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# Training and Technology: Potential Issues for Shipping

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**Abstract**

Following a review of the literature on training and ICT implementation in various organisations, and preliminary analysis of a pilot study on training in shipping, this paper draws out some potential issues for shipping with respect to training and technology. The issues considered include: the acquisition of skills; motivation; and constraints on learning.

**Key words**: technology, training, shipping, motivation, knowledge transfer

## Introduction

Over the past century, a large number of technologies have been introduced onboard ships (Winbow, 2002), for example, radio-navigation, radio-communication, electronic chart display and information system (ECDIS), automatic identification system (AIS), computer technology, and automation. New technologies offer a range of benefits. They help to increase productivity via the facilitation of reductions in crew size and turnaround times (Sampson and Wu, 2003). They also have 'the potential to improve the efficiency and effectiveness of watchkeeping and to improve the safety of operations' (IMO, 2003). Furthermore, new technical developments, for instance, electronic fuel injection (EFI) systems, can both reduce costs and protect the environment.

To reap the benefits of new shipboard technology, however, its users – seafarers – need adequate training. A quick search of Maritime Accident Investigation Branch (MAIB) reports suggests that inappropriate use of shipboard technology due to poor training can cause accidents. Lack of familiarity with the shipboard ECDIS equipment, for example, has been a contributory factor in a number of accidents, including the groundings of *Pride of Canterbury* and *CFL Performer* (MAIB, 2008a; 2009). Similarly, the inappropriate use of ARPA radar was identified as a factor leading to

the collision between *Costa Atlantica* and *Grand Neptune* (MAIB, 2008b). In another incident where the vessel *Prospero* made contact with a jetty, ship officers' inadequate knowledge of the vessel's podded propulsion system was found to be a causal factor (MAIB, 2007). A number of recent studies have likewise found that seafarers appear to be insufficiently familiar with/trained in the use of the new shipboard technology AIS which may lead to the transmission of erroneous AIS information (Bailey, 2005; Bailey et al., 2008; Harati-Mokhtari et al., 2007; Norris, 2007). Inaccurate AIS information can mislead seafarers when making collision avoidance decisions, and thus may have serious consequences.

Researchers, commentators, and policy makers have unanimously pointed out that training on new equipment is essential to avoid similar accidents in the future (Bailey, 2005; Gray, 2008; Grey, 2008; Hadnett; 2008; Harati-Mokhtari et al., 2007; IMO, 2003; *Lloyd's List*, 2007; Norris, 2007). With more and more sophisticated instruments introduced onboard ships, it is suggested that adequate training and ample familiarisation time are crucial for seafarers to acquire competence in operating them. Commentators also point out that seafarers need to be made aware of the limitations and potential errors of technologies. Further, Bailey (2005; Bailey et al., 2009) argues that training needs to take into account not only the operation and limitations of equipment, but also how the introduction of new equipment can potentially modify shipboard practices.

Thus, it is important to look into training provision and practice in shipping in order to improve it. This paper reports the preliminary findings of a pilot study on training and technology. It draws out potential issues for shipping in the light of these findings and also with reference to previous research undertaken in other sectors. The pilot study is part of a large on-going project which looks at seafarers' adaptation to, and training on, new technologies. The first part of the project which focussed on AIS when it was first introduced onboard ships has been completed (Bailey, 2005; Bailey et al., 2008). This pilot study prepares for the next stage of the project - a large scale survey examining seafarers' training on new shipboard technologies/equipment in general. It aims to identify issues that will be explored in detail in the survey. As part of the pilot study, thirteen interviews were conducted in the UK, two with college lecturers and eleven with officers undergoing training. Nine interviewees were deck officers,

including five chief officers and four 2nd officers. The other two were engineers, one 3rd engineer and the other 4th Engineer. The officers were asked about their training on, and experience with, onboard technologies, while the lecturers talked about the design, provision, and forms of training courses.

**Acquisition of skills**

Research on training and ICT implementation suggests that end users in general acquire ICT knowledge and skills from four sources: vendors, companies, colleges, and themselves (Benson, 1983; Nelson et al., 1991). Vendors, companies and colleges provide formal training which is structured, institutionally sponsored, explicitly planned and organized, led by instructors, and associated with assessment and evaluation. By contrast, self learning is informal. It is not institutionally planned but individually initiated in everyday life (Conlon, 2004). Informal learning activities can take the form of self-directed reading, experimenting with new equipment, and observing and/or consulting colleagues (Aiman-Smith and Green, 2002; Spitler, 2005).

