Portable aids for pilotage

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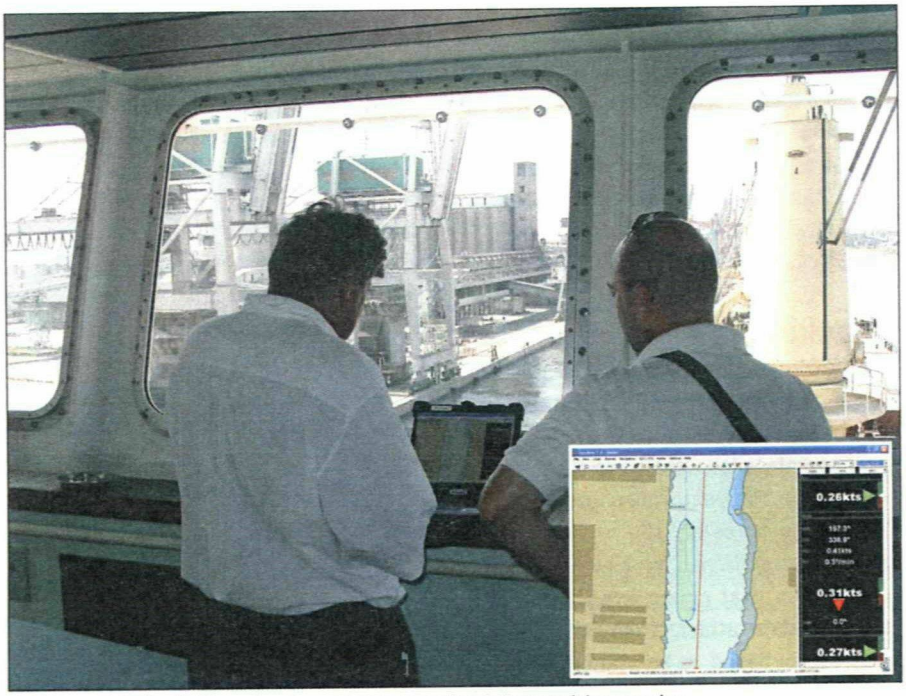

▲ Pulling off the berth. Observing the system in operation during a training exercise.

Ports are facing increasing demands to accept larger ships and turn them round rapidly and consistently, without regard to the weather. Consequently, safety margins for pilotage and ship-handling are decreasing and the already high-pressure job of piloting is getting even more challenging. Simultaneously there is an increased emphasis on accountability; and when things go wrong it is normally the master and the pilot who take the blame.

Pilots have traditionally relied on their local knowledge and ship-handling experience to control the behaviour of ships in confined waters and when berthing. They are backed up by the other members of the bridge team, although on many ships the team is very small and often of unknown reliability. Ships using paper charts can rarely manage to keep an up-to-date position displayed on an appropriate chart; those with an electronic chart system or ECDIS can do better, but most ships are not so equipped. The result is that the back-up for the pilot when transiting narrow channels is effectively only the master's eye; and unless the master has local knowledge, that may be insufficient to detect an apparent problem and issue a challenge in sufficient time.

When berthing large ships, very precise control of transverse velocity is required in the final stages to prevent damage to the berth and the vessel. Approach velocities, which ideally need to be less than about 8 cm/sec (0.16 knot), are very difficult to judge by eye – especially when the bow is 200m or more from the bridge. Laser docking systems have been used at critical berths in some ports but these are expensive and a separate installation is needed at every berth for which fine control is required.

Information about other ships, particularly those which may be hidden around bends, is now available on almost all ships via AIS (automatic identification systems). In busy ports this information can be extremely useful if it is displayed as an overlay on the ship's radar or ECDIS. Its value is limited, though, if the ship is only fitted with the minimum keyboard display (MKD); and that is, unfortunately, the norm.

What is available to assist the master and the pilot in ships which otherwise have only rudimentary facilities?

Electronic aids for pilots

Enter the portable pilot unit (PPU) – a generic term for a self-contained sensor and display system, taken aboard a ship by the pilot for use by himself and the bridge team. Simple electronic aids have been used privately by some pilots for years – the simplest being a hand-held GPS or PDA with a small-scale chart, which gives the pilot a measure of independent confirmation as to the receiver's position. Slightly more sophisticated systems may have a remote GPS receiver on the bridge wing, feeding a laptop computer with a reasonable-size display. However purpose-designed systems are now available and one of their great strengths is that their information is available to the pilot at his

PPUs – feedback needed

PPU technology has huge potential for improving safety and efficiency in navigation, provided the technology works correctly, good procedures are in place and the operator is properly trained to use it. However these units – which work so well – tempt users to push the envelope of operational limits and the industry needs to think hard about their role. At the Institute's last IBS conference, for example, Captain Jorge Viso MNI, Chairman of the American Pilots' Association Navigation Technology Committee, came up with the wise observation that 'you should not take a ship anywhere with a PPU that you wouldn't go without it'.

