Serving the professional interests of pilots and pilotage throughout Australasia

AUSTRALASIAN MARINE PILOTS INSTITUTE

SAFE Passage

SUMMER 2021/22

In this issue


PILOT

THE AUSTRALIASIAN MARINE PILOTS INSTITUTE (AMPI)

Level 2, 128-134 Crown Street
Wollongong, NSW 2500

Postal Address:
PO Box 860, Newcastle, NSW 2300
www.ampi.org.au

COVER IMAGE:
Simulation Wireframe Graphic

Contents

Ramblings *of the Editor*

The industry is going through some controversial changes and it's often difficult to document the motivation or final consequences of these changes until they unfold.

The situation in Brisbane is probably the most topical change that is occurring, wherein the new contract for pilotage services has been issued to Poseidon Sea Pilots. This was an unexpected development after 30 years of continuous service by Brisbane Marine Pilots, and particularly unusual with the former Chairman of Brisbane Marine Pilots at the helm of Poseidon competing against his ex-colleagues.

To hand over pilotage in a major port without an extended transition process one would expect that there are significant risk management processes in place. In 2001 the pilots on the River Humber were replaced with some similarities, albeit under different circumstances. Sadly, there were several major incidents that occurred during the training of new pilots on chartered ships which would suggest that it is no easy feat to start a pilotage service from scratch in a major port. We also should not forget the untold stress on all the pilots involved and their families.

Whilst appreciating that it may upset some members; we have elected to publish an article introducing Poseidon Sea Pilots. It is important that regardless of personal feelings, we maintain the integrity of AMPI with an impartial approach in this respect.

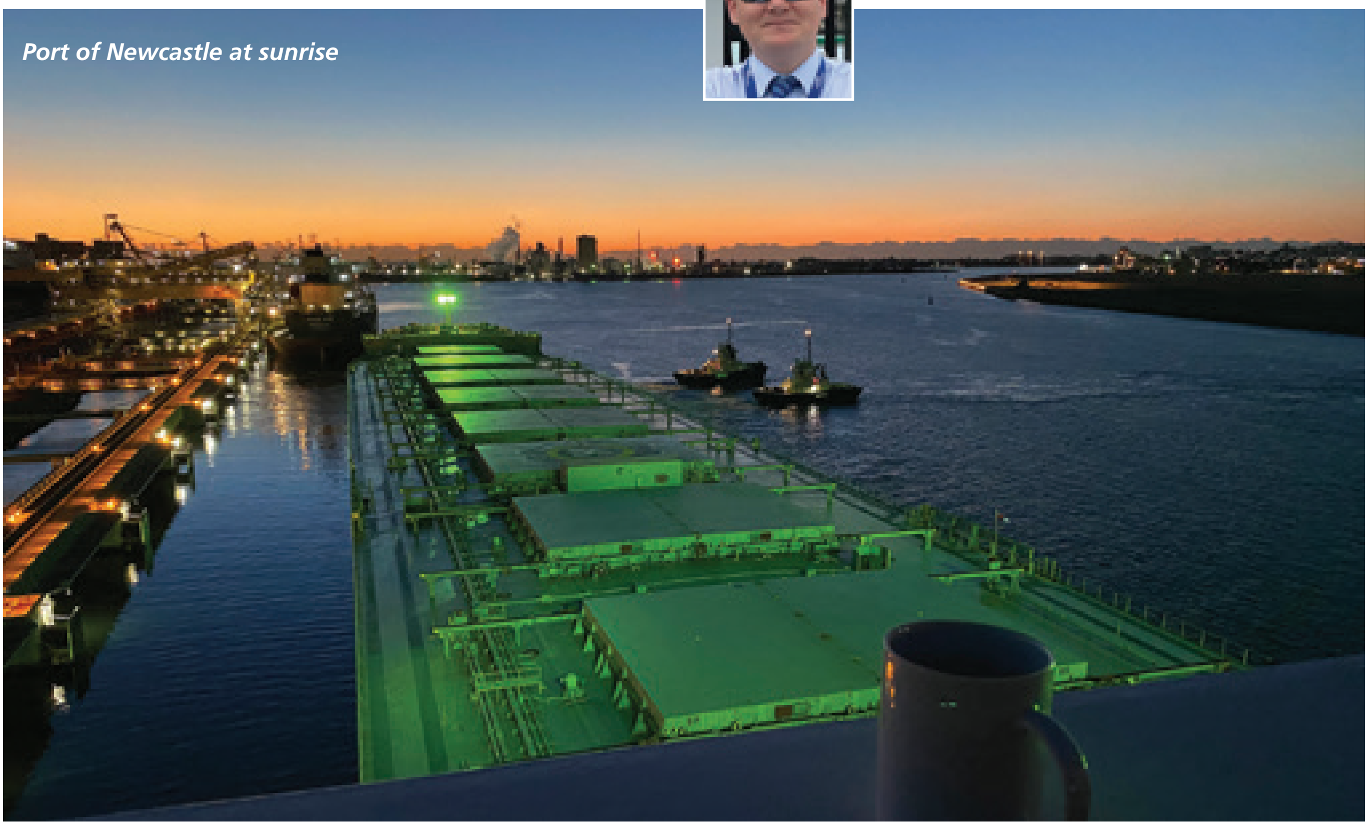
Also topical is the renewed interest in some ports for the use of simulation to replace on-water training. AMPI and IMPA support the use of simulator to supplement training but not replace on-water training. Like many other ports, my own employer are heavy investors in simulation to enhance our training, yet I also have significant reservations about replacing on-water training before seeing the results of controlled trials in a major port on a smaller sample of trainee Marine Pilots.

