Speed matters

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Speed (or more precisely the translational velocity and angular speed) is the most important factor for the safe berthing of ships. Today there are accurate, user-friendly and inexpensive solutions for the reliable and precise measurement of berthing speed, yaw and approach angle, using state of the art GPS technologies.

Some ports take risks unknowingly; they accept inefficiencies and a lack of accountability. Progressive operators make Portable Piloting Units (PPUs) work for them. These advanced navigation and berthing aids give ports a competitive edge and enhance safety. This article explores how some imperceptibly small changes during ship approach can mean the difference between a normal berthing and serious damage. It looks at the technology now available to ports and pilots which can improve skills, reduce risks and improve profits.

Considering kinetic energy

The laws of physics are clear. The kinetic energy of a ship is a function of its mass, its speed and rotation. During berthing some or all of that energy must be absorbed by the fenders. If fenders are over-compressed then loads rise until something breaks, buckles or collapses to absorb the surplus. A split fender and distorted steelwork may be the result, but the consequences are often worse with punctured hulls and/or berths closed for unscheduled major repairs. These risks can be virtually eliminated for the cost of less than one fender system.

Engineers have always considered the lateral (translational) berthing velocity of ships in their designs. But they invariably ignore the rotational speed (yaw) component despite its large influence on the ship's kinetic energy. Yaw is caused by wind or currents, sometimes by equipment failure or human error. Whatever the reason, yaw is likely the culprit in many berthing incidents which result in hefty costs for ship owners and their insurers.

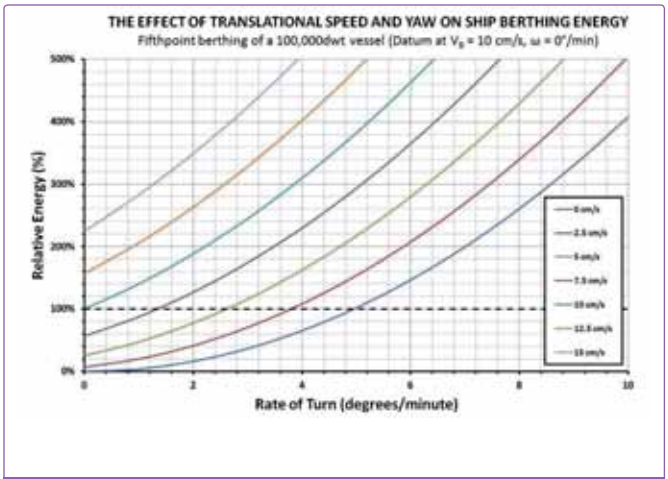
The limitations of visual checks

Consider this: follow the minute hand of a clock turning at six degrees per minute and ponder the difficulties a pilot faces when trying to judge a one degree per minute rate of turn while aboard the rotating ship. Add in an un-forecast fog bank or snow storm, perhaps a squall or tug failure. Yet one degree per minute raises the ship's normal berthing energy by 40 per cent. Increase that to 3 degrees a minute and the berthing energy is easily double the normal value 'assumed' by the dock designer – quickly exceeding any design safety factor for the fenders and structure. More surprising is that these modest yaw rates occur routinely just metres from the fenders. Most are caught and corrected, some are not.

Why have engineers ignored yaw? Probably a combination things: the lack of historic data; most design codes assume $\omega = 0$; maybe a misunderstanding about how yaw and translational speeds are related; lack of awareness about the tools and aids available to simultaneously and accurately measured speed and yaw on the ship and/or from shore.

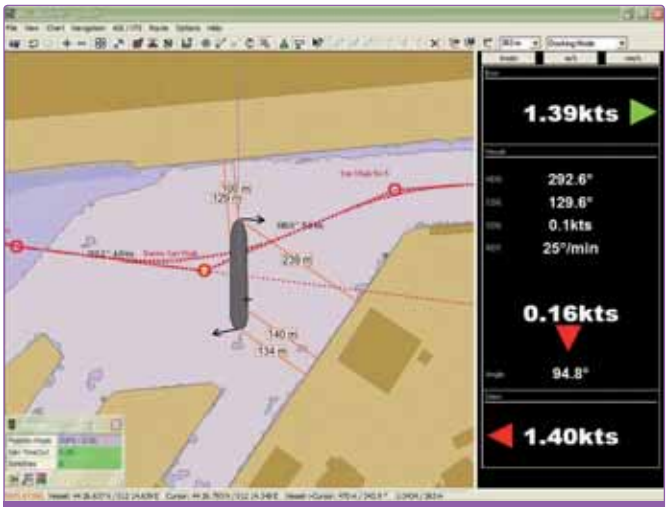
This is no longer the case. Affordable MEMS gyroscopes and rate of turn indicators can detect and measure ship's heading to better than 0.2 degrees accuracy and rate of turn to less than 0.5 degrees a minute. A well trained eye might just about detect this, but never 100 per cent of the time for a busy, multi-tasking pilot. And even the very best pilots couldn't hope to judge a ship's exact bow position, hidden from view and perhaps 200 metres distant with two centimetres accuracy. Or estimate speeds and vectors as slow as 2.5 centimetres per second (0.05 knot) without any visible reference points.