Similarly, our interview findings suggest that seafarers acquire their skills with new equipment both formally and informally. Formal training is normally provided by external experts including training institute lecturers, company trainers, and equipment providers. User manuals, company circulars, and experienced colleagues onboard may help seafarers to acquire skills informally.

When the technology is simple, seafarers are likely to be left to their own devices and acquire skills by reading user manuals and in some cases with the aid of company circulars. Some deck officers learned to operate AIS in this way. Several interviewees mentioned explicitly that formal training for AIS was not necessary because it was simple. One second officer explained how he learnt to use AIS by referring to manuals and by a process of 'trial and error':

> Just by reading manuals and trying it yourself. It is like a new phone, if you know the basic operation of a phone, for example, off the hook means you have to call, and cancelling the call is the red button, then you can slowly, slowly

> learn from using it. Or maybe if you find a new button, "Oh, what is this?" Then you just refer to the manual. That's how, especially with the AIS, and I don't think there is any course for it. There may be a course, but it's not very necessary, it's just a piece of small equipment. I learned it just by looking at the operator's manual and just physically doing and checking and that is all.

It is pointed out by IMO (2003), however, that technical manuals can constitute poor training material. One reason may be that consulting manuals takes time as the above quotation suggests. Furthermore, it may not be appealing to read manuals, especially when they are not written in seafarers' first languages and/or when their quality is poor. IMO (2003) suggests that computer based training (CBT) is a better training approach. Compared with manuals, CBT seems easier to follow, and it may demand less time and effort from seafarers. Interestingly, none of the interviewees mentioned the use of CBT in relation to new equipment, although CBT has become a common training strategy in the shipping industry (Ellis et al., 2005).

Previous research relating to training and ICT implementation suggests that peers play an important role in the learning process (Gallivan et al., 2005; George et al., 1995; Lambrecht et al., 2004; Spitler, 2005; Winter et al., 1997). In organisations, there are 'resident experts' (Nelson and Cheney, 1987) or 'master users' (Spitler, 2005) who are ICT users with advanced skills. They often give *in situ* help to users who are experiencing problems (Spitler, 2005). It is noted that the most common way for users to solve ICT related problems is to talk with colleagues close by (Lambrecht et al., 2004). More significantly, obtaining information from peers with technical expertise, rather than via formal training, has been found to be closely related to end users' computing skills (Winter et al., 1997).

Onboard ships, seafarers also transfer knowledge and skills to each other. Learning from manuals takes time as suggested earlier. To learn quickly and with less effort, some seafarers opted for advice from experienced peers. The 3rd engineer interviewed explained how he learned the principles regarding the operation of Dynamic Positioning Systems (DPS) from senior engineers onboard:

> Well, sitting down with the chief engineer and the second engineer, and we might drink coffee in the engine room, I can ask them [the principles], but we talk while we drink coffee. And that's the whole idea behind it. Plus the fact that as we use the equipment, the new guy kind of gets walked through and shown how everything operates.

Experienced colleagues can answer questions directly, which helps less experienced seafarers to avoid the trial and error process. Furthermore, peers are able to transfer knowledge which is not in manuals but acquired through long-term experience.

Knowledge transfer from senior officers to juniors not only helps the latter in the current job, but also prepares them for the future ones. One second officer mentioned this point in the interview:

> If the company want to promote a second officer to a chief officer, then that second officer, when he's onboard, should be able to learn [how to use the shipboard loadicator]. The company will not provide onshore training. Suppose I want to get promoted, I will ask my ex-chief mate or master, whoever, "teach me this." …

The seafarers we interviewed tended to suggest that formal training is necessary when new equipment is complicated. This view concurs with research finding in other industries which suggests that complex technology creates high "knowledge barriers" and that only formal training can provide users with the requisite knowledge to overcome the barriers (Robey et al., 2002; Sharma and Yetton, 2007). Amongst seafarers, formal training was reported to be delivered by external experts either from training institutions, equipment manufacturers, or in-house training departments. Compared with user manuals which detail operational procedures, training programmes also explain the theory behind equipment, the limitations and error sources. Furthermore, being delivered by experts, it was said that training opens trainees' eyes to the full potential of new technology. One chief officer reported the benefit of formal training as follows:

> [The training] gives us a good knowledge about certain things, even if you're using equipment for a period of time. Maybe we are not using it to its maximum potential. And because, okay, we may risk following a set pattern, I just use the equipment for whatever information I need or whatever I need to use. But maybe I don't want to try to find out what else it can do. But once we go back to college or a training centre, you know that's where we can get to know about more what it can be used for.

