is Schuffel et al (1989). The study springs from the fact that the work involved in controlling and manoeuvring a ship is changing due to automation from being largely constituted by “active manual control actions” into being largely constituted by “passive monitoring activities” (p. 61). This is not a development endemic to the maritime world, but has been under way in all kinds of work practices. This is partly due to economic and production pressures, partly due to the fact that some error-prone tasks are thought to be better carried out by automation machinery than by human operators. However, Schuffel et al note that there are known problems connected with automation as well. Loss of vigilance and poor readiness to act could be the results of automation if the wrong tasks are automated, condemning operators to inactivity or to only perform boring routine tasks.

Schuffel et al (1989, p. 65) wanted to investigate “the feasibility of single-handed bridge operation in a conventional and an automated bridge” in order to address the potential problems of increased automation. A simulator experiment was designed where mental workload and navigational accuracy was measured. Measurements of mental workload (via performance of a secondary task) and navigational accuracy were assumed to reflect a “navigational safety” variable. There were three conditions in the experiment, (1) two officers working on a conventional (as of 1989) bridge, (2) one officer working on a conventional bridge, and (3) one officer working on a future (as of 1989) automated bridge (position estimation was automated and navigational information was integrated on a single display). The results showed that navigational accuracy was superior on the automated bridge (3) than in the other conditions (1 and 2). The mental workload of the navigation task in condition (2) was significantly higher than in the other conditions (1 and 3). This is an example of a relatively early study that tried to address problems of automation. The results indicated that despite these problems, automation can indeed to beneficial in terms of navigational safety.

Lee and Sanquist (2000), eleven years later, also address problems with automation and new technology, but employing a different method. They develop a cognitive task analysis tool in order to examine “the cognitive demands of collision avoidance and track keeping, with and without advanced technological aids” (p. 273 (abstract)). The task analysis of collision avoidance and track keeping activities where based on interviews and observations. The idea is by doing this task analysis, Lee and Sanquist has a functional specification of what is involved in the tasks investigated which they claim is

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5Read differently, Schuffel et al (1989) show that with the help of automation, shipping companies can save money by reducing the number of officers on the bridge while still retaining the same (low) level of navigational safety.
valid regardless of which technology is used. The steps and transitions of their models must be accounted for in real world navigation, whether by automation or by the human operator, in order to for the activities to be successfully performed. Armed with their models (represented by state-transition diagrams), they “apply” them to the use of ARPA radar and ECDIS systems in collision avoidance and track keeping.

Lee and Sanquist claim that their models explain some observed phenomena regarding the use of these technologies (and perhaps they do), for example the problem with safety zones in ARPA radar, and a tendency among mariners to make erroneous judgements about the scale of ECDIS charts (which are “zoomable”, unlike paper charts that are fixed at their “real” scale). But apart from this, they also seem to claim, on inductive grounds (from the explanatory success of their task analysis), that the task diagrams can be used in a predictive manner to anticipate “design flaws” and “training requirements”. While Lee and Sanquist's paper is rich in interesting examples and ideas, it seems to me that these are not really related to their the task analysis they have done, but rather to the observations of various effects of new bridge technology (the benchmark of their diagrams). Their more general claims about the utility of their state-transition diagrams for making predictions are doubtful. A similar, more sophisticated (or at least more intricate and complex) model building approach is Itoh et al. (2001), where they build and test a cognitive model of a watch keeper involved in simple manoeuvring, although without the explicit aim of investigating the effects of new technology, but in order to facilitate risk assessment in simple navigational scenarios.

These snapshots represent a quite common approach to human factors issues in world of maritime navigation (and in other technology-intense work sites for that matter). I will not claim that this kind of work is useless (it is not), neither that what I have referred to in any way indicates that the general standard of work in this tradition. The fact is though, that some of the assumptions underlying this approach and its methodology have received a lot of critique lately, and alternative avenues of research have opened up.

Workplace studies
There has been a growing dissatisfaction with more traditional approaches in Human-Computer Interaction research and human factors, as well as a growing number of workplace accidents related to the introduction of new technologies. These accidents have according to Heath and Luff, thrown “into relief how little we know of the ways in which tools and technologies, ranging from pen and paper through to complex multimedia workstations, feature in day-to-day organisational activities” (2000, p. 4). In the face of this glaring knowledge gap, there has been a proliferation of what Heath and Luff (2000, chapter 1) call 'workplace studies'. Workplace studies are (1) “naturalistic, consisting of ethnographies based on extensive fieldwork”, (2) “concerned with explicating the situated character of practical action”, (3) “with taking the orientations of the participants themselves seriously”, (4) “with examining how participants co-ordinate their activities with each other, and [finally, (5)] with explicating the indigenous resources on which they rely” (p. 18). Studies done within a number of theoretical frameworks fit this characterisation (for example, distributed cognition, activity theory, cognitive engineering, and ethnomethodology and conversation analysis). The differences
between these frameworks are less important than what the work done within them have in common. Studies have been conducted at a variety of workplaces where technology plays a major role, for example air traffic control (Goodwin and Goodwin, 1996), a London Underground control room (Heath and Luff, 2000), medical practice (Cook and Woods, 1996), engineering practice (Rogers and Ellis, 1994), an air plane cockpit (Hutchins, 1995b), work in a refrigerated warehouse (Kawatoko, 1999), as well as the bridge of a navy ship (1990, 1993, 1995a) and work on fishing boats (Hazlehurst, 1994).

While the methods used by the kind of human factors work done by Schuffel et al (1989), Lee and Sanquist (2000) and Itoh et al (2001) might provide some knowledge of the kind of problems experienced by users of technology in highly artificial situations, they will not provide any reliable knowledge about problems experienced by practitioners when using these or similar technologies in situ unless more knowledge about those real world work practices are gained (Rogers and Ellis, 1994, p. 120). The knowledge which has been gained about in situ work practices have pointed out some problems with the experimental factors-and-variables approach. Task analysis approaches often miss important but taken-for-granted informal working practices, such as, for example, the sharing of information through inadvertent overhearing of the conversations of colleagues (Roger and Ellis, 1994, p. 121; Norros and Hukki, 1998, p. 86). Ethnographic studies of work, which trace the seemingly trivial and mundane organisation of everyday activities, are instrumental in getting informed about such informal working practices, not easily captured by task analysis methods which require individuals that perform discrete actions in a sequential manner.

As Woods and Roth (1988, p. 418) point out, in particular, studying the adoption and use of new tools is a fruitful way of understanding the demands of a specific work practice and meanings that populate what they call people's “natural problem-solving habitats”:

“...quite a lot could be learned from examining the nature of the tools that people spontaneously create to work more effectively in some problem-solving environment, or examining how preexisting mechanisms are adapted to serve as tools, [...] or examining how tools provided for a practitioner are really put to use by practitioners.” (1988, p. 418)

The basic idea is that people and organisations are not merely passive infinitely plastic recipients of technology but are active transformers of technologies as much as they are adaptive users (Cook and Woods, 1996). Such dynamics are completely missing from Lee and Sanquist's (2000) approach to predicting the consequences of new technologies and anticipating design flaws. Of course, even if engineers and designers are armed with whole libraries of thick ethnographies, they might still not be able to predict and anticipate what consequences a specific technology might have. Detailed knowledge of a practice might at least help us to understand what disruptions new technologies will cause in current working practices, even if it will not help us do predict how people will deal with and adapt to these disruptions (Rogers and Ellis, 1994).

In a way, maritime navigation has been a prominent working practice in the “field” of workplace studies, due to Hutchins' much cited and referred study of team navigation work at a navy vessel (1990, 1993, 1995a). This work also provided much of the initial
motivation for me to both to study maritime work in this thesis project, as well as providing important parts of the theoretical backdrop. One of Hutchins' doctoral students also made similar work, but this time on-board fishing boats off the west coast of Sweden. Both Hutchins' and Hazlehurst's studies are very much concerned with the role of technology in maritime work (whether navigation or fishing), but their field sites differs much from my own (as well as from each other's). Hazlehurst do not focus much on navigation per se, and the navigation work documented by Hutchins was performed by a whole team, utilising much more basic technologies than the ones existing on the bridges I visited. On those bridges, the navigation work was usually carried out by one, sometimes two, persons, with the help of quite sophisticated electronic navigation aids (ECDIS, ARPA radar, AIS). Of course, the most important difference is that there was no AIS when Hutchins and Hazlehurst performed their fieldwork.

Some detailed descriptive work within conversation analysis has been done on the features of VHF communication as well (Pritchard and Kalogjera, 2000; Sanders, 2003), although these studies have been focused on issues of interest endemic to conversation analysis and have not related the communication to the work of navigation.

Finally, I want to cite what Shipboard Automatic Identification System Displays: Meeting the Needs of Mariners (TRB, 2003) had to say about research on the use of AIS:

   “Although several researchers have investigated mariner collision avoidance and navigation strategies and information needs [...], no one has systematically evaluated how AIS can support these and other information needs.” (TRB, 2003, p. 105)

While one chapter of the report (TRB, 2003) is devoted to an analysis of general requirements on AIS display design (chapter 4), one to reflections on human factors issues (chapter 5), and another devoted to anecdotal input from various early AIS projects (chapter 3), the report do not rest on any empirical research of actual AIS use.

1.4 Research aims/questions

The aim of this thesis work was to look at the actual use of AIS, as opposed to the prescribed or intended use. Since AIS is a technology in its infancy, this can be seen both as a contribution to an evaluation of the technology that exists today, and as fieldwork potentially contributing to the design of the AIS technology of tomorrow.

As a recent report from the US Transportation Research Board (TRB, 2003) states, understanding the work context of the bridge in which AIS is embedded is an important step toward designing AIS into a system that provides not only data, but information of relevance for making decisions about navigation.

   “Understanding mariners’ information needs and how they vary, therefore, is an important first step in developing requirements or standards for shipboard display of AIS information.” (TRB, 2003, p. viii)

However, this is not a thesis in interaction design, although it could, I think, inform such a thesis in interesting ways. The focus is to the describe how mariners have adopted AIS

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on the bridge, what problems they have encountered, what gains they having experienced using the technology and so forth. The aim of my ethnography was thus to study how mariners' have “made the technology their own”\(^6\). This open-ended research aim necessarily make the thesis an exploratory one.

\(^6\)I have nicked this phrase from a paper by Paul Dourish (1999), where he discuss what he calls appropriation: “Appropriation is what happens when a group 'makes a technology its own'. This often takes the form of unexpected or unanticipated uses of technology, although it can also mean the development of novel practices organised around the specific opportunities offered by a technology” (p. 1).
2.0 The natural history of my research

When I started working on this thesis I saw the introduction of AIS in maritime navigational practice as an ideal domain for looking at the impact of new technology on work practice. While the practice was entirely alien to me at the time, I knew that it was both a very old work practice with a long tradition behind it (unlike aviation work for example) as well as a practice presently depending on a lot of highly sophisticated technology. I also knew that a lot was at stake in the work practice – money, the environment, human lives – and suspected that trying to understand the use of technology in this domain would be crucial for improving safety at sea, as well as being an interesting enterprise in itself.

The doing and writing of this ethnography has been the outcome of a constant struggle between my methodological and theoretical interests, and my encounters with the real world of maritime navigation. In the beginning, my intention was to study the implications of the use of AIS on mariners’ interpretation and application of the COLREGS. However, this goal was abandoned for several reasons. First of all, AIS was a recent technology, not in widespread use, so the implications of AIS-use on the COLREGS were likely to be very insignificant. Secondly, I found that it would be very difficult too observe the interpretation and application of any rule of the road. When starting out, I was under the assumption that navigating a large ship was carried out by a team on the bridge. If this had been the case, then interpretations and negotiations of how the rules were to be applied would perhaps be carried out openly in conversations between members of the navigation team (this was my hunch at least). Partly, this assumption was perhaps induced by my reading of Hutchins' *Cognition in the Wild* (1995), a major source of inspiration for starting on this thesis. However, I found that navigating a ship was to a large extent a solitary affair and the conversations between crew members on the bridge rarely touched on navigation at all, let alone the COLREGS in particular. As is common to ethnographic fieldwork, the initial focus of research envisioned for this thesis was thus found to be based on erroneous assumptions. This illustrates an important advantage of the ethnographic method, not a disadvantage. Experimental approaches that study cognition in the captivity of the laboratory runs the risk of exploring problems and topics which are irrelevant, or solved by very different means, outside the laboratory.

After giving up on investigating the impact of AIS on the Rules of the Road, I briefly considered an exclusive focus on another topic, the development of trust in the adoption of AIS. However, I found that most of the theoretical work on trust had little to say about the data I had already collected at that point, and it was difficult to combine with my methodological approach, which I wanted to keep (for an example, see Lee and Moray (1994)). I finally decided for the more general research focus presented here.

The rest of this chapter is a presentation of the theoretical and methodological starting point of this project. Theory and methodology are here tightly coupled. The theory provides some underpinning for adopting ethnographic method in cognitive science, and
the findings of ethnographic studies has been a cornerstone in building the kind of
cognitive theory I favour here.

2.1.0 Theoretical perspectives

2.1.1 Distributed cognition
The first and foremost theoretical framework in which I imagined this project were that
of distributed cognition. I will briefly lay out the basic claims of distributed cognition in
this section. The most immediate and interesting consequences of taking a distributed
cognition view on things are methodological. I will first lay out the theoretical rationale
for taking this view, and thus indirectly provide a rationale for my methodological
approach. Discussion about the latter can be found in the Methodology section (2.2).

The core idea of distributed cognition is to dust off the old symbol-shuffling view of
traditional cognitive science by applying it to a new unit of analysis (Hutchins, 1995b, p.
266). The “old” – but still popular – unit of analysis in cognitive science is the mind of
the individual agent enclosed in the “biological skin-bag” (to use Clark's (2001)
wonderful image). Distributed cognition takes the unit of analysis to be cognitive
systems, delimited by functional relationships between system components. Whether
these components are within or outside human bodies, made up of neural tissue, paper,
perturbations of molecules in the air, or pixels on a digital display, is left unsaid. Thus,
neither the boundaries of the unit of analysis, nor the type of mechanisms involved in
cognitive processes are set by any special physical or biological properties (Hollan,
Hutchins and Kirsh, 2000).