Even a small rate of turn can increase berthing energy well beyond normal design limits

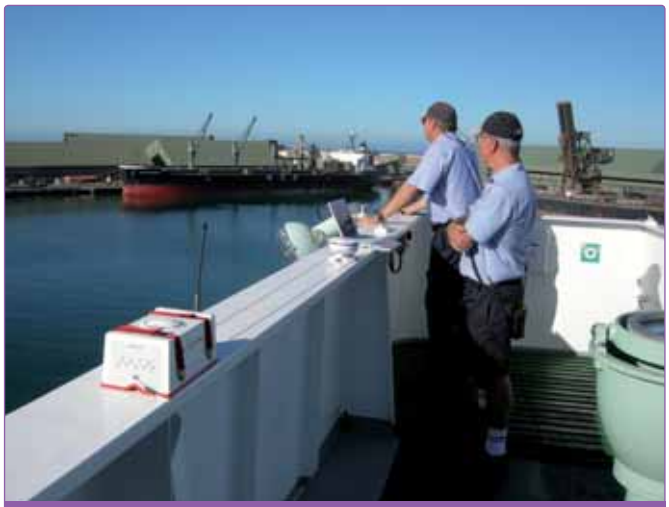


Example of different translational and rotational speeds and their effect on berthing energy

HarbourPilot PPU systems commonly use ruggedised displays and professional navigation software – a pilot's own electronic chart display and information system



In confined spaces, HarbourPilot increases situational awareness, gives early warnings and reduces risks



HarbourPilot just takes a minute to set up and can feed several pilots with the same information

The bridge in a box

This is routine stuff for a PPU which combines GPS with differential or real time kinematic (RTK) corrections, integrated with a microelectromechanical systems (MEMS) gyroscope and rate of turn sensors. PPUs weigh only a few kilogrammes, come packaged in a compact box and have a 15 hour battery life – often described as a ship's 'bridge in a box'.

One button operation, graphical and familiar software, laptop or tablet displays are optimised for daylight viewing and night operations. A modern PPU system tells the pilot at a glance exactly what the ship is doing at any time, triggering alarms when recommended limits are exceeded, but without taking the pilot's attention away from other key duties.

Some manoeuvres call for more than one pilot. PPUs can distribute the same data to every pilot as well as to shore control rooms or remote monitoring stations if required. Data is automatically logged. This is invaluable as a training tool and to record and accurately replay events.

In offshore operations there are no reference points and motion trends of one vessel can be hard to estimate from the approaching ship. The need for early warnings is even greater, particularly where dangerous cargoes are being handled. This situation demands specialised PPU systems which communicate and provide relative position data. This can be linked to jack-knife and proximity alarms, riser monitoring and even an emergency shutdown system.

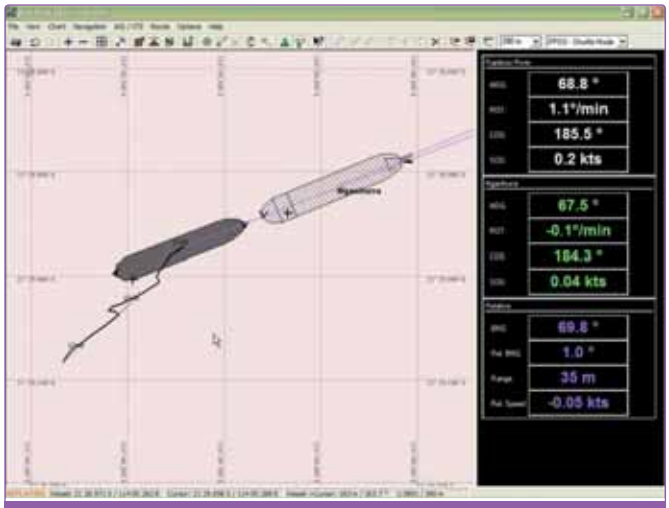
Conclusion

Every port operation carries a risk, but the level of risk is easily and cheaply reduced with current PPU technology. Even so, the cost of a good PPU can be beyond an individual, self-employed pilot.

More ports and terminal operators need to seriously consider the healthy returns for a very modest investment in PPUs for their pilots. PPU equipped pilots can play an important role in improving safety and more efficient operations. PPUs have proven their worth as training tools too. The data collected over time helps build a data archive which is invaluable when new facilities are built. If the worst should happen – now less likely if PPUs are deployed – then logs are available to show the exact sequence of events. Incidents are resolved more quickly, legal costs are lower and less time is lost. Radar was a new technology 50 years ago but is standard fitment on every ship today. Portable piloting units have 'come of age' and represent the next evolutionary step with benefits for pilots, ports and everyone else in the marine cargo 'chain'.

ABOUT THE AUTHOR

Mike Harrison is a berthing expert with 30 years industry experience in the design of fenders, bollards and other mooring equipment. His in-depth knowledge of the entire approach, berthing and mooring process comes from international experience gained in ports around the world. With the growing acceptance of ship and shore berthing aids, Mike now focuses on risk management and specialises in GNSS portable piloting solutions to predict and



Tandem berthing and other offshore operations often require several pilots to share data for enhanced safety

Without shore reference points ShuttlePilot gives pilots on several vessels absolute and relative information as well as early warning alarms

prevent incidents, as well as providing fender and mooring consultancy services to vessel owners, their insurers and legal teams. A keen safety advocate, Mike voluntarily co-chairs PIANC Working Group 145 which is studying and investigating the berthing speeds of large ships and related topics, collecting and analysing extensive volumes of data which is due for publication shortly. This is the first comprehensive report into modern ship berthing speeds for over 30 years with data provided by the broad international working group membership representing major ports and engineering consultants in Europe, Asia and North America.

ABOUT THE ORGANISATION

Inshore Systems provides PPUs to pilots and others needing accurate real time information of the berthing process and for moored ships. These systems integrate highly accurate GPS receivers with gyroscopes and rate of turn sensors in a compact and light weight package – often referred to as a 'bridge in a box'. Applications range from precision navigation, tight swings, lock entry and docking. Other solutions are available for ship-to-ship, ship-to-buoy and tandem berthing including safety critical floating production, storage and offloading (FPSO), floating liquefied natural gas (FLNG) and single point mooring (SPM) operations.

ENQUIRIES

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