Another advantage of formal training is that it corrects misconceptions and the misuse of equipment militating against the transfer of bad practice from peer to peer. One college lecturer recounted how in one training session one trainee realised that his previous usage of AIS was wrong and dangerous:

> Last week, we were putting the AIS on. One guy commented, "You know I use that all the time for collision avoidance." Another guy said, "Well we've got a letter from the superintendent, it's not to be used for collision avoidance." The first guy said, "No, I use it all the time." Now that was brought to us, and I said "Well you're fighting on this, why your company sent out letters telling you not to use it?" The second guy said, "It's due to target swap." So he explained to the first guy. You see him now, "Oh, I didn't realise that. I didn't realise."

Though beneficial, formal training does not solve all problems; and it arguably needs to be complemented by informal learning. According to research findings in other sectors, formal training only provides an initial and short stage in the learning process when new technology is first introduced (Spitler, 2005). In the on-going use of the technology, new problems will continue to crop up and users will need to consult colleagues, technical experts, and manuals, or go through other forms of informal learning processes in order to solve those problems (Lambrecht et al., 2004; Santhanam et al., 2007; Spitler, 2005).

In shipping the issue of standardisation may make informal learning even more important. Onboard equipment is produced by different companies and therefore takes the form of different 'models' with different operational procedures. This places constraints on the onshore training provided by training institutions and/or company

departments, since the instruments in training centres may be different to those onboard ships. Therefore, training centres focus on the transfer of generic knowledge, which can be applied to different situations with the aid of operational manuals and/or experienced peers. One nautical college lecturer explained this point in the interview:

> We can teach generically the procedures of utilising the instrument, but you go on a ship and every ship has a different make of. So it's a different way of operating a system, say, GMDSS, of two different makers. But your generic knowledge of how to do it, that knowledge will be enhanced by going to the manuals to see what buttons to press.

These words indicate that formal training alone does not provide seafarers with adequate skills for the operation of new equipment due to the issue of standardization. When a well-trained seafarer joins a new ship, a process of familiarization is still required. He/she needs 'old timers' to pass on the relevant knowledge, and he/she may also need to refer to the manuals, in order to operate ship specific equipment.

The issue of standardization may also make long-term onboard training less viable, especially for big companies, as one chief officer explained:

> Interviewer: Does the company ever send people to the vessel and give you courses onboard?
> Respondent: It really isn't effective because with a fleet of 200 ships, you cannot get around everybody. And in six months, the whole crew will be on different ships, different systems, so the best thing to do is a common course for everybody.

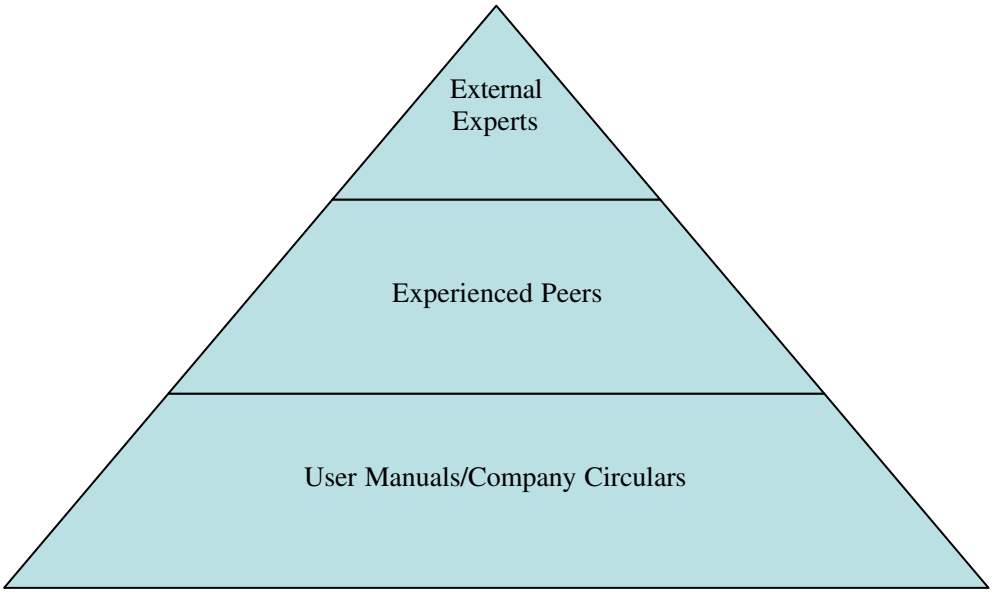
Clearly a common course is a generic one which may not provide seafarers with ship specific skills. To acquire the latter, seafarers need informal onboard learning.