We have several articles here that consider the capability of simulation whilst also describing the significant differences between marine simulation and the simulators used to train airline pilots. One major omission in using marine simulation to replace on-water training can be the lack of investment in data that is of a high enough quality to provide a realistic simulation such as highly detailed bathymetry, sub-surface currents, hydrodynamics, detailed graphics, and a sufficiently diverse number of high-quality ship models. Of course, simulation is also removing the human factors that make our job so wonderful, dealing with the diverse and interesting characters onboard a ship and the challenges that they often create in what should be an otherwise uneventful pilotage.

I hope that you continue to enjoy reading Safe Passage and I would encourage you to reach out to me if you would like to contribute articles, letters, photos, or news that would be of interest to our readers.

Safe piloting,

Captain Ricky Rouse
Editor / Newcastle Pilot



Port of Newcastle at sunrise

President's *Report*

OVERVIEW

2021 has again been a frustrating year as the Delta Variant has led to severe lockdowns in NSW and Victoria which had a knock-on effect regarding border closures in the other Australian states. There is however light on the horizon as it appears that after a slow start with the vaccine roll-out that it is now gathering steam and hopefully lockdowns and border closures will be a thing of the past by the end of the year in a majority of states.

Vaccines are a major key in dealing with Covid, as while they may not prevent us from catching the virus, they hopefully allow us to avoid serious illness and hospitalisation and also allow us to avoid periods of isolation. Being classed as 1A workers has helped us to be vaccinated though I understand that some pilots are hesitant in being vaccinated and I can only encourage them to be vaccinated voluntarily before it becomes mandated (as in WA).

Going into the future I think the virus is something that we are going to have to live with and yearly booster shots will become the norm much like the flu shot we currently have each year. Who knows, maybe five or ten years down the track the Covid and flu jabs will be combined so we only have to have a single booster shot each year. Anyway, by then I'm sure we'll have something else to worry about.

As I have previously said by bringing ships in and out of port, we as pilots are working on the front line, helping to maintain the vital supply lines that help to keep our country running. This helps to provide a certainty to Australia that continues to be needed in these difficult times.

One area of concern that AMPI has been dealing with during the past year is to do with the use of non-pilotage experts dealing in an expert world. A recent example of this is when a Port Authority reduced the number of tugs used for very large ships in their port without consulting the pilots, without utilising a proper risk management approach, or undertaking ship simulation to see if it is feasible and then having no standard operating procedures in place for the change. They just decided that this could be done to save money.

To not even ask for pilot input to me is counter intuitive as after all it is both the Port Authorities and Pilots responsibility to protect amongst other things the environment. The public nowadays are expecting us to do that and to not do that is abrogating responsibility.

It is not the everyday usage of tugs that needs to be worried about but the low risk - high consequence type of events that can occur whilst piloting. There is also the fact that as ships have become larger then safety margins have subsequently decreased. Engine failures can also be an all too frequent occurrence in ports and port approaches and for these reasons adequate tug assistance must be maintained.

Secretary / Administrator

Our Secretary / Administrator Marvie has continued to be of great assistance to AMPI and has done a great job throughout the year in keeping us on the straight and narrow and has recently accepted an extension to her contract. Marvie has also taken on the role of helping with the administration of the CPD program.

AMPI CPD Program

This program has continued to be well used with the intention of the program being to establish a benchmark for ongoing pilot training that is relevant to pilotage and in line with world best practice.

Shaun Boot and Craig Eastaugh have continued to develop and continue to improve, the online program that is accessed through the AMPI website. These changes include making data entry a lot easier. As stated above Marvie has undertaken training to help manage and administrate the CPD program.

Mentoring

AMPI in collaboration with The Company of Master Mariners of Australia and The Nautical Institute, has set up an Australian Maritime Mentoring Program. The program has been developed to bridge the gap between new entrants to the maritime industry and the senior maritime professionals who are already established in their careers. By doing this we can grow our industry by preparing the next generation of leaders.

It is also hoped that the Australian Maritime Mentoring Program will allow new entrants to the industry to educate us and help our member organisations better understand the challenges and issues that they face, especially in relation to training. If we can understand those issues, we can better provide relevant guidance to government and industry on how to prepare for the future and also possibly help to introduce a level of empathy which is sometimes missing in the maritime industry.

There are presently 26 paired mentees / mentors, and it is hoped that once these pairings are settled that another social media campaign will be conducted to recruit more mentees. So far all of the feedback has been positive.

For the mentoring program to be a success there is a need for the mentors to be interested and enthusiastic and to aid in this a webinar was held in September the aim of which was to give the mentors enough information on the key skills needed to be an effective mentor. This was again a well attended webinar.

More information on how to become a mentor or mentee is available on the website and again Ricky Rouse must be thanked for being a driving force in the establishment and running of the mentor scheme.

Women in Maritime

AMPI has been asked to partner another Connecting Women in Maritime event which the board has agreed to do. It is good for AMPI to be a partner in these types of events as it helps to bring an awareness to the maritime industry around different roles or challenges that may be found by women in maritime as well as providing opportunities to support increasing women in maritime technical development and professional networks.

The organiser of these events, Jeanine Drummond is hoping to hold an event in Mackay in March (tbc). Jeanine has recently held successful Connecting Women in Maritime events in Dampier and Port Hedland.

