TALK AND TRUST BEFORE TECHNOLOGY: FIRST STEPS TOWARD SHORE-BASED PILOTAGE

M Lützhöft and **K Bruno,** Chalmers University of Technology, Sweden

SUMMARY

Many instances discuss shore-based pilotage (SBP) as if it was only a question of putting technology to work. "The technology exists", we are told. The Swedish Maritime Authority commissioned a "pilot study" to clarify definitions, technical and operational limitations, and to suggest a way forward regarding testing and simulations. Here, some of the results of the study are presented. It is for instance clear that in the minds of today's pilots and VTS operators, technology is not a central aspect of their work. Communication and trust are two issues that both seen as far more important, and they are presented and discussed.

1. INTRODUCTION

Shore-based pilotage – often defined as *"an act of pilotage carried out in a designated area by a Pilot licensed for that area from a position other than onboard the vessel concerned to conduct the safe navigation of that vessel"* [1] – is a point of both interest and some controversy to the maritime community. Some argue that with today's technology, time and resources can easily be saved by providing piloting services from the shore; one argument is that if air traffic can operate under constant ground-based control, the same should be possible for maritime traffic. This is however disputed by practitioners in the field, who assert that the domains are very different and that pilots are needed onboard most ships to maintain an acceptable safety level [2].

In order to shed more light on the feasibility of shore-based pilotage, the Swedish Maritime Administration (SMA) commissioned a preliminary study, which this paper is based on, to clarify definitions and technical and operational limitations. The study was also to suggest possible ways forward with regards to testing and simulations.

2. BACKGROUND

Pilots have been employed in seafaring since ancient history, working under varying conditions. In medieval times, as recorded in the so-called "Sea Laws of Oleron", the captain had the right to cut off the pilot's head for endangering the cargo or the crew [3]. This practice has fallen into disuse in modern times, something which can easily be construed as an early victory for Human Factors in this domain.

A newer idea, also with the prospect of changing the working conditions of the pilot, is the idea of shore-based pilotage. As a concept, it is fairly new, and intimately linked to advances in maritime technology, e.g. AIS [4]. The presented motivations vary, but it is commonly assumed that shore-based pilotage has the potential to facilitate the flow of traffic and to improve safety. There is also a perception that a system with shore-based pilotage will require less manpower than traditional piloting, thus helping to alleviate today's shortage of seafarers.

One simple form of shore-based pilotage already exists in several European ports [5]. When the weather conditions prevent pilots from boarding at the regular boarding point in these ports, certain vessels can be remotely guided to calmer waters – where a pilot can board – with the aid of radio instructions from a shore-based pilot, who uses radar to monitor the progress of the ship. The service is only offered to vessels that fulfil certain requirements on length and draft, and the master, the pilot and the port authority must all agree that the shore-based pilotage can be carried out safely. This enables a limited flow of traffic even in adverse weather conditions, and is likely a great asset for heavily trafficked ports like e.g. Rotterdam, but is of course far from being a service that actually improves the efficiency of a port in good weather.

Whether or not shore-based pilotage can improve on, or at least maintain, today's safety level is still an open question. The fact that even the limited form detailed above not only works, but works in bad weather, indicates that it is not an impossibility. On the other hand, an onboard pilot seems to have a positive impact on safety. According to statistics from the Swedish Maritime Administration, only 6 out 42 groundings in Swedish waters during 2007 occurred with a pilot on board [6]. Exactly how this safety effect works is not clear, but one earlier analysis [7] indicates that the safety gain is not evenly distributed across all ships that are subject to pilotage. It is rather dependent on variables such as ship manoeuvrability and crew competence, with ships that are comparatively harder to control (less manoeuvrable, less experienced crew etc.) benefitting more from having a pilot onboard.

At this stage, however, it is too early to discuss issues as complex as system safety effects or efficiency. It is not even clear exactly what a more advanced form of shore-based pilotage is or might be, nor what would be needed to carry it out. The present study aims to be a first step towards answering those questions.

3. EMPIRICAL STUDY

3.1 INTRODUCTION

In order to get input from domain experts, we interviewed active pilots and VTS operators at the port of Göteborg, Sweden. The purpose of the interviews was to gather opinions from domain professionals about the prospects of shore-based pilotage, as well as to get a picture of the work situation today, at sea and in the control room (it is assumed that shore-based pilotage in any form will have tasks in common with how VTS operates today).