As these systems develop technologically, operational practices will evolve as well. So if you have experience using PPUs, *Seaways* would like to hear from you.

David Patraiko FNI

▲ Congested waterways.

conning position, rather than a 5m walk away. This article will examine the strengths and weaknesses of various options.

Display software

If a pilot-provided system is to be used for matters relating to ship safety, the master reasonably wants assurance that the chart is reliable and ideally an official one. These requirements may be met by a system using raster charts; but in practice the additional functionality available from vector chart data weighs heavily in its favour for pilotage. Official 'S-57' charts are the preferred option, though for ports where such data is not yet available, very high quality charts in S-57 format can be generated quite simply and economically. When the source data used for these charts is the port's own surveys, its reliability is assured. (Six ports in three continents are currently using specially created S-57 charting in conjunction with systems my own company has supplied.)

Although any ECS software could in theory be used for the pilot's display, in practice it is preferable to use customised software which eliminates features not relevant to pilotage and incorporates extra functionality specifically for pilot use. Features which can be particularly beneficial include:

- The ability to save ship parameters for re-use and easily switch between ships;
- Displaying navigable areas adjusted for ship's draft, under keel clearance and height of tide;
- Ability to plan constant radius turns for large bends, and subsequently monitor the ship's actual turning performance to ensure precise adherence to the plan with the aid of a curved-path predictor;
- Specialised display options for the berthing phase, to monitor distance and angle off the wharf, together with closing rates at bow and stern;
- Recording raw sensor data to enable variation of display parameters during playback.

Sources of navigational data

The simplest and least expensive electronic aid is one that uses a single GPS receiver; ideally it will be differentially corrected to improve positional accuracy and provide a degree of integrity monitoring. For many ports, corrections are conveniently and freely available either from a 300 kHz beacon or via WAAS/EGNOS/MSAS. A simple system is typically a PDA or laptop and a single antenna, either integrated with the display (PDA), or separate and connected to a laptop display via a cable or a wireless connection. A separate antenna allows display operation inside the wheelhouse, enabling more sophisticated software to be used.

Simple systems are inexpensive and easily portable – and may be all that is required in relatively straight and wide channels. They show the position of the vessel (or more correctly, the GPS antenna) in relation to its surroundings and so can help prevent confusion as to which buoy the ship is passing etc.

As ships move into more restricted waters, these systems become less effective. The size of the ship in relation to the navigable water becomes significant and it is critical that the ship's outline is accurately displayed on the chart. While this can be achieved in some software by entering the ship's dimensions, together with the offsets of the GPS antenna, the displayed picture is only meaningful if heading is accurate. Simple systems can only assume that ship's head is the same as the COG (course over ground); while this is reasonably valid when the ship is moving in a straight line with no wind or tidal stream, displayed heading will be gravely in error once the ship starts to turn – especially for vessels with the bridge aft. At slow speeds, and particularly when using tugs or moving astern, ship's head and COG may be up to 180° in error.

For precise navigation in confined waters it is vital to know heading, as this allows every part of the ship to be shown in its correct position on the chart. There are two main ways of obtaining heading and ROT (rate of turn) for use on a portable system: AIS and portable pilot units with their own heading sensors.

AIS for navigation

AIS was developed primarily to provide reliable information about other ships in the vicinity, for collision avoidance purposes. Great potential was seen for the pilot to use this information by overlaying it on his own portable chart display: and with this in mind, IMO made it mandatory for ships to provide pilot plugs.

Subsequently, some people have advocated using the pilot plug data as a low-cost source of 'own-ship' navigation information. If full and precise data were available from every ship's sensors (including precise DGPS positions - preferably to four places of decimals, heading accurate to 0.1°, and rate of turn) this would be an excellent solution. Unfortunately, in reality the AIS pilot plug solution falls well short of providing the level of precision needed by pilots operating in close quarters:

- The quality and precision of navigational data needed for AIS to meet its primary anti-collision function is considerably less than that needed for precise navigation.
- Significant gyro compass errors are common.
- Most ships do not have an ROT output.
- The physical installation of the pilot plug aboard many ships is inadequate; indeed there are still ships which either do not have one or whose bridge team do not know where to find it! It is often not fitted where it should be - at the front of the bridge, close to the pilot's conning position - but may be at the back of the charthouse. Many installers seem to interpret the wiring instructions wrongly, so that the data is being transmitted on the 'receive data' pin.

Some AIS pilot plugs have been found to have no valid data available at all, and this may lead to the pilot losing concentration while trying to establish a data flow. Distractions like this, combined with potentially unreliable data, do not make a

positive contribution to vessel safety in pilotage waters.

A recent study carried out by Lloyd's Register showed other worrying problems with AIS, including inaccurate data - with incorrect course and speed presenting serious implications for collision avoidance (and, of course, also for own-ship data in pilotage use).

The result is that while AIS can be very useful for providing information on other ships in the vicinity, particularly if it is displayed on the radar or ENC, the pilot is unlikely to be able to rely on the navigation data provided from the AIS plug for safe, accurate own-ship pilotage.