Pilot ladder transfer

There is a lot of work being done in this space. AMPI was asked by AMSA to comment on various papers dealing with pilot ladder amendments that were to be discussed at the IMO's Maritime Safety Committee (MSC 104) meeting in October. These papers proposed amendments to SOLAS Regulations so that:

- the technical requirements for pilot ladders as a part of the combination arrangements are specified
- a new output can be written that would address the issues identified with pilot transfer arrangements and to improve the safety of pilots at sea.

IMPA also submitted a paper which provided comment on one of the submitted papers from China. This paper supported China's proposal for the new output and IMPA would also expect to take an active role in helping to develop amendments to SOLAS Reg V/23 and resolution A.1045(27). IMPA also stated that they have already begun an in-house review of its boarding arrangements poster to make it more user-friendly and instructive for ships' crews. The results of that review could be shared as part of the proposed work item.

Unfortunately, due to time constraints these papers on improving pilot ladder safety were not considered at MSC 104 but should be considered at MSC 105 which is due to be held in April 2022. AMSA will again be in touch before this date to ensure our position hasn't changed or if there have been any other developments that need to be considered.

Adam Roberts has continued working on ISO Parts 2 and 3, with ISO 799 Part 2 – Maintenance and Use of Pilot Ladders being published in May 2021 and ISO 799 Part 3 – Associated Equipment (after some initial push-back from certain flag states) due to be published in April 2022. Part 3 will deal in detail with trapdoor ladder arrangements.

The yearly IMPA Pilot Ladder and Helicopter Safety Campaign has recently been completed and I thank all of those who chose to participate.

The **AMSA Pilot app** remains in place and should be used to report dangerous and non-compliant transfer arrangements.

Alternate Pathway

Work on the alternate pathway is still slowly progressing but has been on the backburner lately due to other concerns in the industry.

AMPI still sees this sees this as an opportunity to ensure that AMPI is central to any discussions on pilot training especially as there are other bodies in the industry that are also possibly considering port pilotage training programs.

Peer Support

This is one of the most important services that AMPI provides to members and their families. The service continues to be well utilised and has assisted in a variety of issues. The AMPI service continues to be funded by membership.

Please remember that if you are struggling to cope due to the pressure brought about by the COVID 19 virus or for any other reason then please seek out help and talk to your fellow pilots, wives, partners or use the PAN Network. In these times we all need to think about our and others mental health and well-being.

Communication

The issue of communication has continued to be problematic not only due to COVID but for a variety of other reasons as well. It is hoped that with the easing of travel restrictions due to the vaccine rollout that some travel around the country may again become possible in the New Year In the meantime, social media will remain the norm and AMPI has in place the following to help in this regard:

The AMPI website – This is where all of the AMPI information is available and the information provided includes upcoming conferences and workshops, accident investigations, CPD log in, peer assistance contacts, positions vacant, etc.

The AMPI App – The AMPI App has been available since earlier this year and the Board recently decided to use Google analytics to gain information on the usage of the app.

Safe Passage – Two editions of our professional magazine are published each year and have included many interesting articles and stories from pilotage organisations around the country. Ricky Rouse from Newcastle has taken over as Editor and has done a great job in producing the two Editions of Safe Passage that has been published this year.

Facebook – AMPI has a Facebook page, and AMPI will be happy to be your 'friend' so join in and make a contribution to the group.

In addition to the above, all AMPI board members are all contactable by email or phone. All regions of Australia are represented on the board so if you have any issues, contact your regional board member. I encourage you to do so for you the members are AMPI and your participation will help us to be a stronger body.

Conferences, Workshops and Webinars

There is finally some good news on this front with an AMPI conference to be held in Port Kembla on the 30-31st March 2022 with Rob Tanner and his team working hard to bring all the parts that make up a conference together. The Australia's Maritime Future Conference will bring together national experts presenting on a range of topics including:

- Australia's future freight task
- Diversification in the maritime workforce
- Port sustainability
- Maritime Autonomous Surface Ship
- Seafarers' welfare and associated health risks

The conference will also assist in developing and maintaining the high standards of pilotage in regional ports.

As usual at these types of events there will be an opportunity to network with maritime experts from throughout Australia.

AMPI has also been engaging the membership and other maritime industry participants through the use of webinars with a very successful webinar being held earlier in the year on ports providing ECDIS routes and passage plans to ships as part of the pre-arrival process. This webinar attracted well over 150 participants and thanks must go to Ricky Rouse for his organisational skills in bringing this webinar together.

The next webinar will be held on the 14th of November at 1900 and will focus on talking to Marine Pilots from Ports in Western Australia, Queensland and New South Wales, who have all been recruited from a variety of different seagoing backgrounds, to find out about their pathway into Marine Pilotage, how they transitioned and the challenges that they have faced.

This webinar will offer a great opportunity for anyone interested in going to sea to find out more about these different pathways.

It is AMPI's intention that these webinars will continue (especially in the leadup to the March Conference) with various topics of interest being covered.

Reduction in Marine Pilot training requirements

Due to concerns over a proposed reduction in Marine Pilot training requirements government lobbying has been conducted with Government Ministers, Parliamentary Advisers, AMSA, ATSB and various State Transport departments to promote the interests of our Marine Pilots and gain support for the issue. The outcome of these discussions was generally positive with no major changes envisaged in the future. These discussions are ongoing.

This concern has also led to the introduction of two position papers on the use of simulation in marine pilot training both of which are available on the AMPI website.