The data indicate that onboard training was provided on some occasions. For example, manufacturers sometimes provided initial onboard training when new equipment was first installed on a ship. Sometimes companies were reported to send a technical officer onboard to provide training. In both cases, however, training can only be

provided to a few seafarers, who then pass on the knowledge to others. As such, the source of knowledge transfer quickly changes from external experts (formal training) to experienced peers (informal learning).

The above discussions suggest that there are three levels of knowledge transfer (see Figure 1). The most basic level is self-learning by reading – knowledge transfer from written materials. It is most effective when technology is simple and straightforward. Since written materials do not respond to learners' concerns, this level of knowledge transfer is a process of trial and error. When self-learning is combined with learning from experienced peers, knowledge transfer reaches another level – it is interactive and responsive, which, arguably, can be more effective and less time consuming. When the technology is complicated, knowledge transfer from external experts may be deemed necessary. Even when technology is simple, learning from external experts may have advantages, because experts have more knowledge of the full potential and limitations of the technology.

**Figure 1: Three Levels of Knowledge Transfer**[1]




[1] Computer based training (CBT) is not considered here because none of the interviewees mentioned it. Nevertheless CBT and other forms of video training seem to be common. If they are to be added to the model, they could be situated in between 'experienced peers' and 'user manuals/company circulars', since they provide a sense of interactivity.

**Constraints on training and issues of motivation**

To adopt new technology and to acquire relevant skills, individuals need to be motivated to learn. In other contexts, it is found that individuals are likely to have the motivation if they perceive the technology to be useful in helping them to achieve their goals (Davis, 1989; Davis et al., 1989; Zhao and Cziko, 2001). Our interview data indicate that this is also the case with seafarers: when they perceived that training was necessary for their careers for example, they expressed a willingness to attend courses. One chief mate reported that he was willing to attend some courses because they would give him confidence to do a proper job and help him with promotion:

> This [attending necessary training courses] is required for your promotion. One definitely would like to take the courses. … If there's a certain area in which I feel weak. I feel that I could have definitely gone for some more intense training, because at the end of the day we're masters, we're going to take over the ships so we must be very, fairly confident.

However individuals have different goals which may be mutually exclusive. If new technology helps them to achieve one goal but negatively affects others, they may not be motivated to learn (Zhao and Cziko, 2001). Research in other industries has shown that end users were reluctant to take ICT training if it demanded use of their own time even though ICT was useful for their job (Benson, 1983; Brand, 1997; Galanouli et al., 2004; Monk, 2004; Valcke et al., 2007; Waite, 2004). In shipping, similarly, time imposes constraints. Formal training is likely to take place in training centres ashore, which means training is undertaken when seafarers are 'on leave'. Several informants explicitly mentioned that they were unwilling to take training courses during their leave time. One chief officer, for example, stated:

> The human resource department arranges the courses and then the person involved has to go and attend courses. But the hitch point is: when do they do these courses? The courses are done in their time off. … Now, how else in this world, people go for training courses on Saturday and Sunday? I mean people who work Monday to Friday do not take training courses on Saturday and Sunday, do they? They only do training courses on weekdays, when colleges

are running. But for seafarers, they have to do all the courses possible when they come home on leave, which they earn after working four months or six months away from home at sea, and then the employers expect them to train in their time when they're on leave, and then go back on the ship. So that's why you get rarely any seafarer volunteering to do courses and training to enhance their skills. What they want is a decent piece of leave.

In the case of onboard training when equipment is first installed, some seafarers may not even be able to attend due to time constraints. New equipment is placed onboard only when a ship is in port. At this time, however, seafarers tend to have busy schedules due to short turnaround times. As a result, not all seafarers can attend initial training given by the technician responsible for the installation. One chief officer recounted his experience:

Informant: During my last assignment a piece of equipment was installed. We had it installed during cargo operations and the contractors came on. When they were ready to start testing it and show it how it worked, because of busy port turnaround, we were only able to spare the second mate. So he went up and found out how it worked. As I say, during a busy port turnaround we weren't able to spare anyone else, and another day we had to see what it does. It was just a PC with a feed, it gets connections. What else does it get? I don't really know what it gets, because I was the mate then, and that was the second mate's gig. It wasn't so much safety equipment, not something I played about with a lot.

Interviewer: So you personally never got any training on how to use it?

Informant: No. During this passage I would ask the second mate "So what does this do?" Give me a quick rundown. But it's not a piece of equipment I used a lot, although I could use it to find out the weather and stuff.