3.2 METHOD

The interviews were performed using a focus group method. A focus group is essentially a form of group interview that collects information from several participants at once and at the same time makes use of the dynamics of a group discussion. The basic principle behind a focus group is that the participants are presented with a topic or with a set of topics and are encouraged to discuss these with one another. The discussion is led and controlled by a moderator.

Two focus groups were performed at VTS Göteborg. The first consisted of pilots and personnel from the Swedish Maritime Administration, including former pilots, and the second was held with VTS operators and SMA personnel. The participants were asked to discuss the subject "what characterizes successful ship assistance?" This expression was chosen to be appropriate both for the pilots and the VTS personnel. In the next step the characterizing aspects were grouped in categories. The experts then ranked the headings of these categories in order of importance. Another discussion regarding the ranking was held. When the participants were satisfied with the ranking the focus group was concluded. The meetings took approximately 2, 5 hours each. It should be noted that several of the participants had been involved in previous studies of the same subject. These participants claimed that this format allowed them to contribute opinions and knowledge that earlier studies had not captured.

3.3 RESULTS

The interviews generated a large amount of data of varying characteristics and relevance. Presented below is a summary of the results from both focus groups.

3.3 (a) Focus group 1 – The onboard perspective

The first focus group consisted of pilots and administration personnel (whereof some were former pilots) and focused on the onboard perspective, i.e. ship assistance from the point of view of a pilot onboard. The results presented below are divided into three categories. The two main subjects that were discussed during the focus group were the establishment of rapport between the pilot and the ship's crew, and the safety of the ship, the surroundings and the environment. In addition to these two we present is a category for general results.

Contact pilot-crew

The main part of the group claimed that a good rapport between the pilot and the crew, and especially the master, was a condition for successful pilotage. The pilots described this contact as the most important factor in their work, deciding what their role in the bridge team will be. The establishment of the rapport is then the basis for the pilot's work onboard. A typical comment was *"A good rapport between a pilot and a crew on all levels is a prerequisite for safe operations."*

The rapport was categorized in terms of social, psychological and diplomatic rapport. The importance of mutual trust was emphasised, i.e. that the crew trust the pilot's knowledge and that the pilot trusts the crew's competence. The establishment of trust is closely connected to a personal rapport. An important dimension of this is that when the pilot is onboard he also knows who he is talking to and notices if the crew understand or not. Via radio you are not sure who you are talking to and if the information is received and understood correctly.

It is also important to have a personal rapport to be able to handle information and clear up questions, for instance related to the passage plan. To jointly go through the plan ensures that all agree on the plan and that all are aware of it. It was described in the following way: the pilot can, after establishing rapport, work as an addition to the bridge team and assist with different tasks which may possibly be outside the primary mission as adviser. Even in those cases where the crew is well prepared for the passage the pilot could support by confirming the crew's decisions and knowledge.

Safety

The main objective was regarded to be the safety of the ship, its surroundings and the environment. A successful pilotage is a pilotage where no damage to the ship or its surroundings occurs. The pilot was generally regarded as an asset in the safety work even if there were varying views in the group. A comment was that the pilot adds an extra dimension to safety. Everybody agreed that an important part of the safety is the pilot's ability to judge the ship's status. The pilot comes from the outside, has no own interest in the ship and is therefore able to judge the navigation and manoeuvring equipment in a neutral and objective way. A pilot will do this in order to investigate the conditions for his own task and not in any formal inspecting role. Still, it increases safety as it is a direct foundation for the work of a pilot. A ship with bad equipment must be piloted with larger margins. One comment was: *"To have knowledge of the ship's status is* *important from a safety perspective and a prerequisite for risk assessment".*

General

Pilots had observed that there sometimes was a lack of trust between ship's crews and VTS operators. One explanation offered may be that many crews lack knowledge about the VTS system and therefore are unaware of the competence held by the VTS operator, what services are offered or to what extent they can trust the information received. Another point was that much of the knowledge held by the pilot is so-called silent knowledge that is difficult to verbalize and hard to teach to others. It takes personal experience to gain it – the pilots talked about a *"fairway culture"* and a *"feeling"* for the fairway, which includes how it works and how the service could best be performed. This is also something that is hard to teach and which grows with increased experience. The fairway culture in combination with the pilot's local knowledge makes it more or less automatic to note deviations in the fairway (buoys missing etc) which can be reported immediately.