The original cause of this concern was contained in a change to the NSW Pilotage Code where initial on-water training was to be replaced by simulator sessions. This change has since been removed in the recently completed review of one part of the NSW Pilotage Code. AMPI was well represented at this review and Lyndon Clark, Jon Drummond, Malcolm Goodfellow, Nick Leonard, Gyles Deacon and Scott McLennan are all to be thanked for their efforts in canvassing views from their fellow pilots and in gaining a suitable outcome.

Industry Engagement

AMPI has continued to engage with industry via discussions with Ports Australia when needed and AMPI has recently joined Shipping Australia as a corporate associate member. This has been done to help AMPI engage with industry to ensure that the pilotage services provided by its members are meeting the needs of shipping stakeholders This engagement is important as it allows AMPI to provide expertise and guidance in an area that is critical for protection, of not only ships, but also for port infrastructure and the surrounding environment.

This expertise and guidance will also lead to an enhanced understanding of the processes that are involved in providing a safe and efficient pilotage. AMPI in looking to the future, will also be actively identifying improved ways of risk managing pilotage as increased automation and autonomy is introduced in the shipping industry.

AMPI needs to show that it is here to help.

In closing this President's Report I would like to thank the AMPI board who help to manage the pilotage issues in their spare time. We need to remember that all board members and other contributors are working on AMPI issues in their own time as well as holding full time pilotage positions around Australia. This requires a need to ensure that contributions between work, family and other commitments strike the right balance. This is why it sometimes takes time to provide answers to members' queries but rest assured they are being addressed.

At this AGM several Directors are stepping down and I would like to thank Craig, Ben, and Gavin for the great work that they have carried out whilst they have been Directors of AMPI. Their knowledge and dedication will be missed. I also welcome the new Directors to the Board and look forward to working with you.

Captain Peter Dann
AMPI President

Treasurer's Report

I am pleased to present the financial position of AMPI for the Financial Year (FY) 2020/2021. Our income for this FY was derived from membership subscriptions, CPD fees and advertisements. We thank our members and sponsors for their continued support.

At the start of the FY on 1st July 2020, the net assets totalled $364,088. In the FY20/21 budget, we had forecasted a total revenue of $187,074 minus operating costs of $117,123 resulting in a projected net income of $62,955.90. As accounted for in the FY20/21 budget, there were no workshops due to travel restrictions, therefore no income or expenses for this entry.

The audited financial statements for FY20/21, show total revenue of $176,409 minus operating costs of $102,146 resulting in a net income of $73,509. The actual income was lower than budgeted, mainly due to late subscription payments. However, operating costs were also lower due to limited travelling and representation costs and fewer than anticipated professional consultancies for various projects. This combination of factors resulted in a higher than budgeted net income.

At the end of the FY on 30th June 2021, our net assets totalled $437,597, an increase of $73,509 from the previous FY 2019/20. It is worth mentioning that the yearly increases in our net assets are possible due to maintaining low overhead costs and a conservative approach to expenditure. All Directors, including President, Vice-president and Treasurer, are non-paid volunteer positions. Our very efficient administrator, Marvie Rouse, is the only paid member of staff. As we operate remotely there are no overhead office costs. I would like to thank all involved for their generous dedication which has allowed AMPI, among other achievements, to keep building a solid financial position.

For this current FY 2021/22, we have forecasted total revenue of $275,765.42 and operating costs of $182,173 resulting in a net income of $111,809.72. The increase in revenue and costs is due to the forthcoming AMPI conference "Australia's Maritime Future Conference" to be held at Port Kembla from the 30th to 31st March 2022. As travel restrictions ease, we also expect our President and Directors to increase travel whilst representing AMPI at different national and international events, accounting for a slight increase in our projected operating costs.

AMPI continues to grow its membership. At the end of the FY2020/21 our membership status was: 260 full members; 21 associate members; 4 retired members; and 2 honorary members. The membership revenue increased from the previous FY 2019/20 from $154,906.30 to $163,515.47. The number of members in the full and associate categories continues to increase with employers signing up their pilots and the introduction of the Australian Mentoring Programme.

We do not lose sight that AMPI's mission is to be the professional representation body of Marine Pilotage throughout Australasia and the pilot's industry voice, representing pilots and pilotage at state, national and international levels. The strategic financial plan of AMPI is to facilitate the accomplishment of this mission by building a solid financial position that enables us to deliver service and value to members and stakeholders.

How are our funds spent? Our resources are allocated to various tasks: organising workshops, conferences and webinars; running the CPD programme; administration costs; book keeping and auditing; paying tax and corporate fees; reaching out to our members via the Safe Passage and promotional items; annual subscription to IMPA for all our members; maintaining the Peer Assistance Network; maintaining our website, social media, and the AMPI application; implementing the Pilot mentoring programme; drafting and promulgating best practice codes; engaging professional consultancy when required; and, paying for travelling expenses to attend stakeholder meetings. The total cost of all these activities during the FY 2020/21 was $102,146.

During this past year, we have increased our level of expenditure by organising free webinars and introducing the Australian Mentoring program. For the FY2021/22, we will continue to offer all current benefits and services and we are also exploring other initiatives to ensure we stay connected to our members and you all get excellent value for your membership.

Finally, we would like to thank everyone, as our success is only possible through the generous commitment of our members and sponsors and the unwavering dedication of the Board of Directors, Safe Passage editor, administrator, and collaborators.

Stay safe and see you at the forthcoming AMPI conference in Port Kembla.