Perhaps the best way to illustrate the radical shift of focus made in distributed cognition,
as well as the framework's fidelity to the symbol-shuffling roots of the cognitive
scientific enterprise, is to retell Hutchins' (1995a, p. 356) story of “How Cognitive
Science Put Symbols in the Head”. The story, I believe, de- and re-constructs the self-
image of cognitive science in a very illuminating way. According to the “official” story
of cognitive science, the computer was made in the image of the human mind. Reasoning,
formalised in symbolic logic and mechanised in computers, was after all seen as the
primary activity of the human mind. But, as Hutchins point out, the kind of reasoning
done with symbolic logic was actually – at least originally – the activity of an extended
social and technological system, not the activity of an unencumbered mind or brain:

“Originally, the model cognitive system was a person actually doing the manipulation of the
symbols with his or her hands and eyes. The mathematician or logician was visually and manually
interacting with a material world. A person is interacting with the symbols and that interaction does
something computational. This is a case of manual manipulation of symbols.

Notice that when the symbols are in the environment of the human, and the human is manipulating
the symbols, the cognitive properties of the human are not the same as the cognitive properties of the
system that is made up of the human in interaction with these symbols. The properties of the human
in interaction with the symbols produce some kind of computation. But that does not mean that
computation is happening inside the person's head.” (Hutchins, 1995a, p. 361)

Hutchins emphatically concludes: “The physical symbol-system architecture is not a
model of individual cognition. It is a model of the operation of a sociocultural system
from which the human actor has been removed.” (Hutchins, 1995a, p. 363) The work of
the navigation team investigated by Hutchins (1990, 1995a) is in many respects similar to
the original model cognitive system of the logician interacting with tools and symbols
according to Hutchins, and hence the idea of a physical symbol-system (Newell and
Simon, 1976) is useful for describing this work. It is a bit unclear how strongly Hutchins
identifies distributed cognition with the PSS framework, and whether he believes
distributed cognition to be a theory of sociocultural systems in general or only of a
symbol-shuffling subclass of such systems. I will allow myself to use “distributed
cognition” more loosely though, to refer to a general perspective on cognition as the
activity of systems larger than the individual human brain or body, involving other
individuals, artefacts and other environmental structures. Sometimes, this distributed
activity is fruitfully couched in the language of physical symbol-systems, sometimes it is
not. Sticking to the case of systems involving a lot of symbol-shuffling, one big
methodological advantage is the possibility of stepping inside the cognitive system and
actually observing the public flow of information in the system (de Léon, 2003, p. 15,
Hutchins, 1995a, p. 128-9, 1995b, p. 266). Of course, not all information-flow is public
and even if it is public in some sense, it might be difficult to notice and interpret by an
observer of the system.

Hollan, Hutchins and Kirsh (2000) claim that when human activity is looked upon from a
distributed cognition perspective, three general kinds of distribution of cognitive
processes become visible:

- “Cognitive processes may be distributed across the members of a social group.
- Cognitive processes may involve coordination between internal and external (material or
  environmental) structure.
- Processes may be distributed through time in such a way that the products of earlier events can
  transform the nature of later events.”

(Hollan, Hutchins and Kirsh, 2000, p. 4)

Social distribution
The distribution of cognitive processes across participants in an activity gives rise the
insight that “social organization may itself be viewed as a form of cognitive architecture”
(Hollan et al., 2000, p. 4)8. By saying that cognitive processes are socially distributed in
this way, one is not simply saying that different cognitive tasks are handled by different
people but that the cognitive processes themselves unfold between people. Such an
insight highlights questions such as:

“1) how are the cognitive processes we normally associate with an individual mind implemented in
a group of individuals, 2) how do the cognitive properties of groups differ from the cognitive
properties of the people who act in those groups, and 3) how are the cognitive properties of
individual minds affected by participation in group activities?” (Hollan et al., 2000, p. 4)

7 In Hutchins (1995a, p. 363) and (1996, p. 67), distributed cognition seems to be a framework restricted for
description of a subclass of sociocultural systems, but in Hollan, Hutchins and Kirsh (2001), “distributed
cognition refers to a perspective on all of cognition, rather than a particular kind of cognition” (p. 3).
8 In Hutchins study of team navigation (1990, p. 208, 1995a, p. 199), he actually suggests that coordination
of different crew members could be fruitfully be modeled with a production system architecture (such as
ACT or SOAR)!
The first and last question will not concern us much; they are outside the scope of this thesis, although they are obviously important for cognitive science in general (see (Clark, 2001) for an inspiring summary of how those two questions might be answered). The second question, about the difference between the cognitive properties of extended cognitive systems and those of sole actors embedded in them, will be relevant when we discuss the role of AIS communication in coordinating maritime traffic.

Agent-environment coordination
What about the second kind of distribution, the one between internal and external structures? The central idea here is that artefacts (broadly construed) transform the set of cognitive abilities involved in the performance of tasks. This idea contrasts with the more commonly made claim that artefacts amplify or enhance certain cognitive abilities (Norman, 1991, p. 19, Hutchins, 1995a, p. 155). A few artefacts of course, fit this amplification view. Norman (1991, p. 19) gives the example of a megaphone that amplifies a person's voice to reach over greater distances. This is a straightforward case of amplification. Most artefacts however, do not have such an amplification effect, but rather change the set of cognitive subtasks required to solve certain problems. Norman (1991) illustrates this by asking us to consider the case of a checklist (or “to-do” list). From the perspective of an outside observer – “the system view of the artefact” (p. 20) – the list seems to be a memory aid. The person-plus-list system do not forget to do certain actions as often as the person-without-list. From the system view then, the list does seem to amplify memory. If we switch perspective on the other hand, to “the personal view of the artefact” (p. 21), we see that the list does not amplify memory at all, it simply transform the set of abilities and subtasks involved in achieving some goal state, or performing some task. Memory is not enhanced; it is made redundant (although we still have to remember to use the list). Other cognitive abilities are called for instead, such as reading and interpreting list-items. In many cases (but far from all, or usability engineering wouldn't be a thriving field), these abilities are the ones that human beings are quite good at. By putting our own cognitive resources into interaction with artefacts, props and aids, we can achieve tasks that would be extremely difficult if performed without them. While our “naked” cognitive profile is essentially “Good at Frisbee, Bad at Logic”, with the help of pen and paper (and a few thousand years of cultural evolution), we can still do pretty good at logic (Clark, 2001, p. 133). The problem with the amplification view of cognitive artefacts is that it mistakes the cognitive properties of the person-artefact system for the cognitive properties of the person herself. According to distributed cognition however, the boundaries of the person is not the boundaries of mind (see Latour's review (1996) of Cognition in The Wild, and Hutchins' reply (1996) for an interesting discussion of this issue).

Distribution in time
Finally, cognitive processes are distributed in time at several levels. The moment-to-moment microgenesis of thought is embedded in the ontogenesis of individuals, in turn embedded in the sociogenesis of practice and culture. Since the mind, according to distributed cognition, extends beyond the brain and body to the cultural artefacts around us, culture and history shapes cognition. Hutchins uses the concept of “precomputation” (1995a, p. 164) to capture the way artefacts re-distribute cognitive work over time. Going
back to Norman's example of a cognitive artefact, a checklist, the preparation and construction of the checklist is a cognitive task that can be performed way ahead of the point were we will use the checklist. This allows us to do the task at a suitable time when we are not under any time pressure. In addition, when the task was made, it could be copied and distributed to anyone who needed it (Norman, 1991, p. 21). de Léon (2003, p. 13, 21) points out that this type of cognitive distribution (de Léon particularly talk about the “biographies of things”) is an understudied component of the distributed cognition framework. De Léon thinks that this is rooted in the methodological problems besetting the study of the historical dimensions of human cognition (p. 21-2). One either has to do costly longitudinal studies or engage in speculative historical reconstruction. Another obvious kind of distribution of cognitive work over time is learning processes, both at the individual and at the organisational level.

I will not do anything to amend the relative neglect of the role of cognitive distribution over history. In this thesis, the most interesting kind of cognitive distribution occurs between ships, as we shall see later. The role of the AIS artefact in maritime navigation is of course the overarching focus of the thesis so the role of external resources in cognitive processes are important as well.

2.1.2 Communication and common ground

Of obvious importance to the kind of social distribution discussed above is linguistic communication and sharing of knowledge. I will use Herbert Clark's notion of common ground and communication as joint or collective action to get a grip on the nature of the social distribution of cognition (Clark, 1992, Clark, 1996, Clark & Brennan, 1991). The basic idea is that it takes at least two people to use speech or any other kind of medium for communication. To successfully mean things to each other they need to engage in cooperative work. They need to establish, and continually monitor, a common ground in order to understand one another. The common ground is the set of “mutual knowledge, beliefs and assumptions shared by the speaker and addressees” (Clark, 1992, p. 81). When people speak – through the air or through a VHF-radio link – they design their utterances in light of the common ground of themselves and their audience(s). Clark refer to this process by which audiences shape utterances directed to them as “audience design” (1992, p. 201). The audience here might consist of both the primary other participant, the addressee, and various side-participants of the communication. In addition, various overhearers might be present. These might be openly present bystanders or eavesdroppers whose presence is unknown to the speaker. In the case of maritime navigation both the activity of navigation and activity of VHF-communication between ships can be seen as joint activities, one nested within another.\(^9\) VHF-communication can take place between a speaker and an addressee, or sometimes, between a speaker and several addressees. Since VHF-communication is taking place publicly, other ships often listen in on exchanges. Whether these vessels are considered to be side-participants,

\(^9\)For example, the theories of the philosopher David Lewis and the economist and social theorist Thomas Schelling have been used to describe both collision avoidance (Cannell, 1981) and language use (Clark, 1992, 1996; Clark and Brennan, 1991) as a problem of coordinating actions.
bystanders, or eavesdroppers will, according to Clark's idea of audience design, will likely influence the way VHF calls are formulated.

Clark (1996, p. 45-7) points out, very much in line with distributed cognition, that external representations are powerful devices of coordination, helpful in keeping track of common ground. In fact, from a distributed cognition perspective external representations can be seen as a form of common ground. In the context of this thesis, the information provided by AIS might be seen as a form of common ground for ships fitted with AIS.

2.2 Methodology

2.2.1 (Cognitive) ethnography

Given my interest in the actual use of AIS at bridges (and to some extent, VTS stations) and my lack of domain knowledge, an ethnographic approach followed naturally. I am interested in situated cognitive activities unfolding on – and between – bridges and the role played by AIS and other technologies in structuring these activities. This wide and elastic unit of analysis requires, at least initially, a large amount of observation and description.

As an ethnographer, my primary goal is one of learning about work on the bridge(s) and the role of AIS in (changing) that work. This goal contrasts with that of mainstream cognitive (and social) science, according to which scientists are not in the learning business but in the business of testing hypotheses (Agar, 1996, p. 113-9; Silverman, 2001, p. 43).10 While my aim was never to put any explicit hypothesis to test, a hypothesis, which was tentatively tested, emerged toward the end of my fieldwork (see section 4.1.2). The character of this thesis is still exploratory and descriptive though. This character follows from the research questions I pose, not from the fact that I use ethnographic method or from the fact that I adhere to a certain theory of cognition. Contrary to popular belief (in some quarters), qualitative method such as ethnography is not necessarily limited to exploratory and descriptive research (here I am following Silverman, 2001).

There are (at least) two reasons for doing “merely” descriptive and exploratory studies. In the context of technology and work, one reason is that observation and description is often the only possible means of finding out about new unanticipated use patterns of technologies (Hollan et al, 2000, p. 8-9). These new use patterns are important because they can inform designers about what technologies mean (what roles they play) in the activities in which they are embedded. Being informed about actual usage is obviously important for designers since it reveals something about the needs and demands of the users. Another reason for doing research in a descriptive/exploratory mode is supplied by the theoretical insights of distributed cognition. I quote Garbis (2002) at length:

10Some philosophers of science conceives of even exploratory ethnographic research as a form of hypothesis testing though (Johansson, 2003), and a prominent view within developmental psychology is that learning is the activity of generating and testing hypotheses (Gopnik & Meltzoff, 1997).
"These differences between the study of the individual mind and that of cognitive systems, in combination with our poor knowledge of how socio-technical cognitive systems function, imply that we should take a rather humble approach when it comes to methodology. As a consequence it seems only reasonable that our initial method should be that of observation and description. Describing the seemingly trivial aspects of actions and interactions between the people in a cognitive system, as well as the way they use cognitive artifacts, is the primary method adopted by distributed cognition. […] The fact that we start out with a description of the object of interest is also the reason why distributed cognition should be conceived as a descriptive framework rather than a predictive one, something which critics all too often fail to recognize.” (Garbis, 2002, p. 78)

A descriptive approach dovetails appropriately with my adopted theoretical perspective in distributed cognition. This is not a coincidence of course. My choice of research problem, theory, and methodology emerged in parallel, mutually constraining each other. The focus of the thesis is the activities on the bridge, not the theory I have used to organise my inquiry. Other theoretical frameworks than distributed cognition would probably work equally well for my purposes. The particular choice of distributed cognition simply reflects my educational background in cognitive science. But what is special about ethnography done within the theoretical framework of distributed cognition?

Hollan et al (2000) describe cognitive ethnography, i.e. ethnographic research within a distributed cognition framework, as an “event-centred” ethnography. Cognitive ethnographers are interested “not only in what people know, but in how they go about using what they know to do what they do” (Hollan et al, 2000, p. 6). To more precisely pinpoint how the theory of distributed cognition is supposed to guide and organise ethnographic inquiry is difficult though (and the literature on distributed cognition does not give much help here I am afraid). Perhaps the best way to do this is by giving a full-fledged demonstration, rather than by putting forth a few thin principles of cognitive ethnography. The proof is in the pudding, as the saying goes. However, Hollan et al (2000) give some clues. They present four core principles of cognitive activity identified by distributed cognition:

-people establish and coordinate different types of structure in their environment
-it takes effort to maintain coordination
-people offload cognitive effort to the environment whenever practical
-there are improved dynamics of cognitive load-balancing available in social organization. (Hollan et al, 2000, p. 8)

These principles are supposed to organise the ethnography by directing the attention of the ethnographer and by foregrounding certain aspects of the activity and the setting under study. Hollan et al (2000, p. 8) mention “information flow, cognitive properties of systems, social organizations and cultural processes” as phenomena that generally merit special attention. In many cases, the processes and interactions picked out by these principles occur at a moment-to-moment time-scale and are difficult to document adequately without the help of video- or, minimally, audio-recording. Such techniques are therefore (or should be) prominent in work within distributed cognition (Hollan et al, 2000, p. 6). However, cognitive ethnography is not tied up with a specific research technique. Depending on the research questions one poses and the means available, different research techniques are appropriate.
Exactly how one should use these core principles in the note-jotting fieldwork is far from clear, and a lot, I think, simply up to what the ethnographer find interesting at the moment. Mainly, the core principles are used in the analysis of fieldwork notes. Some researchers distinguish between open data-driven ethnography and more formal theory-driven ethnography, guided by specific analytical frameworks. Baszanger and Dodier (1997, p. 19) for example, distinguish between formal in situ studies exemplified by work in conversation analysis, ethnomethodology, and situated cognition, and in situ studies “grounded in a specific context (cultural, historical, etc.)”. However, this ethnographic study does not fit comfortably in either category. Part of what drove me into facing my research questions and the specific domain of maritime work was certainly the formal theory of distributed cognition, but my in situ observing and interviewing have to a large extent been ‘grounded in the specific context’ of whatever was happening on the bridge. Informal interviews thus often strayed away from topics of special relevance for distributed cognition.