3.3 (b) Focus group 2 – The shore perspective

The second focus group consisted of VTS operators and a person with administrative duties at VTS Göteborg. The focus here was on the shore perspective, i.e. the fairway passage from a VTS operator's point of view. The main discussion subjects in this group were safety of the ship and its surroundings, traffic flow management, and contact between ship and VTS. These are presented below, in addition to a general category.

Contact VTS-ship

Much of the discussion centred on communication between VTS and ship generally. Today no standard communication or even a standard language is used; both Swedish and English are used in parallel. This was highlighted as a problem; one participant noted that if the language problem was solved, the safety would markedly increase. Communication is also to a large degree adjusted to whom you are talking to. A comment was that it is important not to talk *"too well"* and not use an advanced language, which could be seen as arrogant at the same time as you risk not being understood. It was further noted that it is hard enough to understand simple tasks over radio, and probably almost impossible to perform more complicated tasks, for example to coordinate a turn. However, the participants believed that a lot of this could be solved with standardized routines for communication and with training. An important note was that: *"trust comes from knowing the other party's competence",* since we believe that pilots and air traffic controllers have no problems of creating trust over a radio link (and are also studying this further at present).

Safety

Just as the first group, the second group saw safety for the ship, its surroundings and the environment as a primary objective. The participants pointed out that environmental safety is an extremely important part of their work. One person stressed that the safety of oil transports was in principle the highest priority, since an oil spill would have serious consequences, and even threaten future operations. Apart from environmental factors general safety was ranked highly. The role of the VTS operators from a safety perspective was also discussed. The VTS operators today have no possibility to engage directly in the navigation of a ship but are limited to transmitting information. Nevertheless, the participants believed that traffic information alone could be a strong tool to increase safety. Another point was that VTS operators continually follow-up on ships and therefore have a possibility to provide information when something starts to go wrong, for instance if a ship is leaving the fairway.

Traffic flow

Another subject being discussed was the role of the VTS in order to make operations work effectively and to maintain a good traffic flow in all types of weather. Efficiency was highlighted as the most important after safety and the VTS operators play an important role (someone commented that the demand for efficiency should not be driven to the point where safety was endangered). The participants pointed out that many of the ships taking a pilot to Göteborg are well equipped and have such well prepared crews that they in principle could manage without a pilot onboard. If these ships could be assisted from shore, large economical and time effective gains could be made.

3.4 DISCUSSION

The most prominent result from the first focus group was the importance the pilots attribute to establishing good contact with the regular crew of the ship. It was considered to be a prerequisite for all successful piloting. The pilots also commented that rapport with the crew enabled the pilot to find his own role within the bridge team, and that this role was not always the role of navigational advisor. Rather, with a well-prepared crew, the pilot could end up in a more passive role, more supporting the crew's own decisions than helping to make them. This view was supported by the VTS operators, who claimed that from their point of view a significant percentage of the ships trading in the port of Göteborg were so well equipped and had such competent crews that they would be able to do quite well without a pilot onboard.

A point which was brought up during both focus groups was that many of the regular crews lacked knowledge about the VTS system and the role of VTS – including knowledge of the training and competence of operators – and that this could lead to insecurity and a lack of trust. The VTS operators believed that this lack of trust was in part related to the lack of standardized communication routines.

These results indicate that shore-based pilotage, though not suitable for all vessels in all fairways, would likely be possible for a segment of ships. If a significant portion of the vessels obliged to take a pilot today would be able to manage without a pilot, then those vessels could be assisted from the shore instead, at least in simpler fairways and good conditions. In that case, not taking a pilot can in one sense even benefit safety, as it eliminates the risk of the pilot and the master failing to establish a working relationship, with a subsequent negative working climate on the bridge. This is something which previously has been demonstrated to be of some concern [8].

Further implications of these results for shore-based pilotage has been discussed at some length elsewhere [7, 9]. The rest of this paper will focus on examining possible ways to proceed, particularly with regards to issues of trust and communication, which we believe are essential in any implementation of shore-based pilotage or, more generally, any kind of shore-based ship assistance, including VTS.

4. TALK AND TRUST (AND TECHNOLOGY)

There is sometimes a tendency to discuss shore-based pilotage in purely technological terms. This is a misguided approach. It is not technology, but rather human adaptive abilities, that makes work in complex systems or organisations possible [10]. This is also supported by our empirical study; the participants almost exclusively discussed the human aspects of the issue. Before proceeding further, then, the roles of the humans in the system should be defined. Two very important (and partially interrelated) aspects of this are communication and trust: how land and sea stations can communicate as efficiently as possible, and if and how it is possible to establish mutual trust without meeting in person.