Captain Bernardo Obando
AMPI Treasurer / Vice President

Performance Standards for *Marine Simulation*

In 2020, the UK Maritime & Coastguard Agency (MCA) approved a training program allowing cadets to replace some sea time with simulator time.[1] And they're not alone—there's increasing interest in using ship simulators to replace real-world experience, even for marine pilots. But does it work?

The aviation industry has used simulators in pilot training and assessment for almost a century. Despite key differences between maritime and aviation, the maritime industry can still learn from their experience.

The "Fifty Years of Flight Simulation" conference in 1979 considered the potential and limitations of simulators in training, and commented, *"Flight time reduction is, of course, the great advantage imposed by simulation..."*

Shortly afterwards, in December 1980, the Advisory Group for Aerospace Research and Development working group released a report.[2] It explained:

> ***"The…simulator is a device for the acquisition, development, and maintenance of… skills. Its use may give considerable savings in…time, …space, [and] fuel consumption, …and also enable trainees to carry out operations which…would be dangerous to life and machine. These advantages have been recognized, and…simulation is now widely established as a method for pilot training."***
>
> ***"…Serious questions have been raised, in both the technical and training communities, as to the complexity of simulation that is required for effective pilot training."***

Over 40 years later, the maritime industry is asking the same questions. This article looks at the state of modern simulators, compares simulator regulation and certification in aviation and maritime, and considers the effectiveness of simulators in training and assessment.

What is a simulator?

From games like chess to full-mission bridge simulators, simulators mimic real-world operations or processes, giving people a chance to develop or practice their skills. As technology develops, simulators are becoming ever more popular. The Google Play Store offers an impressive range of "ship simulators"—you can practice fishing, mooring, or even command a warship, but that's not what we mean when we discuss simulators in maritime training.

Most modern flight and bridge simulators are physical interactive simulators—they are physical models that respond to our interactions. A bridge or flight simulator comprises several interdependent parts:

- hardware (including controls and computers);
- software;
- ship or plane models;
- port models;
- environment models; and
- scenarios.

Each part plays a key role in the impact of the final product: even with the best hardware and software in the world, inaccurate models or unrealistic scenarios will undermine your simulation and prevent you from achieving your goals.

Is simulator training effective?

"Transfer" is the key measurement of simulator effectiveness—it measures the percentage of skills that transfer from the simulator to the real world. To measure transfer, you must first identify which skills you're assessing.

In January 2019, a gamer beat Formula 1 drivers in a real-world car race.[3] Although he'd also had a year of practice

in real cars, it's an impressive demonstration of transfer of driving skill, as it normally takes decades of real-world training to beat the pros. However, if we measured transfer for the skill of changing a tyre, the driving simulator would have failed miserably—it's not designed to exercise that skill.

Piloting a ship undeniably requires a wider range of skills than driving a Formula 1 car; however, this does not negate simulators' usefulness in marine pilot training or assessment in a range of relevant skills.

As flight simulators have been around for so much longer than bridge simulators, most research into simulator effectiveness and training transfer focuses on aviation. Despite that, researchers across industries agree that simulators, even low-fidelity simulators, are effective for both training and assessment of suitable skills.[4] Just as a Formula 1 driving simulator won't teach you how to change a tyre, a ship simulator that doesn't provide an appropriate environment to practice a particular skill, won't help you to develop that skill.

Factors affecting effectiveness

A wide body of research on flight simulators shows no increase in transfer on moving vs stationary simulators, even for tasks in which motion and force information would serve a primary cue in the real world.[5,6] A study on the computer game "Microsoft Flight Simulator" showed that even a low-fidelity simulation on consumer hardware had positive skill transfer to real planes.[7] Despite this, noauthority would let a student fly a real plane solo just because the student was competent on Microsoft Flight Simulator.

To maximise transfer, a ship simulator's fidelity must be appropriate for the skill being trained. For deck cadets practising basic mid-ocean collision avoidance, a low-fidelity simulator is perfectly adequate. Conversely, for marine pilots learning to manoeuvre a deep-draft vessel in a narrow channel or berth a car carrier in strong winds, higher fidelity is critical.

But for the pilots, ship handling is only the most visible aspect of their job. People skills, clear communication, multi-tasking, situational awareness, and coordination of multiple moving parts is also essential; learning these requires a range of experience in different conditions.

While it's technically possible to practice many of these aspects in a simulator, it would require more people and resources than training centres normally have, and raise the cost considerably.

Maritime simulation in practice

Like aviation, maritime uses simulators to provide a safe training environment. It's inarguable that it's better to run aground or collide in a simulator than on a real ship; however, few mariners claim a simulator is perfectly analogous to a ship—even the best simulator is never the same, even if the difference is only in mindset. The key question is: does it matter?

Case study: South Shields Marine School

In the North-East of England, South Shields Marine School trains about 40% of UK Pilots, and has run specific courses for pilots from all around the world. 13 years ago, after almost 30 years as an Orkney pilot, Mel Irving "retired" to South Shields to work on their simulator. He's now responsible for the delivery and development of advanced simulation training, including research and development projects, and ship handling, pilotage and bespoke courses.

Simulators

The school's Marine Simulation Centre has 14 bridge simulators, which they can use together or individually, including:

- two full mission bridge simulators with a 360° field of view;
- a four bridge navigation simulation suite with a 120° field of view; and
- eight secondary bridges and special task simulators, including riverboat, anchor handling, dynamic positioning, and functions such as ice navigation, anti-terror and SAR-training.[8]

Models

Simulators come with a set of "off-the-shelf" ship and port models. Mel explained that these models, while suitable for STCW NAEST-type courses, lack the detail to accurately simulate manoeuvring characteristics and hydrodynamic effects required for specialist training.