In my fieldwork, I have been relying on observations and informal interviewing. I used a notebook, a digital camera, and a Mini-Disc recorder to record observations and interview talk. I view my informal interview data as primary. Most of the data presented in this thesis was gathered from informal interviewing – or merely talking – at the bridge. I thus follow Agar (1996, p. 157) in taking “the transcribed informal interview as the methodological core” of ethnography. My observations were of great importance too, but mainly in virtue of the way in which they situated the informal interviews. The relation between observation and interviews is a hotly debated topic among qualitative researchers (mainly because of different views on how to interpret interview data), but my (and Agar’s) stance is probably the default one – if not in theory, then at least in practice. As Silverman remarks, “ethnographers have not always been as keen to use their eyes as well as their ears.” (2001, p. 61). I have not used the photos I took with my digital camera in this final ethnographic product; they mainly functioned as cognitive scaffolding for my own reconstructions of episodes from the field.

Why did I not use a video camera to record the activities on the bridge? From my adopted theoretical point of view, this certainly seems like the natural thing to do. However, there is also a pragmatic point of view (partly adopted, partly forced upon me). Since the domain was largely alien to me, a large part of the fieldwork was geared towards familiarising myself with what (in a broad sense) was going on at the my field sites. Video-material would also have been very time-consuming to analyse, and I judged that field notes and audio-material would be enough for my purpose. Additionally, the

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11Emerson et al (1995, p. ix) points out that discussion about the process of writing of ethnographic fieldnotes has – until recently – been curiously missing in the anthropological literature. Partly, they suggest, because “ethnographers are often uneasy or embarrassed about fieldnotes” (p. ix)! Most methodological discussion instead focus on how to go from fieldnotes to finished ethnography.

12For a good example of a formal in situ study, see (Lave et al, 1984). Hollan et al's (2000) conception of cognitive ethnography is clearly in line with Baszanger and Dodier's characterisation of situated cognition as a formal theory-driven ethnographic approach. They write that “in general, we give pride of place to the principles of distributed cognition, for it is these that inform experiment, ethnographic observation, and design of work materials and work places.” (Hollan et al, 2000, p. 8).
presence of a video camera would perhaps have made crew-members uneasy, especially without me having gained their trust beforehand. However, video-material could certainly have helped me in order to capture the interactional detail of what was going on at the field sites (this detail is to a large extent lost – or at least very difficult to capture – using only your own sense organs and mundane artefacts like pen and paper). A continuation of this study could, with the help of a video camera, focus in more detail on the key tasks, activities and episodes identified here.

The time constraints and my (initial) lack of domain knowledge have certainly conditioned my ethnography in other ways as well. According to Hollan et al, in cognitive ethnography “there is no substitute for technical expertise in the domain under study.” (2000, p. 6; also de Léon, 2003, p. 15n11). While my ethnography is no substitute for a full-blown ethnographic study by a former mariner, it is a first attempt to look at the use of the AIS technology by ethnographic means. If looked upon in the context of interaction design/CSCW, I have done a combination of ‘quick and dirty’ and ‘evaluative’ ethnography (Hughes et al, 1994). My ethnography is ‘quick and dirty’ not because it has been sloppily and hastily carried out but given the research task I have set myself upon, the amount of time spent on the field (i.e. on the bridge) has been very small. It could also be characterised as evaluative since I have not been looking at maritime work prior to the implementation of AIS to inform the design of the system. I have rather attended to the actual use of the technology in maritime work, and my “data” could be used to see in what ways (some of) the aims of the introduction of AIS has been achieved (or not).

As I have already mentioned, one of the advantages of the wide unit of analysis of distributed cognition is that it becomes possible to “step inside the cognitive system” (Hutchins, 1995, p. 129; also 1995b, p. 266). In light of this advantage, it is no surprise that a lot of ethnographic work done from a distributed cognition perspective has been concerned with how groups of people do cognitive work aided (or hampered) by extensive linguistic communication and use of various external representations (De Léon, 2003). As De Léon (2003, p. 15) puts it, “[t]he communication between members engaging in joint work opens up a window through which the researcher can gaze”. When, on the other hand, “the relatively shuttered mind of a discrete individual” (ibid.) is the object under study, the advantage of a widened unit of analysis is less easily cashed out. Now, I have certainly not been studying ‘a discrete individual’, but the work practice I have been observing has contained less linguistic communication between crew members for example the team navigation work described and analysed in (Hutchins, 1990, 1995). This circumstance has contributed to my heavy reliance on interview data.

2.2.2 The unit of analysis
I have already mentioned that an important shift of perspective brought about by distributed cognition is the widening of the unit of analysis from the individual mind/brain to larger systems involving both brain, body and world. But once we reject the skin and skull as boundaries of our unit of analysis, what are the boundaries of our unit of analysis? Hollan et al (2000) gives the following (dauntingly) abstract characterisation of the unit of analysis in distributed cognition:
“Distributed cognition looks for cognitive processes, wherever they may occur, on the basis of the functional relationships of elements that participate together in the process. [...] In distributed cognition, one expects to find a system that can dynamically configure itself to bring sub-systems into coordination to accomplish various functions. A cognitive process is delimited by the functional relationships among the elements that participate in it, rather than by the spatial co-location of the elements.” (Hollan et al, 2000: 3)

This provides an abstract theoretical tool with which to engage the nitty-gritty details of whatever part of the social world we are studying. What does the tool pick out from the domain under study? What is the unit of analysis in the domain of maritime navigation and AIS-use? The short answer is that finding this out is really what the whole research process is about. By filling out the conceptual framework of distributed cognition with concrete mundane detail – by “ascending to the concrete”13 – one is carrying out the actual data analysis, while at the same time explicating the theory (this process, I believe, is what is characteristic of descriptive frameworks, as opposed to predictive theories).

Not only is the unit of analysis widened spatially from the individual mind/brain to a larger set of objects (artefacts, other individuals) but it is also made elastic (Garbis, 2002: 80, see also Hutchins, 1995a: 292). What is studied is activities, not objects, and the set of components involved in the functional systems we are interested in varies. For example, when looking at ship navigation, sometimes the unit of analysis might only encompass the bridge and the people working there, sometimes the unit of analysis might also include the interaction with other ships or shore stations; it all depends on the questions we pose and the currents of information flow in the systems under study.

2.2.3 Participant observation

As Hammersley and Atkinson point out, in a minimal sense, “[a]ll social research is founded on the human capacity for participant observation” (1995: 21). If we want to observe a social activity, we are bound to – at least in a minimal sense – participate in it. By saying I made participant observations, I simply mean that I openly, as opposed to secretly, made observations in natural settings. The amount of participation was low, I didn't actually engage personally in maritime navigation or communication. I participated by being an obvious actor on the bridge; asking and answering questions, pointing, making requests and occasionally fiddling with bridge equipment.

There are different roles one can take as a field researcher, deliberately or not. Each role has different sets of advantages and disadvantages, varying according the setting being researched. Hammersley and Atkinson (1995: 104) reproduces a helpful scheme devised by Junker (1960: 36) to conceptualise the different roles of field researchers. The different roles indicate different levels of involvement in the social activity being observed on the part of the researcher. Junker distinguishes “between the 'complete participant', 'participant-as-observer', 'observer-as-participant', and 'complete observer’” (Hammersley and Atkinson, 1995: 104). In the case of maritime navigation, the example

13A participant at the 2nd Nordic Baltic Conference on Activity Theory and Sociocultural Research in Ronneby, September 7-9, 2001, whose name I have forgotten, used this suggestive phrase to characterise the final stage of data analysis in Activity Theory research. Anyway, the phrase stuck.
of a 'complete participant' researcher is a mariner working on the bridge, secretly engaged in ethnographic inquiry. The 'complete observer' on the other hand, would be an observer hiding from view on the bridge, silently studying the navigational work. Obviously, the “choice” of role on the field made by myself was to a significant degree shaped by my lack of time, money and knowledge, as well as by ethical considerations. Adopting the role of 'complete participant', 'participant-as-observer' or 'complete observer' were simply not available options. Without extensive training, there was no way in which I could adopt the role of a regular participant on the bridge, and without such a role on the bridge, it would be impossible to do observations secretly. Hammersley and Atkinson (1995: 109) stress that it is desirable if the ethnographer is able to shift roles during research, in order to understand the way in which different roles give access to, and shape, different kinds of data. My ability to do this was extremely limited, but I sometimes played more ignorant than I actually was, in order to get more detailed and spelled-out data from my informal interviews (occasionally, I also played less ignorant than I actually was, simply to avoid feeling embarrassed).

2.2.4 Interviews

As I have already mentioned, the great body of my collected data consists of accounts from informal interviews with mariners. There are well-known problems with using interviews in social research. The paramount problem concerns the relation between the accounts of interviewee's and the world described in those accounts (Hammersley and Atkinson, 1995: 124-6, 139-40, Miller and Glassner, 1997: 99, Silverman, 2001: 86). In general, I have adopted a rather naive naturalism in my treatment of interview data. Although I grant that the relation between accounts given by the interviewees and what they describe are problematic, unless one can elaborate on this by showing how the accounts relate to the world they describe, I believe little is won by insisting on this problem. My interest has mainly been in the world of maritime navigation described by my interviewees, rather than the accounts they give when queried about it. When I have had data that allowed me to say something about the relation between accounts and the world described I have done so, but often this has not been the case and so I have treated my data as unproblematically representing the world outside the interview context. I agree with Hammersley and Atkinson's (1995: 156) sober conclusion that “accounts produced by the people under study [...] can be used both as a source of information about events, and as revealing the perspective and discursive practices of those who produced them”. Generally though, the interviewee's accounts has been treated as “a source of information about events” (especially accounts that has provided me with general background knowledge about the domain, rather than questions posed in order to probe some hunch or working hypothesis).

In addition to the informal interviewing carried out during participant observation, I conducted interviews with the mariners in less informal settings than the bridge, such as in cabins or offices on the ships. Sometimes these were arranged in order for me to ask important questions I had forgotten during the participant observation, to straighten out unclarities, follow up topics touched upon during the observation, et cetera. The 'less informal' interviews I did on the last ship visit (S4) were a bit different than the earlier ones. Before this visit I had found a topic that I found really interesting, the
potential loss of public information on the open VHF-channel, and decided to probe it with the help of some navigation scenarios during the interviews.

The scenarios
The scenario presentation consisted of a simple white A4 paper with schematic coast lines and ships drawn upon. There was two scenarios (scenario 1 and 2, see Appendix A), the first was a basic set up with three ships (ship A, B, and C), and the second had two additional ships (without any letter tags). Both scenarios took place on the same chart, with arrows pointing to four different ports (“Norrhamn”, “Östhamn”, “Sydhamn” and “Västhamn”). Ship A and C have AIS units onboard, ship B does not (although this is not initially apparent in the scenario).

Scenario 1:
- The interviewee was first presented with scenario 1. He was then instructed to imagine himself being OOW on ship B with “Västhamn” as his destination (see complete instructions in Appendix A). Since ship B did not have an AIS unit, the interviewee was not aware, at that point, that ship A and C did have AIS and access to the information it provides. The question then posed to the interviewee, was simply: “What do you do?” with the added instruction: “Please tell it in the present tense, as if it was happening now. Please reason about how the other ships might happen to navigate”.
- When the interviewee seemed to be finished deliberating from the point of view of ship B, I proceeded to the next step. I filled in the text “AIS” in the ship icons A and C on the paper with a ball point pen and then told the interviewee to imagine that he was the OOW on ship A instead, that his destination was “Sydhamn” and that the destination of ship C was “Norrhamn” (according to the AIS). Again he was asked: “What do you do?”
- When the interviewee seemed to be finished talking about the scenario from the point of view of ship A, I finally told him to imagine that he was ship C, that his destination was “Norrhamn” and that the destination of ship A was unknown, despite the fact that A has AIS (presumably because it had been put in by anyone on ship A). Again, the interviewee was asked what he would do in the situation, and asked to speculate about what the other ships were likely to do.

Except the initial question about what they would do and how they interpreted the situation represented on the sheet of paper, I proceeded – if required – with follow-up questions about, for example, what COLREGS rules were (or could become) of relevance in the situation, what additional information might be of help in the situation, what difference AIS would make, et cetera. I also tried to make the interviewees sketch and develop different possible scenarios on the paper sheet, although this proved to be more difficult than I had expected. The interviews was recorded with a mini disc player.

Scenario 2
In case scenario 1 would prove to be a too simple and uninspiring scenario to talk about, the more complex second scenario was made. The steps gone through with scenario 2
were exactly the same as in scenario 1. Two additional ships were included in the second scenario.

While on my fourth ship visit (S4), I also developed a very simple scenario on-the-fly, using the “real” paper chart used on the bridge (in case the ECDIS is out of order). This, again very simple, scenario took place in at a difficult passage which the ship passed on every journey, and the idea was that this might spark memories that might prove more vivid than the recollections ignited by the schematic scenarios devised by myself (again, see Appendix A). Overall, the primary point of using these scenarios was to set off the imagination of the interviewees and make them recollect and talk about situations where AIS could make a difference.

2.2.5 Focus group

Before the last ship visit, I had the opportunity to arrange and moderate a focus group at a maritime conference held in Sweden. Focus groups is “a research technique that collects data through group interaction on a topic determined by the researcher” (Morgan, 1998: 6). In my case, the focus group consisted of eight participants, drawn from the participants of the conference. There are problems with using only one focus group. Morgan (1998) stress that “[r]egardless of the circumstances, collecting only one group creates severe problems”, since the outcome of the group interaction is likely be the result of an unusual composition of participants. This problem is alleviated by the fact that I have been able to triangulate my focus group data with my data from individual interviews and my data generated from participant observation. Furthermore, the exploratory nature of this study makes the use of only one focus group less of a problem.