The Institute's own AIS Forum provides some interesting insights into some of these problems – see www.nautinst.org/ais

Independent PPUs

For a pilot to feel confident with his equipment, he must know that the information provided for both position and heading is accurate and reliable. This can be achieved using a PPU that is completely independent of the ships equipment - with its own position and heading sensors - carried aboard, set up and operated by the pilot. A good system provides the reliable accuracy needed to conduct safe and efficient pilotage, even in poor visibility conditions, with accurate, high precision position, heading, velocity and rate of turn data. The charting software can thus display present position and movement and predict the future position and aspect of the ship to a very high accuracy. A well-designed system takes less than one minute to set up, is easy to use, and will have been specifically designed for pilotage.

Typically such systems derive their headings from a highly customised and very precise form of GPS compass, using two GPS antennae. The position of the master antenna is entered into the software as an offset from the bow and centre-line, enabling the shape of the ship to be accurately shown in relation to it.

This information when combined with the pilot's experience, knowledge and intuition, leads to much more precise pilotage. Dedicated software allows the pilot to plan, execute, and subsequently analyse his pilotage: the result is an informed pilot who is fully aware of his situation at all times, including – and most critically – in restricted visibility.

Restricted visibility

When visibility is poor, it may be possible to postpone ship movements until conditions improve, though commercial pressures mean such delays are treated increasingly as unacceptable. A sudden reduction of visibility during a critical passage must be coped with as safely as possible, despite losing a major source of navigation information (for most pilots the major source). Radar is normally the alternative aid used, though unless they have a PPU or a fitted ECS on the bridge, ships effectively end up being piloted by radar alone. Radar is of limited use when negotiating narrow winding channels, especially in large vessels with high antennas, as critical close-in information is lost below the radar beam.

A high quality PPU provides a very effective source of alternative information. If it is capable of measuring and displaying rate of turn, and especially of curved path prediction, it may even be the prime navigation sensor used in restricted visibility, with radar as the secondary monitoring system. For pilots who routinely use a PPU as an aid to visual pilotage, the transition is very smooth and virtually seamless – especially if the alternative is an unfamiliar radar set whose state of tune may be far from optimum. In training for blind pilotage, one port – which has a high incidence of fog in the winter months – routinely practises using the PPU as the prime source of navigation information, with a second pilot having override authority. Their experience is that there is no deterioration whatsoever in the quality of the navigation, and the second pilot has never needed to intervene. Of course, in genuine restricted visibility, the system would be used in conjunction with radar blind pilotage techniques, as under no circumstances should a PPU (or radar for that matter) be used as the sole source of navigation information. The PPU provides a second source – and a very capable one – to enable safe navigation to continue.

Sharpening skills

Contrary to what one might expect, our experience shows that working with a PPU does not create dependency, but rather improves the quality of pilots' work, even when they are not using it. One very experienced pilot commented: 'I can do a better job using only your equipment, and not looking out of the window, than I can do by eye... By using the predictor and rate of turn, the ship can be kept precisely on the designated track around bends in a narrow channel. It is further evident to me that by using the equipment and also looking out of the window, I have increased the database on which my mental assessments are made. My pilotage skills without the equipment are thereby (also) improved.'

Some advanced PPUs also give the pilot the ability to precisely monitor docking performance. My own company's HarbourPilot's position and heading solution, for instance, is so stable that it is able to measure the athwartship motion of the bow, over 200m from the sensor, down to 2cm/sec – which allows very small movements at the bow to be easily detected. This is achieved without introducing latency due to filtering and meets the docking requirements of almost any port. Some systems offer RTK (real time kinematic) corrections for the GPS in an attempt to achieve even more precise measurement – but at a very high cost because of dedicated shore infrastructure, and with a less robust differential solution. Due to reliability issues experienced with RTK solutions in the past and recent major improvements in DGPS accuracy using high quality receivers, the latter is our preferred option.

For experienced pilots, the recording and playback capability of dedicated piloting software provides an excellent tool for analysis and self-critique. It can also be used very effectively in training and debriefing new pilots, as many of them already have experience with the plan-view method of ship-handling from experience in using ship handling simulators.

The recording and playback facility can also be used during check pilotage, providing an invaluable record of what actually happened – thereby providing a powerful tool for analysis and fine tuning of technique.

Conclusion

Demands on the shipping industry will continue to increase, as will pressures on pilots and port services to meet these demands. Portable electronic aids – of varying degrees of sophistication – are now available to assist pilots in meeting the challenge.

Most pilots readily accept PPUs as a valuable aid to close-quarters ship-handling, and as a means of improving safety and efficiency while also reducing their stress levels. PPUs such as HarbourPilot complement the pilot's skills by providing accurate information to support decisions. PPUs are invaluable as a means of fine-tuning the ability of pilots so they can consistently provide precision piloting – which ultimately means greater safety and efficiency in ports.