For more advanced operations, they use special software from the simulator manufacturer to create their own high-fidelity models, including new harbour developments and the actual ships that will use the berths. Once they've generated the initial models, people who know the area or ship well assess them, then the simulator staff tweak them until they reflect reality. An accurate model needs a lot of time, often more data than is readily available, and a solid understanding of the software.

Uses

As well as the familiar STCW courses, South Shields Marine School uses bridge simulators for:

- pilot training and assessment;
- familiarisation of masters and crew on new ships and ship types;
- accident/incident recreation;
- pilots and industry practising high-risk manoeuvres, such as towing newly launched sections of aircraft carriers,[9] or close-quarters manoeuvring in sensitive areas;
- ship design; and
- modelling and impact assessment of harbour developments.

Standards and certification

Simulator standards and certification ensure simulators meet the minimum criteria to achieve their intended purpose. A simulator doesn't have to be perfect, it just has to be appropriate for the skill being trained or assessed. Consider chess, a simulator for teaching strategy, or even the cardboard cockpits developed for procedural flight training during COVID.[10] Neither is a high-fidelity replica, but both are effective in achieving a limited set of goals. This is acknowledged in both aviation and maritime simulator regulations, which classify simulators based on the skills the simulator is designed to train or assess.

Aviation simulators

For flight simulator standards, there are four relevant bodies in Australasia:[11]

1. US Federal Aviation Administration (FAA)
2. European Aviation Safety Agency (EASA)
3. Australian Civil Aviation Safety Authority (CASA) (recognises FAA and EASA approval)
4. New Zealand Civil Aviation Authority (CAA) (recognises FAA approval)

This article focuses on the FAA definitions, as FAA approval is the most widely accepted in the region.

Classification

While we use the term "flight simulator" colloquially to describe anything that replicates some part of the flight experience, approval bodies break them down into defined categories.

According to the FAA, a full flight simulator (FFS) is:

"A replica of aircraft instruments, equipment, panels, and controls in an open flight deck area or an enclosed aircraft flight deck replica. It includes the equipment and computer programs necessary to represent aircraft... operations in ground and flight conditions having the full range of capabilities of the systems installed in the device as described in part 60...and the qualification performance standard (QPS) for a specific FTD qualification level."

FAA and EASA break FSS down into four levels, A to D, where Level A has 3-axis motion and night visuals, and Level D has 6-axis motion; night, dusk and day visuals; dynamic control loading; and the highest fidelity.

A flight training device (FTD) resembles a FSS, but meets lower standards. There are 4 levels of FAA FTDs in production:

4. basic cockpit procedural trainer, often with just a touch-screen;
5. specific class of aircraft, which meets specific design criteria;
6. high fidelity, aircraft specific, with specific aerodynamic modelling; and
7. helicopters only, with all controls & systems modelled, and a vibration and visual system.

Aviation Training Devices (ATD) are the FAA's last categories of "flight simulators." An ATD is:

"A training device, other than a full flight simulator (FFS) or flight training device (FTD), that's been evaluated and approved by the Administrator. In general, this includes a replica of aircraft instruments, equipment, panels, and controls in an open flight deck area or an enclosed aircraft cockpit. It includes the hardware and software necessary to represent a category and class of aircraft...operations in ground and flight conditions having the appropriate range of capabilities and systems installed in the device..."

The FAA splits ATDs into basic (BATD) and advanced (AATD), depending on whether they're adequate to provide training for the specific "procedural and operational performance tasks" for particular qualifications.

For each model, FAA representatives complete functional and performance tests, including an initial inspection of the systems, and an operational evaluation of every manoeuvre and system operation. They repeat this annually to confirm that simulators comply with the current approval test guide.[12] [13]In addition, they assess and classify airport models based on the fidelity and whether they're appropriate for the type of simulator and intended use. [14]This is all auditable, and if any tests fail, the simulator can't be used for training.

Maritime simulators

Maritime simulator approval is both simpler and more complex. The only mandatory standards are in STCW, which sets goal-based simulator standards. As an international convention, this should make maritime simulator classification simpler; however, classification societies approve and certify simulators against more detailed non-mandatory standards. DNV, a leading classification society, explains that they:

- *"Ensure...simulations provide the relevant level of physical and behavioural realism in accordance with recognised training and assessment objectives;"*

- *"[Confirm] properly installed and configured simulator equipment;"* and
- *"Prove [the] simulator systems used for mandatory training or assessment conform to international requirements."* [15]

For marine pilots, this is almost irrelevant: international (STCW) requirements focus on basic training for deck officers. As STCW training is the primary market for commercial navigational simulators, any simulators marine pilots use for training will comply with these standards; therefore, they are worth understanding.

While DNV and other classification societies check certain simulators are, *"...capable of simulating...the capability for advanced manoeuvring in restricted waterways,"* and *that models for these simulators, "...realistically simulate own ship hydrodynamics in restricted waterways, including shallow water and bank effects, interaction with other ships and direct, counter and sheer currents,"*[16] once they've approved a simulator, it's up to the training centre to provide extra models. Even for simulators capable of simulating advanced manoeuvring and hydrodynamics, inadequate models can render a training exercise useless.