The use of focus groups has, like participant observation and individual interviewing, its strengths and weaknesses. When doing participant observations (especially as an 'observer-as-participant' or 'complete observer'), it is easy to remain ignorant about possibly important issues and topics which is simply not suitably pursued by doing observation. Even when relying heavily on informal interview talk in doing “observations” it is likely that talk will stay close to things and events within the observational horizon of the researcher and his or her informants. Individual interviews and focus groups avoids this potential problem. Relying on individual interviews alone carries with it different problems. In my case, I believe the lack of expertise in maritime navigation on my part sometimes made it difficult to discuss some issues that surfaced during interviews in detail. Thus, setting up and moderating a focus group was a good way to probe issues to a greater depth. The common knowledge and experiences of the participants in the focus group helped I think, to make the discussion a lot more lively and detailed in some cases, than the exchanges between myself and my interviewees.

2.2.6 Reliability and validity

Reliability of data in qualitative research is often difficult to assess due to the fact that naturally occurring, often messy, events cannot be replicated at the whim of researchers. However, reliability can be attended to by insisting on listening through audio recordings several times to ensure that potentially important data are not misunderstood or missed. If
one has the resources, multiple transcriptions can be made of audio recordings, by the
same or by different persons. However, since my use of audio data has mostly been used
to capture interviews, I have judged that the fine grained details of the interview episodes
are not important enough to warrant multiple time-consuming transcriptions. It is the
content of the interview data which have been in the focus of analysis, not the
interactional forms contained in it.

Validity on the other hand is easier, although still difficult (regardless of whether the data
is qualitative or quantitative), to handle. Validity is not concerned with the quality of the
data itself, but with the inferences drawn from that data (Hammersley and Atkinson,
1995, p. 223). To insure valid conclusions, the researcher must be aware of his or her
impact on data one has gathered. One can take various steps in order to reach a high
degree of such awareness. For example, extensive quotations can be used in the final
ethnographic product to ensure (oneself and others) that one has not misinterpreted data,
and is drawing conclusions from pure speculation. An obvious way of checking if one's
inferences are correct is by triangulating various data sources. I have done this by using
different sorts of qualitative research techniques: interviews, observations, and a focus
group. Other external sources – official documents, previous research – can of course
also be used to ensure acceptable validity. One can also check one's analysis and
conclusions by letting informants read one's descriptions and interpretations. This has
only been done to limited degree though. Particular issues and questions have been
checked by email contact with some informants, but the ethnographic descriptions on the
whole, have not been validated by any informants.

2.2.7 Data analysis
How does one get from note-jotting through results up to one's conclusions? To give the
reader a sense of how field notes look, and thus perhaps demystify them, I have scanned a
page from one of my note books in appendix B. Elaborating from the rough down-jotted
field notes, I wrote more detailed descriptions of events on my computer (an excerpt is
included in appendix B). These descriptions, together with transcriptions of the audio
recording I made, then constituted the data which underlie the results and analysis in
chapter 3 and 4. Of course, as is frequently pointed out in methodology textbooks,
analysis and interpretation starts already when observations are made and notes taken.

Analysis has partly been guided by my theoretical framework, partly by repeatedly sifting
through and categorising my data files. Categories used (and sometimes discarded) have
been for example: “information flow”, “social organisation”, “other actors”, “usability
issues”, “training”, “rules and praxis”, “use”, “communication” and “positive and
negative aspects of AIS”. The analysis has thus been both theory- and data-driven.

2.3 Data collection
Data collection was made at various occasions during the autumn of 2003. The first ship
visit was made in the middle of August and the last one in the middle of December. In the
table below, the various occasions are listed in chronological order. I visited four
different ships and two VTS stations. While my focus was mariners’ use of AIS, since
VTS stations are frequently in contact with OOWs and overhear a lot of ship-to-ship communication within their covered area, I judged that visiting VTS stations could provide useful data. I also moderated a focus group at maritime conference in Stockholm on November 18, 2003.

<table>
<thead>
<tr>
<th>Event</th>
<th>Informants</th>
<th>Type of ship</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>First ship visit (S1)</td>
<td>Pilot (P) Captain (C)</td>
<td>Finnish containership, 120m. long</td>
<td>Radar, ECDIS.</td>
</tr>
<tr>
<td>First VTS visit (VTS1)</td>
<td>Staff member 1 (Staff1)</td>
<td></td>
<td>ECDIS, AIS integrated in ECDIS.</td>
</tr>
<tr>
<td></td>
<td>Staff member 2 (Staff2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second ship visit (S2)</td>
<td>Pilot (P) Captain (C) First mate (FM) Second mate (SM)</td>
<td>German containership, 120m. long</td>
<td>Radar, ECDIS, AIS on iconic display and integrated in ECDIS.</td>
</tr>
<tr>
<td>Third ship visit (S3)</td>
<td>Captain (C) First mate (FM) Second mate 1 (SM1) Second mate 2 (SM2)</td>
<td>Swedish passenger ship</td>
<td>Radar, ECDIS, AIS integrated in radar and ECDIS (no stand-alone display).</td>
</tr>
<tr>
<td>Focus group (FG)</td>
<td>Eight members (M1-M8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth ship visit (S4)</td>
<td>Captain (C) First mate (FM) Second mate 1 (SM1) Second mate 2 (SM2)</td>
<td>Swedish passenger ship</td>
<td>Radar, ECDIS, AIS on iconic display (same type as on S2) and integrated in ECDIS.</td>
</tr>
<tr>
<td>Second VTS visit (VTS2)</td>
<td>Staff member (Staff)</td>
<td></td>
<td>Radar, ECDIS, AIS integrated in ECDIS.</td>
</tr>
</tbody>
</table>

Table 1. The various data collection events. Listed are the informants at each event, the type of ship (where applicable), and the kinds of navigation technology present at the bridge (again, where applicable). Abbreviations given in parentheses are used to refer to the different informants. For example, “S2-SM” refers to the second mate on the second ship, “FG-M5” to the fifth focus group member, etcetera.

When excerpts from audio transcriptions are embedded in the text, I use the abbreviations in Table 1 above to refer to the various ships and informants. Here is an excerpt example:

S4(8)-128 Oll: mm
S4(8)-129 SM1: a bit of trouble.

“S4” means that the recording is from the fourth ship visit, the eight in parenthesis “(8)” refers to the eighth transcription file from S4 on my computer, and the number after the dash refers to the line number in that file. All the interview recordings are of interviews conducted in Swedish, so the transcription files are all in Swedish. I have translated only those lines figuring in excerpts into English. “Oll”, refers to me when having the interview turn, and “SM1” refers to the first second mate (in this case, the one on S4).
3.0 The bridge as “the field”

This chapter contains bits and pieces of what perhaps normally would be found in a Results chapter as well as in the chapter on Method. I simply describe the four “field trips” (for lack of a better term) to bridges that I have made, as well as my two brief visits at VTS stations and the focus group session I moderated. I do not make full thick descriptions of any of these. My objective with this chapter is two-fold. First, I want to give you, the reader, a feel, however shallow, for what typically happened on the bridges I made my observations on (and hence, these descriptions are part of my ethnographic interpretations). Secondly, I also want to describe my method of research, what is involved in a field trip and what I actually did when I was on the selected sites.

3.1 First ship visit

When I made my first field trip on S1, I had tentatively chosen a research focus – the impact of AIS on how the COLREGS were interpreted in different traffic scenarios – and the point of my first field trip was primarily to see the bridge of a ship and get a rough idea of what working on one was like. I had contacted a pilot (S1-P) in the Stockholm area a couple of days before the visit and he called and told me I could come along on a piloting job. The ship was leaving from Frihamnen in Stockholm at approximately 6 pm on that same day. I left the ship with S1-P at about 10 pm, and via a pilot boat and a taxi I got back to Stockholm, leaving me about 4 hours for interviewing and observing.

The ship was a containership with a length of roughly 120 meters. The cargo that was being shipped to Finland, consisted entirely of empty containers. Although, the ship was not fitted with AIS, I figured that at this initial step, getting to know maritime work in a general way was important enough. Furthermore, getting a feel for how maritime navigation was done without AIS could only help me in understanding the impact of the technology.

During the voyage, I primarily talked to the pilot who had taken me onboard, but also had some exchanges with the captain (S1-C). Since this was my first “ethnographic experience” as well as my first visit on the bridge of a ship, the “field trip” primarily gave me some very basic knowledge about what the bridge looked like, what the pilot's job is, what a radar looks like and so forth. I felt very much like a stranger and most of my questions were very general and exploratory. Furthermore, when I made this field trip, I was planning to focus on AIS and its implications for how the COLREGS were interpreted and applied in various traffic situations, so my questions were developed out of that interest.

The crew of the ship consisted of two sets of nine members each. The two sets of members alternated between being on-board and on-shore. One set consisted of a captain, first mate, second mate, seamen, engineers, and a chef.

One day consisted of six watches in the following order (watch schedules similar to this one were followed on S2, S3 and S4 as well):
00:00-04:00  Second mate and a lookout
04:00-10:00  First mate and a lookout
10:00-12:00 Captain and a lookout
12:00-18:00 Second mate and a lookout
18:00-22:00 First mate and a lookout
22:00-24:00 Captain and a lookout

The most obvious navigational equipment on the bridge consisted in two radar screens, each in front of a chair, and one electronic chart display beside the starboard (right) chair, as well as gyro compass, log, and GPS. Additionally, paper charts were available as required. If the electronic chart display should stop working, the paper charts work as back-up (another ECDIS-computer could also fill this back-up requirement). The radar does not have track-steering functionality (autopilot). Track-steering is never utilised when navigating in archipelagos anyway, so track-steering functionality would presumably not have made a difference during my observations (since I left the ship before it left the archipelago).

During the voyage, S1-P used his laptop and cellular phone to hook up to the AIS system. He brought up a chart of the archipelago where one could check up AIS-targets (similar to a ECDIS integrated AIS display). While the pilot demonstrated how the system worked, the captain first showed some interest in what was going on, but then made a point of not being interested:

S1-P: You will have one of those soon as well
S1-C: I do not need it
(Both S1-P and S1-C laughs)
S1-C: I do not even own a computer\textsuperscript{14}

\textbf{3.2 First VTS visit}

VTS1 is manned by two staff members (Staff1 and Staff2), both sitting behind a large wooden counter. Staff1 is responsible for communication with all ships in the VTS area, while Staff2 arranges pilots for all ships in need of one to enter or leave the archipelago within which this VTS station is located. The point of the VTS is not to direct and plan traffic but to provide information about traffic to all ships in the area covered by the VTS. At certain locations in the archipelago, called reporting points, all ships with a weight of more than 300 gross tonnage or longer than 50 meters must report to the VTS. On a large magnetic white board, which is overlaid by a simple outlined chart of the archipelago, ships are manually moved around along different fixed “tracks”. Each position along every track is designated with a number. When ships are somewhere between two reporting points, the VTS personnel moves the ships along the tracks roughly according to their assumed speed (maximum speed allowed). In order to help the VTS with this particular task (i.e. keeping track of vessels when they are positioned between reporting points), some computer software were developed and installed in 1982. The software

\textsuperscript{14}This is not an excerpt from a transcription of an audio recording but a reconstruction based on my field notes.
shows the likely position of ships by displaying the track position number of each boat. The position is extrapolated from the last reporting point, under the assumption that the ship is travelling at maximum allowed speed (i.e. a primitive form of ded reckoning).

One month or so before I visited the VTS, two screens showing AIS information were installed in the room of the traffic information center. No staff member at the VTS got any training in how to use it, although a manual for the system was available (but the manual is primarily written, according to one of the staff members, with mariners in mind, not VTS users).

The staff has taught each other how to use the AIS. What is the AIS used for then? Well, first of all, the AIS has not in any way replaced their old technology (the computer system, VHF, and the big magnetic whiteboard chart). The information provided by the VTS-to-ship communication on VHF-channel 73 is not only for the individual ship itself but also for all other smaller vessels (those with a tonnage under 300 and less than 50 meters in length). This means that it is important, according to the staff, that the VHF reporting continue even if AIS fitted ships do not feel the need themselves of reporting to the VTS (I have had no signs that any OOW have felt that way though). This circumstance, in combination with the lack of radar technology at the VTS, also mean that the VTS personnel cannot interfere in any way with the local navigation decisions made at the bridges of the AIS fitted ships. The introduction of AIS in the VTS has not changed the fact that they cannot see or know what is happening in the archipelago on a micro-level. While they are now constantly fed with information about the position and behaviour of the AIS-fitted ships through the two screens, there is no way they can interfere with local navigation decision, they can merely mediate communication between ships and broadcast information through VHF-radio.

Staff2 point out some advantages with the old magnetic whiteboard, compared to the AIS-displays they have got:

VTS1-245 Staff2: It [the magnetic whiteboard] never has computer breakdown and I mean, you cannot, on a computer display go in with all the information we put up on our magnetic board...

VTS1-246 VTS1-247 VTS1-248 VTS1-249 VTS1-250 VTS1-251 VTS1-252 VTS1-253 VTS1-254 VTS1-255 VTS1-256 VTS1-257 VTS1-258 VTS1-259 VTS1-260 VTS1-261

Staff2 point out some advantages with the old magnetic whiteboard, compared to the AIS-displays they have got:

VTS1-245 Staff2: It [the magnetic whiteboard] never has computer breakdown and I mean, you cannot, on a computer display go in with all the information we put up on our magnetic board...

... VTS1-250

VTS1-251 yeah, you can always get information quickly instead of having, so no

VTS1-252 it is well worked out system and while, the AIS is, I think

VTS1-253 damn fun, because then you see the ships in reality and I

VTS1-254 think the one [system] does not replace the other.

...

VTS1-258 Oll: No, but that looks, well, it is easy to add new functions

VTS1-259 so to speak [to the magnetic whiteboard system]

VTS1-260 Staff2: Yeah, you cannot have, run like a Norwegian computer, Tippex on the screen you know.

VTS1-261 No that does not work.

While Staff2 appreciates the AIS system in some ways, it allows the VTS to see ships “in reality”, she thinks the old magnetic white board system is much more flexible and can incorporate a lot more functionality.
As far as the two VTS workers know, patterns of VHF communication between ships have not changed in any way since the introduction of AIS.

### 3.3 Second ship visit

S2 looked, at least to me, to be practically identical to S1. Like S1, it was carrying empty containers onboard. This was not a Finnish ship though, but German. As when visiting S1, I was accompanying the pilot (S2-P) onboard and primarily used him as my informant, although I also talked to the captain (S2-C) and the first and second mate (S2-FM, S2-SM). (I also met the chief engineer when he took me and some other passengers on a guided tour through the extremely noisy engine room).