4.1 TALK

The ability to maintain control in a system or an organisation is to a large extent based on communication [10]. Within the maritime domain, this is an issue that perhaps has not been given the attention it deserves. There are several maritime accidents where communication, or rather the lack of it, has been incriminated [11]. A notable case is the grounding of the *Sea Empress*, an oil tanker, off the Welsh coast. Present on the scene of the accident was a Chinese ocean-going tug, which unfortunately was prevented from participating in the salvage operation due to the fact that none of its crew spoke English. In the end, a cook from a local Cantonese restaurant had to be enlisted as an interpreter [12].

Although the example has a dimension of comedy, the environmental consequences of the *Sea Empress* grounding became severe, and it is likely that this outcome could have been mitigated had the Chinese tug been used more efficiently. Situations such as these stand in marked contrast to conditions within the aviation domain, in which a highly structured phraseology makes communication possible between parties who do not share a common conversational language. We believe that valuable insights can be gained by looking at aviation routines for communication, and a small study in this area is ongoing. Awaiting its conclusion, some brief preliminary remarks regarding the nature of spoken communication can nonetheless be made.

Perhaps the most obvious aspect is that messages have to be transmitted in a standard language, using a standard vocabulary. Since, in many cases, shore-based operators and ship officers have no knowledge at all of each other's native languages, communication can only work if a common standard language is used. The vocabulary is also important and should probably be designed to be as expressive as possible while requiring mariners and shore-based personnel to memorize as few phrases as possible. This is something that has been discussed and worked on for quite some time, so we do not suggest creating a new phraseology from scratch. What is needed is rather to adapt existing standard phrases to the needs of shore-based pilotage, and to find ways to encourage regular use of them.

Other aspects of communication include cultural issues such as nationality and work subculture, which affects the way one communicates. In cultures where *face* is a serious matter, mariners might, for example, find it hard to admit that they did not understand an instruction. Understanding thus has to be ensured in some way, possibly through a closed-loop communicative routine where all instructions are to be read back fully to the transmitting station. Such a routine does not guarantee understanding, but it is a start.

All this is before we even touch on the technical issues such as the quality of the radio link, or radio interference. Will we for instance need separate channels for each ship to make sure we can get through immediately if necessary? And what sort of backup system is suitable, should the primary means of communication become unavailable?

4.2 TRUST

Having the technical (in the widest sense of the term, also including language and phraseology) means to communicate does not guarantee that the communication will work to maintain control. The domain experts consulted in our study emphasized that mutual trust between shore and ship was also needed, and as much a prerequisite for shore-based pilotage as standardized communication routines.

Trust as a concept has often been studied in the context of close interpersonal relationships. But trust on such a level is hardly necessary (or appropriate) in the case of shore-based pilotage. We argue that what the participants primarily meant by the word "trust" was not a sense of personal trust, but rather a belief that the other party would be competent and knowledgeable, and behave in a predictable way.

In his book *Using Language*, Clark [13] describes the coordination needed to carry on a conversation, starting from the concept of a *joint activity* – an extended set of behaviours carried out by an ensemble of people, coordinating with each other. This work, as demonstrated by Klein and co-authors [14], can also be extended and applied to other coordinated activities.

Klein et al. utilize a range of concepts, many of which are potentially useful in an analysis of shore-based pilotage. A notable requirement for any joint activity is *interpredictability*; the ability for everyone involved to predict – to some degree – the actions of the other involved parties. If there is no interpredictability at all, no coordination is possible.

Interpredictability depends largely on *common ground*; the relevant mutual knowledge, mutual beliefs and mutual assumptions that people employ in support of coordination in a joint activity. Some of the most important types of such mutual knowledge, beliefs and assumptions are listed as:

- The roles and functions of each participant
- The routines that the team is capable of executing
- The skills and competencies of each participant
- The goals of the participants, including their commitment to the success of the team activity; and
- The "stance" of each participant (e.g., his or her perception of time pressure, level of fatigue and competing priorities). [14]

This list is almost a point-for-point reiteration of what our analysis of the empirical study showed is important knowledge for the establishment of mutual trust. It is thus strongly indicated that mutual trust in this context is related to the concepts of common ground and interpredictability.