Classification

STCW A-I/12 part 1 divides simulators into those used in training, and those used in competency assessment. Both types must:

1. be capable of satisfying the specified objectives;
2. be capable of simulating the operational capabilities of the shipboard equipment concerned to a level of physical realism appropriate to the objectives, and include the capabilities, limitations and possible errors of such equipment;
3. have sufficient behavioural realism to allow participants to acquire or demonstrate the appropriate skills;
4. provide a controlled operating environment, capable of producing a variety of conditions, which may include emergency, hazardous or unusual situations relevant to the objectives; and
5. permit an instructor to control, monitor and record exercises for effective debriefing or assessment.

Beyond that, STCW details specific requirements for radar and ARPA in simulators, training and assessment programs, and instructor and assessor qualifications. Some manufacturers offer instructor and assessor courses, but in practice, simulator instructors and assessors often rely on personal research, experience, and on-the-job training.

Classification societies such as DNV break these guidelines down into more detailed requirements. DNV identifies five classes of bridge simulator: [17]

- Class A - a full mission simulator capable of simulating a total shipboard bridge operation situation, including the capability for advanced manoeuvring in restricted waterways.
- Class B - a multi-task simulator capable of simulating a total shipboard bridge operation situation, but excluding the capability for advanced manoeuvring in restricted waterways.
- Class C - a limited task simulator capable of simulating a shipboard bridge operation situation for limited (instrumentation or blind) navigation and collision avoidance.
- Class D - a cloudbased distant learning simulator capable of simulating a shipboard bridge operation for training through a remote desktop solution by enabling physical and operational realism through virtual reality.
- Class S - a special tasks simulator capable of simulating operation and/or maintenance of particular bridge instruments, and/or defined navigation/manoeuvring scenarios.

They go on to detail the minimum equipment, installation, and behavioural realism requirements for each class. DNV certifies simulators at the design stage, then certifies individual installations.

Marine vs aviation simulator standards

Simulation-based assessment in aviation is easier than in maritime as there are a limited number of aircraft types on the market.[18] Flight simulators only have to replicate specific models of aircraft, while navigational simulators must simulate a wide variety of equipment and ships.

Simulator standards reflect this, with aviation standards that assess the aircraft model as an integral part of the simulator, while marine classification societies assess models separately. Further, by reinspecting flight simulators annually, the aviation authorities can ensure they continue to comply with the latest standards.

Software is an integral part of any simulator, and software updates can change the way models interact. In a flight simulator, these changes would need approval; in maritime, they don't. Once a navigational simulator installation is certified, that's it.

Design and testing

If you've played a modern first-person computer game, it won't surprise you that most simulator software engineers have a background in games development. The rest have worked in 3D modelling, or a relevant field such as mathematics or hydrodynamics. Both computer games and simulators rely on the same underlying technologies, including 3D graphics, a physics engine, AI and networking.

Navigational simulator development varies by manufacturer, but they all focus on not reinventing the wheel; where necessary, they collaborate with companies who have relevant expertise.[19 20 21] Because of this, developing a simulator has much in common with developing a computer game. For anyone interested, VStep's "Behind the Simulator" series[22] gives some insight into the development process, from assessing customer requirements, through development, to quality assurance and delivery.

Just as every ship's bridge is different, so is each simulator installation. Manufacturers use off-the-shelf hardware, such as projectors, computers, ECDIS, radar and radios, to meet each training centre's specific requirements.[23]

Simulator limitations

As with any technology, simulators have limitations. Some limitations only cause problems for owners or operators, but others can force trainees to modify their real-world approach to make it work in the simulator. Over time, this creates bad habits unless balanced with real-world practice.

Software

Training centres are subject to the whims of simulator software providers; the limitations of maritime simulator regulations don't help. Just as PC software upgrades can reduce functionality, or leave you unable to open files saved on previous software versions, so can simulator software upgrades.

A 2020 software upgrade at the South Shields Marine School added more realistic graphics to the simulator, including flapping flags, but removed certain hydrodynamic effects and made it less effective at simulating close-quarters manoeuvring. While advanced manoeuvring is critical for marine pilots, it's less important for the target audience—deck officers and cadets—so the software still complies with the STCW requirements.

Worse, many files developed for the previous software system were incompatible with the new version of the software, so staff had to manually convert 20 years' worth of exercises and models to be usable with the new software.[24] All any training centre can do is work around it and ask the manufacturer to reinstate the missing effects; however, there is little commercial incentive for manufacturers to cater to such a niche market.

Hardware

Every simulator has minimum hardware requirements, including memory and graphics cards; as with anything, you get what you pay for. At one end of the scale, South Shields Marine School's simulators use 300 computers to drive 6 interconnected full-mission bridge simulators; at the other end, Bridge Command[25] is a scalable open-source bridge simulator that will run happily on your home PC. However, just as your home PC freezes or lags if you try to do too many things at once, so do simulators.

Like any large file, detailed models need more memory than simple models, and you can get some interesting, if unhelpful, effects when simulators are overloaded.[26] To counter this, it's important to use models and exercises that match your simulation goals.

Detailed models are only necessary for interaction, or specific manoeuvring characteristics—there's no need to simulate hundreds of high-fidelity fishing boats if your ship won't go near them during the exercise. Likewise, holding an accurate model of the entire port in working memory is unnecessary, as long as the visible sections are accurate. As the simulation progresses, the system can load newly visible port sections. This means the computer doesn't need to keep the complete model in memory throughout the exercise, allowing a more detailed simulation without overloading the system.