Unlike S1-P, S2-P did not know much about AIS at all, something which he was in no way reluctant to admit. He “justified” this lack of knowledge and interest by his approaching retirement. He was soon turning sixty and would retire during 2004. He believed though, that the next generation of pilots would likely learn to use the AIS system. During the entire trip, S2-P only used the AIS-unit in order to direct my attention to the system, at no point did he utilise the AIS-unit to help him navigate the ship or find out something about neighbouring traffic. He mentioned though, that the system ought to be useful for monitoring purposes (in order to detect speeding ships for example) in the hands of the coast guard or the police.

The ship only carried a small iconic AIS-display. The display consisted of a screen that either showed a list of alphanumeric data or a low resolution map of the surrounding area, with AIS-fitted ships displayed as small triangles on the screen. Normally, a list of all AIS-fitted objects, usually ships, was shown in the display, with the nearest ship on top and the one furtherest away at the bottom of the list. Each list item was presented in three columns with the name of the ship first, then the distance in nautical miles (nm) to the ship, and finally the ship's bearing in degrees. The arrow-buttons are used to move a marker up and down the list of AIS targets, highlighting one list item at a time. By pressing an “enter”-button when a list item is highlighted, one gets more information about the target. The AIS-unit is a FURUNO, model UAIS Transponder FA-100 (the same unit was also used on S4).

Like S2-P, the second mate (S2-SM) did not know much about AIS but he said that it is useful for identifying ships. One is able to connect a representation of a ship on the ECDIS with a name tag. He complained though, about the abundance of equipment of the bridge and the work needed to keep track of everything. In waters with a lot of unknown traffic, the ability to identify ships could, according to S2-SM nevertheless be very handy. I later asked S2-P about whether this was a function he could profit from, but he answered that this was not so important for pilots since they usually know the ships regularly trafficking their area, and there are VTS stations that keeps track of the identities of ships.

S2-P said that he generally left the operation of bridge technology in the hands of the officer of the watch (OOO), since different ships are fitted with technology designed and manufactured by different companies. He claimed that despite attempts to standardise
bridge technology, displays and control panels often vary extensively between bridges. This circumstance made it less worthwhile for him, as a pilot, to learn how to use bridge technologies, since the knowledge gained would only be locally applicable.

When S2-FM and S2-SM have been using the system, it has primarily been for identification purposes. S2-FM complained that the ECDIS got clogged up with all the overlaid AIS-information when they navigated in crowded waters. On these occasions he apparently often chose to switch all the AIS-information off (he did not seem to be aware of the possibility of selectively turning off certain AIS-targets). None of the crew I spoke to had got any kind of training or education in using AIS. One simply had to learn *in situ* by trial and error or by instruction from other, more knowledgeable, crew members. According to S2-FM, there is no time for training in the use of new equipment nowadays. He never explained what brought about this state of affairs, but S2-P thought that it is due to the fact that there is less crew and more work onboard ships today compared to earlier times. While crews have diminished, the range of tasks carried out by those left have grown (mainly by the introduction of more administrative paper-work). Although manuals for the AIS-system were available on the bridge, they were seldom utilised according to S2-C. Generally, manuals and other instruction material was not used because they were usually written in English or, even worse, if the equipment was manufactured in China, in “Chinese technical English” (S2-C).

### 3.4 Third ship visit

S3 was much bigger than the containerships S1 and S2 and carried primarily passengers across the Baltic Sea. The ship was recently built, its virgin journey took place only two years before my visit. My contact at the shipping company had called it their “flagship” and revealed that it had all the latest technology. This naturally made me a bit excited. While S2 was fitted with an AIS unit, it did not seem to be in heavy use. At this point, I expected to see AIS *in use* for the first time. On S3, AIS-information was overlaid on both the ECDIS and the radar screens. I never saw any stand-alone AIS unit on the bridge – MKD or otherwise – and when I asked if they had one, their answer was negative.

When I boarded the ship, I first met the first mate (S3-FM) who showed me to my quarters. We then immediately went up to the captain's office. After having talked briefly to the captain (S3-C), explaining what my thesis project was all about and what I wanted to do on the ship, I returned to my quarters and prepared myself by going over the questions I wanted to ask and deemed important and checking that my tape recorder was working properly. When it was time for the ship to leave the harbour, I returned to the wheel house (i.e. the bridge).

S3-C had been captain on the ship for approximately two months. He quickly told me that he didn't know much about the AIS system or how to use it and advised my to concentrate my attention on the two second mates onboard (S3-SM1, S3-SM2), who were responsible for navigating the ship most of the time (S3-C and S3-FM primarily worked on the bridge when entering and leaving port). At any one time, there was always at least three people working on the bridge, usually one second mate and two lookouts. When the
ship was entering or leaving port, the captain, the first mate and one lookout took over the bridge. The normal working shift for the second mates was six hours long.

I started doing observations at the bridge around 10 pm, in order to be there when the captain took the ship out from port and I got to talk for a while with S3-FM who showed me how the AIS-system worked. Roughly 45 minutes after leaving port S3-SM1 took over as OOW. At that point I got down to the mess to dine with the S3-C. While eating, I tried to explain in more detail why I was doing my research project, what my background was et cetera. At around half past eleven, S3-SM1 left his shift at the bridge and I got 20-30 minutes with him in the office below the bridge for an interview, which I recorded on an MD tape. The interview proceeded quite satisfactory although it was difficult to get answers to some of my questions, primarily those concerned with trust and different types of bridge instruments.

After the relatively brief interview, I went back to the bridge, where I got to talk to S3-SM2, who was OOW during the whole night until 6 am. I audio-tape the whole interview/observation, which last for about two hours. I found out that asking some questions in situ at the bridge was much more rewarding than asking them in the confines of the office below the deck. I started off by pretending (well, at this point, it wasn't really pretending at all) that I did not know anything about AIS and asked them to “show” me how it worked. I then continually interrupted the mate with questions about things that happened which I did not fully understand. Generally, both S3-SM1 and S3-SM2 seemed to be quite knowledgeable about AIS and how to operate the display from the bridge.

At around 2 am, now the second day of the journey, I went to my cabin to get some sleep. In the morning the ship entered port, and I got off for about an hour to get some fresh air. Shortly before 10 am I was up on the bridge again, where S3-SM1 was OOW again. At around 11 am, S3-FM and S3-C arrived at the bridge. S3-C took over the role as OOW. I got some opportunity to interview S3-FM, again pretending that I was more or less utterly ignorant about AIS, asking all sorts of questions. At 2 pm, S3-SM2 took the watch, and I got a second chance to talk to him, although this time, he had less to say, and I found it hard to come up with relevant and interesting questions. Finally, at around 4 pm, we entered port again, the one we left roughly 16-18 hours earlier. I left the ship and went to find a café where I sat down and wrote up my fieldnotes.

3.5 The focus group

During a single day conference on new technology and safety in maritime transportation held in Stockholm on November 18, 2003 I had the opportunity to arrange and moderate a focus group. The session lasted for about three quarters of an hour and was squeezed in between the main talks programme and the conference dinner in the evening. The group members were recruited during the afternoon on the same day. Eight members were recruited. Two of the talks given were previously during the afternoon were on the topic of AIS; one concerned with technical and infrastructural aspects of AIS, the other with “early practical experience and visions”. Both two speakers were among the eight focus group members. Present at the session were also, were also two helpers who took notes...
and a conference organiser. Here is a table with some data about the eight group members.

<table>
<thead>
<tr>
<th>ID</th>
<th>Years at sea</th>
<th>Number of AIS-ships</th>
<th>AIS-displays</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>33</td>
<td>3</td>
<td>“all kinds”</td>
</tr>
<tr>
<td>M2</td>
<td>42</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>M3</td>
<td>10</td>
<td>2</td>
<td>MKD, ECDIS</td>
</tr>
<tr>
<td>M4</td>
<td>10</td>
<td>5</td>
<td>ECDIS, radar</td>
</tr>
<tr>
<td>M5</td>
<td>28</td>
<td>1</td>
<td>ECDIS, radar</td>
</tr>
<tr>
<td>M6</td>
<td>25</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>M7</td>
<td>10</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>M8</td>
<td>18</td>
<td>4</td>
<td>ECDIS</td>
</tr>
</tbody>
</table>

Table 2. List of focus group members (ID), with information about how many years they have been at sea (Years at sea), how many ships fitted with AIS they have sailed with (Number of AIS-ships), and – if they have sailed with AIS-fitted ships – the type of presentation of AIS-information they have worked with (AIS-displays).

I started the session by handing out a written introduction that briefly explained why the focus group session was held, a list of topics to be discussed and information about how to get in contact with me if the members had any questions or ideas that they would like to share or discuss after the session. Each member also filled out a sheet where they could provide me with information about how to get in touch with them (voluntary), how many years they had been at sea, what kinds of ships they had sailed, in which waters they had sailed, how many AIS-fitted ships they had been aboard (as crew), how AIS-data were presented on those ships, and what other comments they might have had.

The list of topics which they were intended to discuss were the following:

- Preparations for, and installation of, AIS
- The presentation of AIS-data
- Use of AIS
- The impact of AIS on their work
- Advantages and disadvantages of having AIS
- Trust in information from AIS and other bridge technology
- AIS and the future of maritime transportation
- The conference talks

The list of topics was chosen partly based on my interest in getting material for this thesis, partly based on the interests of the organisers of the conference.

After the initial paperwork was done and over, I started the audio recording of the session (using a mini disc player). Two of the focus group members arrived late in the middle of the session. In general, the discussion about the planned topics was easily initiated and the members found much to discuss and exchange their views on.
3.6 Fourth ship visit

After the conference and the focus group, I had decided that looking into the effects of AIS on VHF-communication could be really interesting. I suspected however, that purely non-interventionist observation would not give me much empirical material about this particular aspect of AIS use. I therefore (with the help of my supervisor) made two very simple paper sheet based traffic scenarios that could be used to elicit, or provoke, my informants to talk about the difference between having and not having an AIS unit onboard with regard to the use of VHF-radio. The scenarios were presented on two ordinary A4 sheets of white paper. I used these sheets to make a more or less structured interview about the situation and the participating ships. I asked my informants about what they would do in the situations, given that they were OOW on each of the ships participating in the situation (see appendix A).

The fourth ship I boarded for a “field trip” was bigger than S1 and S2 but slightly smaller in size than S3. Like S3, it was a passenger ship. It was modern, hence fitted with AIS (installed eight months before my visit), although not quite as recently built as S3. AIS-data were presented only on the ECDIS, not on the radar screen as well (as on S3). This time, I stayed much longer on the ship, doing two consecutive return journeys over the Baltic and having the time to interview several members of the crew.

After having settled down in my cabin, I went up to the bridge to observe when the ship was taken out from port. The bridge was much smaller than the one on S3. As on S3, it was the captain (S4-C) and the first mate (S4-FM) that manned the bridge during the left-off from port. After S4-C had taken the ship out of port, the first second mate (S4-SM1) took the place of S4-FM. I started asking S4-SM1 some questions, recording it on MD. After half an hour or so, I joined S4-C when he went to the mess room for a meal. During the dinner, I talked to S4-C about my studies and my thesis project (after a while, S4-SM2 sat down at our table), and I mentioned that I was interested in AIS and its potential impact on VHF-traffic, especially the role of hearing others communicating over the public VHF-channel. Although he conceded that it is sometimes useful to hear ships report to VTS:es, in order to know their position, the rule is that one does not care to listen, and listening just interferes with other performance of other tasks.

After dinner, I went to my cabin to prepare myself for my observations and write up some of my notes. At 8 pm, I went to the bridge again. S4-SM2 was OOW. His shift started at half past six and continued until midnight. Besides him, a lookout was on the bridge as well. S4-SM2 had spent sixteen years at sea, and he had been on S4 the last ten months. Since the wind was above seven Beaufort (or 20 meters/second) he called ahead to the VTS at the port we were approaching (that is, our final destination) to order a pilot.

At midnight, S4-SM1 was OOW for a short while before S4-C and the pilot took over when entering port. The pilot gets onboard at a quarter past midnight. After the ship had docked, I retreated to my cabin and wrote up my notes.

The next morning I was up on the bridge again at 9.30 am. S4-SM2 had his OOW-shift again (from 6 am to 12 am). I started by taking some pictures of the bridge – taking
advantage of the daylight – and then made my first structured interview around the scenarios, unfortunately I were to be interrupted before we were finished (we only got through scenario 1). SM4-C and SM4-FM came up on the bridge again before entering port (the one we left, in the afternoon the day before).

While I waited for making another identical voyage with S4, I spent the day in the port town writing up my notes. During the following voyage, I got the opportunity to go through the scenarios I had devised with SM4-SM2 (picking up where we left off), SM4-SM1, SM4-C, and SM4-FM. The scenarios worked well in that they got my informants talking and recollecting various events, as well as provoking them to think about what the role AIS could play in the scenario situations.

3.7 Second VTS visit

The visit to VTS2 was a very brief one, made the day after the fourth ship visit. I talked to a staff member who knew well how to use AIS and had worked at the VTS for several years. The station was much larger than the first one I visited. Daytime, the station is manned by a staff of two, and during evenings, nights and weekends, by a single staff member. There were several desks arranged toward a several large windows overlooking part of a harbour. On the most central desk, closest to the windows were a twin pair of large flat screens displaying electronic charts overlaid with AIS-information. Beside them stood two radar screens.

VTS2 have the capability to listen in on all VHF channels covering an area from the far south of Sweden to Haparanda in the north. Like VTS1, they only have responsibility and authority to convey information, but not to direct and control traffic. The main task of the VTS is to coordinate and order pilots for ships entering or leaving the port. They are also in contact with the coast guard, customs and other port authorities, as well as their own pilots and “hamntjommar”. AIS is used in order to check whether ships are arriving at their estimated time of arrival (ETA), so that pilots know when they are needed. There are no reporting points (unlike in the area covered by VTS1). When ships do not have AIS, the VTS needs to call them on the VHF in order to determine ETA and send out pilots for the ships.

The VTS, along with the pilot vessels, have had AIS installed for three years. Along with the installation, the staff members of the VTS did a training course where they learned to use the new system. The staff member I talked to first said that there had been no problems working with AIS and that it had not come with any disadvantages, but then added that while AIS did not give incorrect information there sometimes were “local problems” with AIS. What he meant was that the AIS-units onboard ships sometimes where “incorrectly programmed”. Once, for example, a ship was sailing 300 meters parallel with a narrow passage within which ships are supposed to go. This was clearly incorrect, and the staff member used the radar to confirm this that this was indeed an error.

In general, the staff member emphasised that AIS was a complement rather than a replacement to other technology they utilised at the VTS, and the advantage of having

45
AIS technology was that it facilitated ship identification. As far as VHF traffic goes, the staff member had not been aware of any clear changes brought about by the introduction of AIS but he thought that changes would come with time and more widespread use of AIS. Usually, ships were addressed with their names, sometimes with their call signs added, or possibly with position information. Occasionally, ships were addressed with phrases like “ship on my starboard side”, mostly by Russian mariners for some reason.