Common ground can be considered to consist of three different parts [13] – *initial common ground, public events so far* and *current state of the activity.* The initial common ground refers to the knowledge and history the participants bring into the joint actions. This can be both general knowledge about the world, and particular knowledge such as the procedures related to the joint activity at hand or the knowledge that the parties have about each other's background, training and so on. In a shore-based pilotage context, it is important that everyone has sufficient knowledge about all the parts of the system, including the knowledge of roles and competencies of the other people involved.

Public events so far refers to the history of the current joint activity; the events that have happened and the actions that have been undertaken. Shared knowledge of this history works as a coordination device for the participants, and there are always a number of obvious issues to work out whenever a new person is introduced into an ongoing joint activity. To work on this part of the common ground, it would likely be useful to have handover procedures; detailed briefings on what has happened so far and what is about to happen whenever there is a watch change on board or a shift change in the control room. To some extent this already exists, but further work would likely be beneficial.

The current state of the activity refers to the situation at present, which provides cues for further actions. Establishing common ground with regards to the state of the activity will be a challenge for shore-based pilotage, as the information available on the bridge differs markedly from the information available in a control room ashore. The primary source of feedback for the pilot and crew onboard is the view out of the windows [15], which at least in a practical sense is impossible to transmit to a different location. Furthermore, it is possible for the participants in a joint activity to mutually believe that they share the same view or interpretation of the current state when they in fact do not. This often persists until one of the parties says or does something that makes no sense to the other party – this is known as a coordination surprise [14]. The surprise alerts the participants to the problem but by then it may already have started to cause trouble.

Interpredictability, and in particular common ground, are huge theoretical constructs, and further discussion of them are outside the scope of this paper. They are presented here as possible ways to look at issues of trust in a shore-based pilotage setting, mainly because they match very well what our participants claimed is important, and because we believe that they are a fruitful approach to further work in this domain.

4.3 TECHNOLOGY

After discussing the central concepts of talk and trust, some remarks can also be made about technology. Although we argue that human issues are more critical than technology, it is also the case that some sort of technological mediation will be necessary in any implementation of shore-based pilotage. This technology must be designed with care so that it can support work in an efficient way, both while planning the route and during the actual passage. Different technological solutions may be needed for these tasks.

The main source of feedback during the passage will likely be AIS information, possibly together with video cameras (already available in many ports) that enable direct visual input from parts of the fairway and port. For communication, voice-based VHF is likely to remain the primary system for some time. This should be supported by a backup system, such as cellular phones or similar.

Decision support systems are also sometimes mentioned in this context, but that is a complex issue and research in the area is ongoing. We will not speculate on the nature or design of such systems here, but will restrain ourselves to restate that if such systems are to be used, they must be carefully designed so that they can support work in an efficient way.

5. CONCLUSIONS

This paper is an attempt to take the first steps toward shore-based pilotage by outlining and defining some important issues. To conclude, it can be said that shore-based pilotage will not be suitable for all vessels or for all fairways, but that it could probably work for a segment of ships in less demanding fairways.

For shore-based pilotage to work there must be a working standard language and phraseology that is consistently used by everyone involved. Aviation could be a source of inspiration with regards to how to accomplish this, and research in the area is ongoing.

Interpredictability will also have to exist in the system. It can be created by working towards establishing common ground. Some intuitive points about this were presented above, but more work is needed; one suggestion for further research is to identify how common ground between ship and shore can be created and supported. This would be relevant not only for shore-based pilotage but for all sorts of ship-shore coordination efforts, including e.g. VTS as well as communication between ships and shipping companies.

Technology will also be necessary, but at present that is a secondary concern. Talk and trust are needed independently of how any particular technological implementation works. The final conclusion of this paper is thus in the spirit of all Human Factors work: we need talk and trust before technology.

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8. AUTHORS BIOGRAPHY

Margareta Lützhöft holds the current position of Assistant Professor at the Department of Shipping and Marine Technology, Chalmers University in Göteborg, Sweden. She leads the Human Factors research group and is responsible for the thematic area Ergoship in the Lighthouse competence centre. She is a Master Mariner and has a PhD in Human-Machine Interaction.

Karl Bruno is currently working as a research assistant in the Human Factors research group at the Department of Shipping and Marine Technology, Chalmers University in Göteborg, Sweden. He has a B.Sc. in cognitive science and a background in aviation.