Thus, busy schedules in ports may negatively affect onboard training and seafarers' knowledge of some pieces of new equipment. To what extent this is the case, however, remains to be more fully examined.

On some occasions, training not only demands seafarers' leave time, but also their money. Formal training involves external experts and resources, and therefore incurs a financial cost. While well-established shipping companies were reported by some seafarers to be committed to training, one Indian second officer reported that one shipping company tried to transfer training costs directly to him:

> Once I was about to join one company, and they were paying very good, so I was planning to go to that company. But then, the person in the office, he asked me "Do you have this course?" Some bridge team management course. I said no. He said "You have to do that course." As a second mate I did not have to have that course, it's not mandatory. … So I said I don't have that course with me. He said "You have to do that course… But our company will not pay you. You do it off your own. Not a thousand, about 200 pounds in all, and when you do that course you can join us."

Of the eleven interviews conducted with officers, this is the only example provided where an officer was requested to pay for a training course out of his own pocket. However, eleven interviews is a small number and all of the interviews were done in the UK at a reputable maritime college. To what extent this practice exists around the world is therefore unknown and needs further consideration.

In the process of our research, one seafarer refused the interview request because he perceived that the research would result in the recommendation that more training was required for seafarers which he said that he would have to pay for and give up his leave time for. This suggests that great numbers of seafarers may be reluctant to take more training because currently it often requires that they give up some of their leave time and they may also have to pay for it themselves.

As discussed in the previous section, informal learning and peers play a crucial role in skill acquisition. The literature on training and ICT implementation suggests that learning is most effective when it takes place while doing the actual job in the presence of co-workers with whom to discuss problems and exchange insights and discoveries (Gallivan et al., 2005; George et al., 1995; Waite, 2004). Thus, a supportive environment, where peers exchange information, encourage each other to

use new technology, and actively provide useful guidance, can motivate individuals to learn necessary skills and to adopt the technology (Ertmer, 2005; George et al., 1995; Sein et al., 1987).

Whether or not the onboard environment supports and encourages informal learning, however, has not been examined. There are a number of preconditions that need to be met to foster a supportive environment. Firstly, knowledge transfer between peers needs input from both ends: the provider must be willing and have the competence to teach, and the recipient must not be afraid of revealing his/her weaknesses. The extent to which these conditions are met onboard is a matter for further investigation. Secondly, when the relieved worker transfers his/her responsibilities to the newcomer, he/she also needs to take time and effort to transfer the basic knowledge of equipment operational procedures. Given the brief handover process due to fast turnaround, however, it is questionable whether there is sufficient time for this type of knowledge transfer. Thirdly, while seafarers can learn operational procedures from manuals, the latter may not provide sufficient information about the limitations on equipment usage. In this context, seafarers may need some sort of training, CBT for example, or at least the provision of company circulars to provide relevant information. Do companies provide this or other sorts of support? Do companies have policies to encourage and facilitate onboard learning? Such questions remain unanswered and need to be further investigated.

## Conclusion

New technologies have improved efficiency and productivity in shipping. Yet, they also have limitations and may be prone to technical error, which has safety implications. To reap the full benefit of new technologies and to avoid potentially negative effects, seafarers need training in order to acquire necessary skills. Through a review of the literature on ICT implementation and a preliminary analysis of a pilot study on training in shipping, this paper has drawn out some potential issues for shipping with respect to training and technology.

The literature suggests that while formal training is important for successful technology implementation, it is also crucial to create a supportive learning environment where peers exchange information, share experiences of using technology, and actively provide useful guidance to one another. The pilot interview data show that seafarers acquired their skills from three sources – user manuals/company circulars, experienced peers, and external experts – which imply three levels of knowledge transfer. Knowledge transfer from written materials is most effectively used when technology is simple and straightforward. When technology is complicated, knowledge transfer from external experts is arguably necessary. External experts may be assumed to have advanced technical knowledge and therefore are in a position to help seafarers use equipment to its full potential whilst retaining an awareness of its limitations. However, to convert the knowledge transferred from external experts into practical competence, seafarers may still need the help of experienced peers or manuals for the acquisition of practical knowledge, due to lack of equipment standardization.

To develop competence, seafarers need to be motivated to learn. While perceived usefulness can encourage seafarers to take training courses and to learn, demands on their own time and money may discourage them from doing so. Research on other industries suggests that a supportive learning environment can also motivate individuals to learn. To what extent the onboard environment is supportive, however, has not been studied. In the large scale questionnaire survey we intend to explore these issues in detail. Our findings will be reported in subsequent papers.

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