AIS must be a complementary technology according to the staff member since an AIS unit is not a requirement on all ships at this moment. The minimal requirement is an up-to-date chart and a compass, and – for bulkier vessels – a radar. A problem with relying solely on VHF communication to identify and address ships is simply that not everyone listens to the VHF channel and sometimes calls are difficult to hear and understand (examples given by the staff member are the “guttural calls” of Russian mariners and calls made by French mariners trying to speak English).
4.0 Analysis, interpretation and discussion

In this section I will highlight a few themes which, in the light of distributed cognition, emerged from my data. What I regard as the primary theme concerns the effect of the AIS system on VHF-communication. It became primary for several reasons: I have relatively much data to elaborate on, the theme highlights the importance of recognising the social context of work, and it is theoretically relevant, showing the advantage of a distributed cognition framework. It is also interesting that the AIS-VHF theme has been emphasised in, for example, IMO resolution A.917(22) (IMO, 2001). One interesting issue is whether AIS use will lead to a greater or a smaller amount of VHF-traffic. And perhaps more important: what sort of VHF-traffic will increase or decrease with the advent of AIS?

Another theme I will take up is the informational needs of the mariners: What kinds of information do they query the AIS-system for? Some of the discussion about the informational needs also leads into the issues regarding the importance to pay due attention to the social context of work. Questions about informational needs naturally follow from a distributed cognition framework, the commitment to viewing cognition as information processing make data concerning informational needs salient.

The third theme I will take up briefly concerns trust and presentation of information. How does the way of presenting AIS-information influence the perceived trustworthiness and reliability of the informational content? This theme is perhaps one less grown out of a theoretical perspective than by an important topic raised by the mariners (often from very different viewpoints). Still it is connected to the issue of information needs. Mariners do not simply act in accordance with the information they have accessible, but also in accordance with judgements about the trustworthiness and quality of that information.

4.1.0 AIS and VHF-communication

Let us remind ourselves about the objectives of AIS as spelled out by the International Maritime Organisation. It ran as follows:

“[T]he purpose of AIS is to help identify vessels; assist in target tracking; simplify information exchange (e.g. reduce verbal mandatory ship reporting); and provide additional information to assist situation awareness. In general, data received via AIS will improve the quality of the information available to the OOW [Officer On the Watch], whether at a shore surveillance station or on board a ship. AIS should become a useful source of supplementary information to that derived from navigational systems (including radar) and therefore an important ‘tool’ in enhancing situation awareness to traffic confronting users.”

(IMO, 2001, my emphasis)

One explicit purpose of introducing AIS in the maritime world is thus to “simplify information exchange (e.g. reduce verbal mandatory ship reporting)” between ships and between ships and shore-stations. The focus is on the information received by “the OOW, whether at a shore surveillance station or on board a ship”. Why the emphasised articles? Well, as we shall see, one potential problem with AIS usage stems from the fact
that the information on the VHF channel might be received by more than one OOW, shore surveillance station, or ship.

Given the new ways of exchanging information facilitated by AIS, one would expect its introduction to have impacted on VHF-communication between ships, as well as between ships and shore stations. One utterly unsurprising – but no less important – change brought about with the introduction of AIS is that mariners now call upon AIS-fitted ships with their names (or occasionally, their call signs), instead of their position (given in longitude-latitude coordinates or relative to some known landmark like a buoy or an island). This was confirmed by my interviews (S4(7)-261-270, SM2), as well as one observation (by which you can gather that VHF-communication was rarely actively engaged in), and it at least shows that the AIS system is actually used to some extent. However, to what extent mariners with access to AIS information have changed their way of addressing AIS-fitted ships is unclear (for example, the staff at VTS1 had not noticed whether AIS had changed the way ships addressed each other on VHF radio).

Other than this change in the format of VHF-calls, it is difficult to see what changes will follow in the wake of AIS. Of course, this is partly due to the fact that many vessels still do not carry an AIS unit. Furthermore, the system has not been in operation for very long, and the development and change of habits are subject to some considerable degree of inertia (especially under the circumstances in which AIS has been introduced on many ships, without time for any training or education (FG-49-86)). Not only have my informants had vague and differing views about the likely consequences of AIS-use on VHF-communication, but their views have also differed regarding whether certain consequences are desirable or not. Will (some kinds of) VHF-exchanges increase or decrease? Is this increase/decrease desirable?

The creation of 'haves' and 'have-nots' (these are my concepts, not my informants) is also a consequence of the introduction of AIS. How will the fact that AIS-fitted ships have some kind of information at their disposal, which is unavailable to ships without AIS-technology, effect how the two groups interact?

4.1.1 More or less VHF-traffic?

While one of the aims of introducing AIS was to “reduce verbal mandatory ship reporting” this only touches the VHF-traffic between ships and VTS stations. Another aim is to facilitate successful VHF-communication by helping mariners to identify other vessels (IMO, 2001), but there is no explicit goal to increase or decrease the amount of communication.

S4-SM2 thought that VHF-communication had increased with the advent of AIS, at least on his part:

S4(2)-186 Oll: Yeah okay. Has AIS changed like how you use, well for example, S4(2)-187 the radar?
S4(2)-188 SM2: No
S4(2)-189 Oll: or other instruments?
S4(2)-190 SM2: Well you could say that, even if it shouldn't be that way. I would have
S4(2)-191 called that one up anyway since I mean it is
S4(2)-192 a human phenomena, if it is too cumbersome, then ahh, I don't give a shit
S4(2)-193 then. But it does make it easier to make a call and then maybe I
S4(2)-194 will use the VHF more often
S4(2)-195 Oll: Yeah, okay
S4(2)-196 SM2: and that is a substantial difference. I'll have talked to him
S4(2)-197 and told him what I will do and that is of great help.

The hassle experienced by trying to engage ships in communication by addressing them with their position, has thus led this mariner to drop trying to contact other vessels. The advantage given by AIS-technology from this perspective is that it will be clear which vessel is being addressed, and miscommunication will likely become less common. The second mate thinks that this will make him engage in ship-to-ship communication more often, and less hesitantly.

S4-SM1, the other second mate on S4, believed that the amount of exchanges over the VHF had neither decreased nor increased significantly, although some kinds of exchanges had decreased, namely corrections of previous miscommunication, while others – I presume – had increased, such as substantial exchanges about navigational matters.

S4(8)-290 Oll: Ehh, a general question again about VHF communication. Do you think that
S4(8)-291 the AIS, if it has led, or if it will lead to more
S4(8)-292 VHF communication, or less?
S4(8)-293 SM1: I think it will become, no I don't know. It probably won't be any difference. The
S4(8)-294 only thing is that you get directly, “boat Baltica, I am coming here, dut”
S4(8)-295 instead of screaming out "ship in position there and there and there"
S4(8)-296 then it is the wrong boat that answers.
S4(8)-297 Oll: Yeah, there will be less corrections and such?
S4(8)-298 SM1: Yeah exactly
S4(8)-299 Oll: Right

Not only is it somewhat unclear whether VHF-communication has, or will, in fact either decrease or increase, it is also unclear what is desirable. The captain of the same ship to which S4-SM1 and S4-SM2 belong had strong negative views (which he expressed repeatedly) on the abundance of VHF-communication. Here is an example:

S4(6)-85 C: You have to be careful not to use the talk and make it
S4(6)-86 hard because sometimes you might make it, you complicate it
S4(6)-87 Oll: You mean the VHF-talk?
S4(6)-88 C: Yes

And later during the same conversation about Scenario 1, he express this view of VHF-talk even more strongly:

S4(6)-106 C: The good thing here is that I, at an
S4(6)-107 early stage, can see that he is coming from up here. I know that he
S4(6)-108 is coming in on my starboard side and I can, at an early stage, reduce speed
S4(6)-109 Oll: Yeah, right
S4(6)-110 C: so that we never get into a chatty situation
S4(6)-111 Oll: No, right
S4(6)-112 C: and that's where we want to be. You shouldn't, you probably shouldn't
try to build a system where the point is that you are to talk to each other.

“You probably shouldn't try to build a system where the point is that you are to talk to each other”. If indeed AIS will lead to more VHF-talk, as the one of the Captain's second mates think (SM2), then the Captain will not be entirely happy about it.

That AIS helps mariners to avoid mistakes and confusion in communication is agreed upon though. This is due to the fact that ship names become available through AIS and mariners do not have to address ships with their position. When positions are used as identifiers, then often no ship will answer, or even worse, the wrong ship will believe it is being addressed. S4-C tells about an episode in which he took part where this is precisely what happened (while we were discussing Scenario 2):

Okay, what was it that, what mistake was made?
C: They talked to someone here, and he thought that he talked to him but he was talking to the one that was there
Oll: Yeah, okay so it almost became. So it is dangerous to talk when you have three boats.

S4-C believes that AIS will help unmake that kind of dangerously misleading VHF-communication. S4-SM2, the informant I believe was most sceptical about the promises of AIS, is also clearly aware of this problem with misidentified ships and the problems it causes. He also believe AIS to be of great help to sidestep those problems, and says that AIS “has given a better security”:

mmm...but, I was wondering. Have VHF communications changed since the arrival of AIS? People don't still call up using position
out of habit, do they?
No, not if they both have AIS, then you often hear that they make calls using names
yeah
Yeah, because no one likes having to make calls on positions
since it is rare that anyone answers. And, you know, it has been a very, solely, how should I say, result, then it has given a better security

In the first part of the excerpt, we also see that AIS has changed the format of VHF-calls according to S4-SM2. And he also, again, express the assumption behind his belief that AIS will lead to more VHF-traffic: “no one likes having to make calls on positions since it is rare that anyone answers”. Thus, AIS will make mariners use the VHF more frequently since they will not have to call on positions any more (if the addressee is fitted with AIS that is).

This shows what really ought to be obvious: that it is not simply a question of whether there should be a lot or only a small amount of VHF-communication. Whether VHF-traffic is good or not depends on the content of the exchanges. When I asked S4-SM2
whether VHF-communication could become very disturbing, he made it clear that it really depends a lot on the topic of the exchanges. If the talk concerns navigational matters, then “it is not disturbing, [...] then it is only exciting”. On the other hand, if it does not concern navigational matters, traffic on the VHF can become very irritating to OOWs:

S4(7)-124 Oll: can it, can it be, ehh, become very disturbing this
S4(7)-125 the VHF communication I mean [...]?
...
S4(7)-127 SM2: It can. But not when it comes to, I mean when people talk about navigation, then it is not disturbing, I never think so, then it is only exciting.
S4(7)-129 SM2: even if I am not involved, then you listen. But on the other hand, in the Mediterranean and in the Persian Gulf, there is a constant fucking chatter all the time. People are drifting without anything to do, and they just fuck around you know.
S4(7)-135 Oll: Right, it doesn't have anything to do with navigation.
S4(7)-136 SM2: Then it can even come to a point where, which you are not allowed to say, you turn off the radio, and then it's bad.
S4(7)-138 Oll: Yeah.
...
S4(7)-143 SM2: but you shouldn't turn off the radio. But if they are going on endlessly and you are sitting between twelve and four during the night and there is a fucking buzz all the time, then eventually.

The topic being talked about seems crucial then. When the topic is not navigational matters, as in the chatter in the Persian Gulf and the Mediterranean, then the OOW might turn off the radio (on the other hand, the mariners involved in the chatter presumably do not think it concerned with topics they find irritating).

While my interview data does not support any straightforward conclusion about the influence of AIS on the use of VHF-radio by mariners, it does at least cast doubt on suggestions made that AIS will lower the amount of traffic on VHF-channels (which seem to be the view of S4-C for example). My data also suggest that a lower amount of VHF-talk is not necessarily desirable for everyone concerned. First of all, the kind of VHF-talk which is likely to decrease (if any) is talk about navigational matters, since AIS will provide mariners with navigational data which will make a lot of VHF queries about navigational matter surplus, while “chatter” of other kinds is not likely to decrease. Furthermore, it is not necessarily desirable that navigational VHF-talk should be discouraged (as S4-C believes), since it could be genuinely interesting for “third party listeners” (as SM1 and SM2 on S4 claims). But then again, the amount of navigation related VHF-talk might actually increase instead, since initiating communication with other AIS-fitted ships will become easier with the problem of misdirected communication out of the way.
4.1.2 The role of private and public information

During the conference where the focus group was held, one conference participant told me about a very interesting problem connected with the phasing-in of AIS technology in maritime transportation. Some ships, the ones I call the 'haves', will be fitted with AIS and have access to the information sent out by other AIS-fitted ships within VHF-range. Other ships, the 'have-nots', will lack direct access to this information. What the participant pointed out was that this knowledge gap can create problems of coordination.

When AIS-fitted ships communicate, they now address each other with their names, leaving out position coordinates or landmarks (as confirmed by S4-SM2). There is nothing strange in this of course, it is exactly what they are expected to do. But what happens when we view this communicative exchange from the perspective of a third party lacking AIS-technology? While before, this exchange could be pinned to ships on the third party's radar screen via the position information contained in the VHF-calls, the communication now becomes much more difficult to decipher. I will call this The Problem of Public Information Loss.

The hypothesis that The Problem of Public Information Loss is a real problem and a real loss – suggested by the conference participant as well as by Michael Leonard-Williams in a two page paper in Seaways (1998) – was probed by the scenarios used in the interviews on S4. It is important to realise that the accounts given by my informants regarding the possible uses of public VHF-talk was solicited by my scenarios and rather directed questions. Almost all interview excerpts in this section are taken from the scenario-based interviews conducted on S4.

None of the informants I interviewed had really thought about the issues I raised previously, although they immediately recognized what was problematic.

S4(8)-119 Oll: One idea I've had which I am testing now is that
S4(8)-120 Oll: it can, since if it is so that this communication
S4(8)-121 S4(8)-122 S4(8)-123 S4(8)-124 S4(8)-125 S4(8)-126 S4(8)-127 S4(8)-128 Oll: Yeah, because I don't know if it is, what it is called.
S4(8)-125 SM1: no, right.
S4(8)-126 S4(8)-127 S4(8)-128 Oll: And that one is calling up the other one which, they know each other names, but I don't keep track of that over there. So that could be
S4(8)-128 SM1: mm
S4(8)-129 Oll: a bit of trouble.

Like SM1 on S4, his colleague SM2 also recognize the problem:

S4(7)-249 SM2: But of course, if everyone had AIS it would have been much
S4(7)-250 S4(7)-251 S4(7)-252 S4(7)-253 S4(7)-254 S4(7)-255 easier. Especially, like you say, it is an important point actually,
S4(7)-255 when there are this many ships, that they can all follow
S4(7)-255 the communication.
S4(7)-253 Oll: mmm
S4(7)-254 SM2: It does becomes even harder here to keep track of things - like you said, than here
S4(7)-255 where it could understand -
Earlier though, on the same occasion, S4-SM2 made it clear that ships without AIS (ship B in *Scenario 1*) would not be left out of communication initiated to solve traffic situations. “*Some sort of third class citizens*” will not be created according to S4-SM2.

In *Scenario 1* though, ship B is perhaps not exactly a third-party, but perhaps rather one of the addressees. If other ships are nearby, but not considered to part of the situation, perhaps they will not be accounted for by the primary participants. While S4-SM2s statements on this issue are slightly ambiguous, he at least thinks that in the case of a situation like the one represented in *Scenario 1*, the AIS-fitted ships (ship A and C) *should* consider the fact that non-AIS-fitted ships are nearby (ship B) when talking and making decisions about what to do (S4(7)-87-94, SM2).

When, I queried the captain (S4-C) about this issue, he did not at first see what the problem was, or did not consider excluded third parties a problem. When we talked about this issue in the context of ship-to-shore communication, he recognised that it loss of information for ships not fitted with AIS could be a problem, but trusted rules and regulations to handle it. The captain believes that mandatory VTS reporting points will continue to exist until everyone indeed has AIS (and this was at least the case at VTS1).
A premise for The Problem of Public Information Loss to be a real problem, to be a real loss of information, is of course that mariners indeed do listen to the VHF-talk of others. This was confirmed by at least the two second mates:

S4(7)-121 SM2: [...] I would listen and I would hear how they were talking and then I would figure out who was who so to speak.

SM2 is here discussing Scenario 1, taking the role of ship B, the one ship not fitted with AIS. Clearly, listening to the VHF-talk, and “figuring out” the identities of the interlocutors is something he would do (that is, map the voices on the VHF to echoes on his radar screen or in his visual field). This mapping work has to be done whether or not the third party has AIS, but the operations involved will be slightly different.

SM1 even more strongly confirms that VHF-talk is attended to, and says that he sometimes follows others' conversations when they switch over from “public” to “private” channels\(^{15}\) (again, this is about Scenario 1 and SM1 is taking the role of ship B):

S4(8)-57 Oll: If the situation is like this and they make contact,
S4(8)-58 do you listen then?
S4(8)-60 SM1: Yes
S4(8)-61 Oll: So you use it? Is it like, an important source of information, the VHF-communication between ship A and C?
S4(8)-62 SM1: Yes yes, sure. And if they start talking with each other and say that they switch over to channel sixty, I'll do so too.
S4(8)-64 Oll: Yeah okay, right, right.

I believe I have at least shown, using my interview data, that there is a very interesting issue here. Mariners do listen to the VHF-talk between others, and often find it interesting as well as useful (of course, not regardless of the topic, but at least when it concerns navigational matters). Due to the advent of AIS, the format of many VHF-calls has changed, positional information has dropped out and the names of ships have taken its place, and it will possibly lead to a decrease in the amount of navigation related VHF-talk. This could mean that an important source of information is lost for mariners without AIS or mariners having AIS-information presented on an MKD or other small stand-alone display (which do not seem to utilise AIS much, judging from my observations at S2, and some of the comments made during the focus group session).

Recall that two of the most important objectives of introducing AIS stated in IMO’s resolution is (a) to “help identify vessels” and (b) to “provide additional information to assist situation awareness”. However, what I am suggesting here, is that changes in the way mariners use VHF-radio being brought about by AIS, may lead to a conflict between these two objectives. The (undoubtedly useful) help in identifying vessels provided by AIS may cause a loss of important information contributing to the “situation awareness”

\(^{15}\)All channels are public in a sense of course, since anyone with a VHF radio can tune in and listen.
of mariners. Mariners without AIS onboard will especially, but not solely, be subject to this loss.

My suspicion, based on comments made by my informants, is that the widespread use of AIS will disrupt a shared source of information about the environment of navigation, formerly available to both “haves” and “have-nots”. This source is the traffic over VHF-channel 73, used by both ships and VTS stations. Previously, to address a ship via VHF-radio, mariners had to use descriptions such as “northbound ship south of buoy 41”, or “ship at position X Y” in order to get the attention of the addressee. Now, with the advent of AIS, ships can be directly addressed with their names instead (or call signs, if names are difficult to pronounce). This is indeed a positive feature often highlighted in discussions about the uses of AIS. The problem is that as soon as position information is dropped from VHF-calls, the communication conducted over the shared channel will become difficult to use by those “listening in”.

Overhearing ships lacking AIS will definitely not be able to extract information from conversations between AIS-fitted ships, since the identity of ships is disclosed from them. Further, even overhearing ships fitted with AIS might have difficulties getting hold of this information since it will take time to search and find a ship on the ECDIS or radar with only a name to go on. Call signs were sometimes tagged to ship-icons when AIS data was presented on the ECDIS/radar display on S2, S3 and S4, but the names of targets were not displayed. Furthermore, when AIS targets are in “sleeping” mode, in order to reduce the amount of information on the ECDIS/radar, neither the targets call sign, nor its name is displayed. It is also plausible that getting this information by audio will cause less interference with other tasks occupying the navigator, than if he or she has to look up the information visually on his or her AIS unit.

Before going on to the next analytic theme, I want to tie the discussion back the theoretical approach of distributed cognition and the idea of common ground. I think one reason why The (Potential) Problem of Public Information Loss has not been discussed much (as far as I know, the only one who has raised it in print is Leonard-Williams (1998)), is an overly simplistic view of cognition and action as taking place in, and originating from, individuals alone, as well as a complementary view of communication as transmission of messages along a channel between two interlocutors (“the conduit metaphor of communication” (Reddy, 1993). Reflections of these common perspectives on cognition and communication can be glimpsed in the phrasing of the IMO-document cited above: “data received via AIS will improve the quality of the information available to the OOW [Officer On the Watch], whether at a shore surveillance station or on board a ship”. If one is looking at the information flow from the point of view someone at the one end of the conduit of information, it is not surprising that one overlooks what I have decided to call The Problem of Public Information Loss. Adopting a different unit of analysis like I have done, the problem becomes apparent though. The relevant flow of information and “shuffling” of symbols is not taking place in the heads of mariners alone, or even at individual bridges alone, but exchange of information is also taking place in a public arena provided by the open VHF channel. With access to this arena, participants build up a shared set of presuppositions, they establish a common ground. This is a
requirement for this public arena to function (indeed, for it to be a public arena). Communication does not merely involve what Clark (1992, 1996) calls the primary participants but also various side-participants. When designing information and communication technologies like AIS, these side-participants have to be taken into account (they also have to be taken into account by mariners when they design their VHF-calls). This case gives additional support to “the diagnosis that the reason why many systems fail is due to the fact that their design pays insufficient attention to the social context of work” (Hughes et al, 1994, p. 429). More specifically, it reiterates a lesson learned from previous workplace studies, namely the often frequently important practice of sharing information through inadvertent overhearing of the conversations of other (Roger and Ellis, 1994, p. 121). Norros and Hukki calls this phenomena the “openness of communication” and points out that it often serves “as a means to achieve shared situation awareness” (1998, p. 86).

4.2.0 Information needs of the mariners

From the point of view of distributed cognition, usage of AIS is naturally couched in terms of information flow. We can ask: what are the information needs of the mariners with regard to AIS?

My interviews with the mariners has shown that the information provided by AIS that mariners use and find important are the novel information that was previously inaccessible before AIS. Below is a typical answer regarding the primary uses of AIS:

S3(1)-242 Oll: ...what changes have like, the ehh, well in
S3(1)-243 like tasks of the OOW, have AIS brought about, or has it
S3(1)-244 done that...?
S3(1)-245 SM1: No
S3(1)-246 Oll: Any big changes or?
S3(1)-247 SM1: No, it is just that it is easier to identify the boats, see where
S3(1)-248 they are heading and how big they are for example. That is important because
S3(1)-249 it is shallow here sometimes, then you know that it will probably go there
S3(1)-250 instead.

From the pool of interviewees I met, this is a very representative answer. Every single interviewee mentioned the ability to identify other ships as a big advantage, the need for this information was clearly salient to everyone. Many also mentioned both destination and draught (at least S3-FM, S4-SM1 and S4-SM2). Another useful piece of information provided by AIS, which as less explicitly stated as important, was the nationality of AIS-targets. While it was less explicit, it was clear that it was considered to be useful and meaningful data for many mariners (S3-FM, S4-SM1, S4-SM2, and VTS2-Staff).

The gained ability to identify ships was an expected advantage which was merely confirmed by my informants. This was also the case with destination as well. However, at least for non-mariners, the advantage of knowing the draught and nationality of other ships is not obvious. As S3-SM1 explained in the excerpt above, if ships are in waters with varying depths, lets say a deep water passage hedged by more shallow waters, knowing a ship's draught may help mariners to predict how they will navigate (if it is a big ship with large draught, it has to follow the deep water passage).
The use mariners make of information about nationality is the most unexpected. Nationality is not a designated information slot in AIS messages, but can be read from the letter combinations in the call signs of ships (for example, Swedish ships have call signs ranging from SBAA to SMZZ). Call signs can be displayed beside the AIS-targets in the ECDIS or on the radar screen.

At one point, when I visited S3, the first mate showed why nationality might be of importance for making navigation decisions. S3 was trailing a small Russian vessel when the following were said:

S3(4)-125 FM: ...I don't want to go on his inside you know because
S3(4)-126 that Russian over there, you can get some horrible communication problems with
S3(4)-127 him.
S3(4)-128 Oll: yeah okay
S3(4)-129 FM: Their English isn't exactly Oxford English.
S3(4)-130 Oll: No, right
S3(4)-131 FM: No, I will keep my track up here, nice and easy

Knowing the nationality of a ship will project expectations about how the ship is likely to behave, based on previous experiences or on hearsay. The first mate decided to keep his track, “nice and easy”, in order to avoid a situation where he might have to communicate with the vessel.

S3-SM1 and S4-SM1 also commented on communication problems with Russian ships.

S3(1)-119 SM1: ...then there are many, for example Russian ships who
S3(1)-120 perhaps doesn't answer calls and such.
S3(1)-121 Oll: No, okay.

... S3(1)-129 Oll: But the Russian ships. Why don't they then answer calls?
S3(1)-130 SM1: Some do, some don't. I don't know really, I
S3(1)-131 don't know.

The problem described by SM1 is not that of misunderstandings and non-Oxford English, but that (some) Russian mariners neglect to answer VHF calls completely. S4-SM1 also claims that Russian mariners seldom answer calls:

S4(8)-80 SM1: ...There are many Russians that go here
S4(8)-81 as well. They don't hear anything at all.
S4(8)-82 Oll: No
S4(8)-83 SM1: and they don't speak English well, so if a ship answers
S4(8)-84 Oll: Is that why they don't hear, because they are no good at English or that
S4(8)-85 they don't perceive?
S4(8)-86 SM1: Yeah yeah, then they don't answer at all...

The staff member at VTS2 I talked to also mentioned communications problems due to the “guttural calls” of Russians and the bad English of French mariners' VHF calls. One of my interviewees also mentioned that mariners from various countries where the wages of mariners are very low often navigated blindly by their track, often in contravention to
the COLREGS. If their masters told them to navigate without deviation from their track (in order to save time and fuel), they did. According to my interviewee, this behaviour sprang from their great respect (or fear) for authority. In a report of a survey ordered by the Nautical Institute (Syms, 2003), many respondents specifically targeted specific nationalities as having a poor appreciation of the COLREGS or generally as behaving recklessly (p. 8-10). The same report has data which indicate that the beliefs behind this finger-pointing is often inaccurate, reckless behaviour and poor appreciation of the COLREGS is widespread across the board, regardless of nationality. Whatever is really the case about the behaviour of mariners from various nations, it is clear than nationality is a highly meaningful category for my interviewees.

Perhaps surprisingly, no one explicitly mentioned that the heading information was interesting and useful. According to Pettersson (2002; referred in TRB, 2003, p. 63), mariners involved in earlier tests of AIS “want an accurate heading sensor on AIS displays because heading is possibly the most important part of a navigational message” (TRB, 2003, p. 63). The reason for this neglect could be that heading is not a new kind of information, since it was previously (and still is by the way) supplied by the radar when ships were plotted.

It is interesting that two of the slots of information judged to be especially useful by my interviewees, destination and draught, are optionally entered at the start of a ship's voyage. Often this information has not been entered at all, or, even worse, has not been updated and is inaccurate. This issue, as well as the status given to the redundant information supplied by AIS, i.e. the information already provided by other technologies on the bridge, naturally leads into questions of trust and the importance of how AIS-information is presented.

### 4.3 Trust and presentation of AIS-information

To what degree mariners perceive information as trustworthy will obviously influence what use they put the information to. Picking up the questions raised at the end of the last section, I want to look at what my interviewees revealed about preferences regarding how AIS-information should be presented and what they think about the reliability of AIS-information.

How does the fact that the optional part of AIS-messages often have empty information slots, or even slots filled with incorrect information, affect mariners' trust to AIS-information in general? On my visit to S4, SM2 at one point went through the AIS-information sent from a nearby ship, showing me how the ECDIS system worked (on which AIS-information was displayed. I find the excerpt quite revealing:

S4(2)-65 SM2: Position, accuracy low. It's a tanker. With dangerous cargo,
S4(2)-66 perhaps that is what it means.
S4(2)-67 Oll: Yeah okay.
S4(2)-68 SM2: Crew onboard, zero (laughs)
S4(2)-69 Oll: (Laughs) Yeah okay, sounds dangerous
S4(2)-70 SM2: Absurd.
S4(2)-71 Oll: (Laughs) Okay, yeah right. But okay, these vectors they just appear
S4(2)-72 when you
When the information on the number of crew members proved to be obviously inadequate (hopefully, it was inadequate), the second mate asks rhetorically about the draught entry, "can I trust that when it says crew onboard zero?" So, not only is it a problem that the optional entries mariners are interested in might be incorrect, but if some entry is obviously incorrect, it will cast doubts on whether the other optional entries are correct as well, possibly even cast doubt on the correctness of other required parts of the AIS message.

Other aspects of how mariners treat AIS information is evident when they talk about where they want AIS data to be presented, as well as in their answers to questions about how they treated AIS data when it contradicted or differed from information coming from other sources of data (for example when both AIS and radar provide a nearby ship's heading, and the information differs). On several occasions, by several people, the idea was expressed that the radar provided a less distorted channel to the real world than AIS, although it was not quite a universal view. During the focus group session, M5 and M8 had the following quite interesting exchange. The topic of discussion was the advantages and disadvantages of different ways of presenting AIS-data:

FG-104 M8: ...you always want a radar screen
FG-105 to be as clean as possible, you don't want a lot of distracting clutter
FG-106 and you can count AIS-data as that. Today, there are
FG-107 radars where you can get the AIS targets on your radar screen as well. But
FG-108 I think, as a mariner, you rather want to have that information in
FG-109 the ECDIS instead and that which is in the radar is like, that which is true.
FG-110 It's what you see, it is there.
FG-111 M5: Reality.
FG-112 M8: Yeah, it's reality.
FG-113 M5: [inaudible] ...a fictive image which might correspond well enough with
FG-114 reality, but when you get into a situation where you
FG-115 really have to focus on where you are, and why, then
FG-116 you look at the radar, there you know that you have the truth.
FG-117 M8: And what is he doing? What are his intentions? You do know, and
FG-118 even more today, that the presentation of AIS targets is based on the
FG-119 embedded GPS or on a connected GPS. And you don't know
FG-120 the degree of truth of that information either.

M5 talks about the ECDIS as a fictive image, and thinks that AIS information belongs in this fictive representation, rather than in the radar screen which displays “reality”, giving the mariner “the truth”. A similar attitude was expressed by the captain of S4 when I interviewed him and SM2 on the bridge:
The radar is “the one that is” and the radar echo of a nearby ship is the “real enemy”. For a non-mariner, this attitude might be difficult to fathom. Why is the radar image considered as “reality”, while AIS information displayed on the ECDIS is “fictive”? Such a judgement might be grounded in the fact that most of the information in the ECDIS is pre-installed and not updated continuously, while there is much less such pre-installed information displayed on the radar screen. Thus, what is displayed on the ECDIS screen is thought of as less direct and of a more fabricated nature (but the radar image is just as fabricated of course). Interestingly, on S3 where AIS-information was displayed both in the ECDIS and in the radar, this attitude towards AIS-information was not present to the same degree (although, I must admit, the data on which I base this is scant). This is what S3-SM1 had to say:

S3(1)-162 SM1: We do trust the AIS. We do know that when we plot a ship on the radar so to speak, then it takes two three minutes before the correct information is there you know. So we do trust AIS directly...

The fact that the information gained from plotting a ship is delayed was also mentioned by the captain and the first mate on S3. So, following the logic of the mariners who view the radar image as reality, one could say that it is in fact the radar image which is more of a fiction since it is always lagging behind, never being quite up-to-date with reality and truth.

This is not to say that the crew on S3 categorically trust AIS-information rather than information from the radar. But the base for distrust is different. Another reason put forth by the mariners for preferring radar information rather than AIS information is that the AIS information not only depends on the proper working of their own AIS unit, but also on the proper working of the AIS units of others. The radar on the other is truly autonomous, not requiring the cooperation of other ships. This way of thinking was evident in the excerpt from the focus group discussion above. Here it is again:

FG-117 M8: And what is he doing? What are his intentions? You do know, and
FG-118 even more today, that the presentation of AIS targets is based on
FG-119 embedded GPS or on a connected GPS. And you don't know
FG-120 the degree of truth of that information either.

S3-FM provided the same explanation of why he would trust radar rather than AIS in case of a conflict between the two sources:

S3(4)-191 Oll: ...if you imagine that the radar
S3(4)-192 and the AIS would give contradictory information so that
S3(4)-193 the radar echo would be in one place while, for example, this
S3(4)-194 AIS-triangle would be in another place. What would you trust
S3(4)-195 so to speak?
S3(4)-196 FM: Then I would trust my image here (the radar screen in front of him) with caution, because
S3(4)-197 his GPS might have lost the signal for a while. It happens
S3-FM prefers to navigate by his own instruments rather than the instruments of others. If he has problems with his own instruments – radar, AIS, or the various sensors feeding into them – he is likely to be aware of it and be able to take due precautions. If he is fed with false or misleading information from others' faulty instruments, he might not become aware of it until it is too late.

There are naturally a whole host of factors influences how mariners trust their instruments, and how they (think they) prefer their AIS-information to be presented. Paramount here is probably their degree of knowledge of how the system works technically, their hands-on experience with the system and their general attitude toward new technology (see Lee and Moray, 1994). I merely wanted to point out two interesting factors which influence mariners' judgement of AIS-information.
5.0 Conclusions

Here is a point by point summary of my findings organised around the analytical themes of **AIS and VHF-communication**, **AIS and information needs**, and **trust and presentation of AIS information**.

**AIS and VHF-communication**
- Mariners do not only attend to VHF calls directed *at them*, they also listen in on VHF communication between other ships. They do this out of mere curiosity and in order to be updated on the traffic situation.
- The content of the VHF talk of others greatly influences whether the talk is experienced as distracting or of genuine interest.
- Since the introduction of AIS on an increasing number of vessels, the format of VHF-calls between ships fitted with AIS has changed. AIS-fitted ships address each other by their names, not by their positions.
- It is unclear whether AIS will lead to an increase or a decrease in the amount of VHF-traffic. However it is likely that if there is a decrease, the decrease will be in VHF talk related to navigational matters, not in "social chatter".
- As long as some vessels do not have AIS-technology, there may be a Problem of Public Information Loss. The new format of VHF-calls between AIS-fitted vessels make calls difficult to decipher for vessels without AIS (i.e. it will be difficult to identify the primary participants of the communication). This results in a loss of potentially useful information for those vessels without AIS.

**AIS and information needs**
- The main information needs AIS seems to have fulfilled are related to the truly novel information provided by AIS. By far the most commonly mentioned advantage of having AIS mentioned was the ability to identify other ships. Other important information facilitated by AIS was the destination of other ships and their draught. Knowledge of destination and draught help mariners to predict how other ships will navigate.
- Mariners also find knowledge of other ships' nationality useful. There is no designated information slot for nationality in the messages sent out by AIS but it can be read off from a ship's call sign. Nationality is deemed useful because of perceived lack of communicative skills on the part of mariners from certain countries. Also, mariners with certain nationalities are judged, in general, to be more reckless about complying with the COLREGS than others. Therefore, knowing the nationality of a ship is judged to be important for making informed decisions about how to navigate.

**Trust and presentation of AIS-information**
- Where AIS-information is presented seems to make a big difference for judgements of its trustworthiness. The radar is viewed as giving an undistorted image of the world outside the ship, while the ECDIS on the other hand, gives a fictive image, which might correspond well with the world outside, but is still of a more distorted and fabricated nature than the radar image. When AIS information is overlaid on these images, the judgements about the quality of the images seem to be transferred to the
AIS-information. Thus, mariners which had no experience of AIS-information presented over the radar image clearly judged radar information to be more trustworthy than AIS information. However, this was not the case with mariners that had experience of AIS-information being presented on over the radar image.

- Mariners frequently experience that the optional part of AIS-messages contain faulty information. This may lead to a general distrust of the optional information at all times. Unfortunately, the optional part of the AIS-message contains entries for draught and destination, which the mariners clearly thought of as useful information relevant for making decisions about how to navigate.

Some more general conclusions can be drawn from this study as well. What can be said about my chosen methodology and theoretical framework in light of the my empirical material and conclusions? A modest conclusion is that ethnographic naturalistic inquiry constitutes a fruitful way of learning about how people adopt new technologies in their work practices. Some of the knowledge gained in this study is valuable. For example, awareness of what I have called the Problem of Public Information Loss – if it indeed is a problem – could inform the education and training of mariners. Some of the findings about how trust in AIS influenced by where AIS-information is displayed, could be important both in bridge design and for identifying training requirements. Although, it is not directly connected with AIS, the way some of the mariners talked about the epistemological status of information provided by the radar is frightening and should perhaps have implications for how mariners are trained (admittedly though, what patterns in navigational practice this talk reflects are unknown, but the problem have been noted before (Lee and Sanquist, 2000)).

One of the more unexpected findings of the study was the unanticipated use of the call sign of ships provided by AIS. I think it is unlikely that I would have “discovered” this if a different methodological approach had been used. While the (Potential) Problem of Public Information Loss was not discovered by detailed participant observation of in situ work practice, but rather by informally talking to a participant at a maritime conference (such informal talk is definitely part of ethnographic approaches in general though), the problem does highlight the importance of social distribution and coordination, processes which part and parcel of the theory of distributed cognition. The previous neglect of the role of VHF-communication for side-participants reflects an impoverished view of communication. A distributed cognition approach to cognition and communication looks at cognitive processes wherever they occur, and is thus likely to highlight such flows of information which do not conform to such impoverished models.

The findings of this study are all rather tentative, due to the limited amount of fieldwork. However, the findings do point towards some interesting avenues of future research. More research on maritime work practice and the role of technologies in such practices are needed to substantiate and follow up some of the themes explored in this ethnography. Here are four suggestions for further research (all connected to the AIS-VHF theme):
A fruitful avenue would be to collect a corpus of VHF-talk and look more closely at communication between ships fitted with AIS and ships lacking AIS. This could substantiate some of the findings of this ethnography.

Another obvious path forward would be to interview OOWs on ships without AIS to see how they perceive the new situation created by the introduction of AIS. Do they recognise the Problem of Public Information Loss? After all, the perception of the mariner without AIS is central to this problem.

Yet another continuation would be to more systematically explore how OOWs design their VHF-calls in light of the traffic situation they face, and the audience they address (i.e. to phenomena of “audience design” in Herbert Clark's theory (see section 2.1.2)), perhaps using bridge simulation facilities. How do mariners' define the traffic situation? Do they take account of potential side-participants when they address other ships over VHF radio?

Finally, one could move awareness of the Problem of Public Information Loss into the context of design of AIS displays: How could the design of AIS-information presentation promote the OOW's awareness of the Problem of Public Information Loss?
References


Pettersson, B. (personal communication, August 2003).


Appendix A: Scenarios

Scenario 1
The following A4 paper was presented to the interviewee:
The following instructions were then given:

_Imagine that you are the officer of the watch on ship B. Your destination is Västhamn. What do you do? Please tell me in the present tense, as if it was happening now. Reason about how the other ships might navigate as well._

After the interviewee was done with his thoughts on this, and I was done asking follow up questions, I wrote the text “AIS” inside the icons of ship A and C.

_Now imagine that you are the officer of the watch on ship A. Your destination is Sydhamn. What do you do?_

If the interviewee said that he would use the AIS to check what destination ship C was heading for, he was told that ship C was heading for Norrhamn.

_Finally, imagine that you are officer of the watch on ship C. Your destination is Norrhamn. What do you do?_

If the interviewee said that he would use the AIS to check what destination ship A was heading for, he was told that the information slot for destination was blank.

I proceeded after each step in the instructions with questions about, for example, what COLREGS rules were (or could become) of relevance in the situation, what additional information might be of help in the situation, what difference AIS would make, _et cetera_. I also tried to make the interviewees sketch and develop different possible scenarios on the paper sheet, although this proved to be more difficult than I had expected. The interviews was recorded with a mini disc player.
**Scenario 2:**
Scenario 2 had the same instructions as scenario 1, although the scenario was slightly more complex with two additional ships. The following A4 paper was presented to the interviewee:
"On-the-fly" scenario:
The following A4 paper was presented to the interviewee:
This piece of chart copied onto the A4 paper represents a difficult passage, usually with a lot of traffic which S4 passed on every journey. After the A4 paper had been shown, the following instructions were given:

_Imagine that you are officer of the watch on ship C and are heading north. What do you do?_

A followed up with questions about what difference AIS could make in the situation, what potential problems lay ahead in this kind of scenario, which rules from the COLREGS were of relevance in the situation, _etcetera._
Appendix B: From down-jotting to up-writing

Below are two scanned pages of down-jotted field notes from the fourth ship visit. On the next page, I give an excerpt from the “up-written” notes based on these jottings.
After I had written up the jottings from the two scanned pages, the result looked like this. I have left the text untranslated. The names of the informants have been replaced by the signatures (from Table 1).

c. 9:45

C kommer upp på däck och sätter sig i stolen babord om navigatörens sitts, där jag suttit tidigare under morgonen. SM2 börjar diskutera SOW, COG, SOG, heading och dylikt med C och jag kommer in då och då också.

SM2 menar att alla ska egentligen köra på ”SOW”-fart för att det är det som gäller vid sikt, när man ser båtar och/eller deras lanternor. C tror däremot att det mest handlar om att alla ska ha samma fart, inte att det är något speciellt med SOW. Båda är dock överens om att i princip alla kör på efter GPS-fart. C tror att kravet snart kommer att ändras, att snart är kravet att alla ska köra utifrån GPS-fart (det viktiga är dock enligt C att alla gör på samma sätt).

Alla kör också efter ”i sikte”-reglerna även om man inte har andra båtar i sikte. SM2 säger att det egentligen är helt andra regler som gäller då två fartyg inte är i sikte av varandra, då ska båda se till att hålla undan för varandra. C verkar ovetande om denna distinktion. Hur som helst är de båda överens om att man kör efter ”i sikte”-reglerna, även då man inte har varandra i sikte. Detta kan förstås vara pga att ha något på ECDIS:en/AIS:en/radarn ger ungefär samma effekt som om man skulle ha fartyget i sikte istället.


C berättar att det kan vara mycket bra att ha AIS vid bogsering i hamn och liknande. Då kommunicerar man med radarbåtarna via VHF:en och man kan inte se bogserbåtarna (kanske) eftersom den egna båten skymmer radarn på så pass korta distanser.
AIS in The Currents of Sea and Thought - An ethnographic study of mariners' use of the Automatic Identification System

Abstract
An ethnographic study loosely informed by the theoretical framework of distributed cognition was carried out in order to describe how mariners have adopted the Automatic Identification System (AIS) in their work practice, or "made the technology their own". AIS is a transponder-based identification and communication system that allows ships to automatically identify and track each other. In addition to facilitating the identification and tracking of ships, objectives behind the introduction of AIS are to "simplify informational exchange", and "provide additional information to assist situation awareness". Participant observation and interviews were made at four different ships, as well as at two shore stations. A focus group was also held at a maritime conference. The study gave some interesting results. For example, a Problem of Public Information Loss was identified. It is tentatively suggested that this problem has been overlooked partly because of a widespread but impoverished model of communication which does not account for the role of side-participants in a conversation. It is concluded that more research needs to be done on maritime work and the use of new bridge technology.

Nyckelord
AIS, Automatic Identification System, distributed cognition, ethnography
På svenska

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