Physical Environment

While similar, the physical environment of a full-mission bridge simulator is not the same as an actual ship's bridge. In the real world, we gain depth perception through parallax. A simulator can simulate some parallax, for example, that of distant objects moving relative to the ship, but the parallax caused by each eye seeing a slightly different image, or by moving from one side of the bridge to the other, is harder to model.

This forces trainees to compensate, for instance by relying on instruments rather than judging distance and speed by eye. While unavoidable in the simulator, this habit could slow their skill development in the real world.

Models and data

In a simulator, a finite number of data points in a model wave interact with a finite number of data points on a model ship. The computer interpolates between the points to "fill the gaps." The more data, the more detailed the model, but it would require an infinite number of data points to perfectly simulate the real world.

No matter how much data you have, it's never enough to perfectly model the real world. However, a perfect model is unnecessary—the model just needs to be detailed enough for the specific skills being trained or assessed. You can teach a cadet basic manoeuvring concepts using random objects to simulate a ship and a berth; teaching advanced manoeuvring needs high-fidelity models, but they don't need to be perfect.

Effective simulator training for advanced shiphandling relies on detailed, accurate models. Detailed, accurate models rely on detailed, accurate data. Sometimes that data's just not available. Collecting bathymetric data is expensive and time-consuming, so many ports only collect the bare minimum required for safe operation. There's a commercial argument for collecting depth information, but what about currents or tidal streams at different layers? Eddies at different states of tide? When is it enough?

Humans

Simulators are not the real world—they're accurate computer games. Compared with the real world, simulators are a risk-free environment; even in the best simulator, there's no way to forget that. That knowledge can be both a blessing and a curse: a blessing, because it allows trainees to try new things safely; a curse, for the same reason.

Brains

Mel Irving explained that accurate models react in real-time in a simulator. Unfortunately, to users accustomed to computer games, it feels slow. Combined with the knowledge that it's not real, this leads to a tendency to speed up during simulator manoeuvring. Over time, this can create bad habits.

Mel Irving explained that computer-based simulation runs in real time. However, for most ship types the bridge in the simulator is smaller than the real thing. This, together with the lack of depth perception, can lead to users feeling that manoeuvres should be happening at a faster rate. In some cases, this can cause users to question the fidelity of the simulation. Participants would also prefer certain operations, such as mooring or making tugs fast, to happen much quicker on the simulator.

Whether users react as they would in the real world depends on how immersed they are in the exercise. Good exercises draw the candidate in: they forget that they are actually in a simulator, but instead believe that they are in the real world and react accordingly. For this, accurate models and realistic visuals are essential. It takes very little to break this spell, so choosing which areas and models to use is critical.

On a related note, people in a simulator expect something interesting to happen—it's training or an assessment, after all. Participants in a simulation aren't not fatigued, distracted or bored in the way they might be in the real world, and they're primed to respond. In training, this can be positive, however, in an assessment, participants' reactions may not mirror their real-world performance, and may lead to overconfidence.

A well-known example of this difference is the investigation into US Airways Flight 1549's landing in the Hudson. In this case, simulator re-enactments of potential alternative courses of action gave a completely different result when they included a 35 second delay to simulate "... real-world considerations, such as the time delay required to recognize the extent of the engine thrust loss and decide on a course of action." Without this "human factors" delay, the simulation pilots sometimes landed safely; with the delay, they crashed.[27]

Simulator sickness

Simulator sickness is another human-simulator problem. Like seasickness, it results from a mismatch between what we see and what our other senses tell us. Like seasickness, it can cause sleepiness, discomfort, disorientation and nausea. Like seasickness, it reduces people's ability to focus and learn. Unlike seasickness, it can occur even in a stationary simulator. Some operators even find that higher fidelity[28] or a wide field of view can increase simulator sickness.[29] In a moving simulator, any mismatch between the platform motion and the graphics has the same effect.

VR sickness is similar more common than simulator sickness, but has similar causes and effects. With Class D VR navigational simulators entering the market, this could become more of a problem for users. While there are ways to mitigate both simulator and VR sickness, they will remain a problem for some time to come.

The real world

Compared to marine pilots, airline pilots work in a standardised environment with familiar equipment. Not even the best simulator can replicate the range of people, ships and equipment marine pilots will face in the real world. Language, culture, personality, and commercial pressure can turn a technically simple pilotage into a nightmare. And it's not just a training problem.

As explained earlier, we use simulators for tasks as diverse as accident investigation, planning, impact assessment and more. While simulators play a critical role, the real world is not a perfect, controlled environment—it's random and chaotic. Because of this, there's a non-zero chance that something that works perfectly in a simulator won't work the same way in the real-world. As simulators continue to improve and their uses expand, we must always bear this in mind.

The future of marine simulation

The Royal Navy, working with VR company Immerse, developed a cloud-based VR simulation for training submariners.[30]Crew in different locations can work together in a shared VR submarine, while instructors monitor their progress. They can form their team and get used to their roles before they ever meet in the real world.

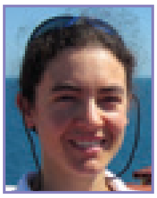
Full-mission (Class A) bridge simulators are expensive and resource-intensive. Trainees have to travel to the simulator, and access is limited. The recently introduced Class D cloud-based and VR simulators will change that, making simulation an affordable, readily accessible tool. Kongsberg's K-Sim platform was the first Class D[31] system to be approved, closely followed by Wärtsilä Voyage's Cloud Simulations.[32] Kongsberg's system has already been adopted by the University of Cebu as a cost-effective and COVID-friendly solution.[33]

As cloud-based VR simulators are less expensive to develop than other classes of simulator,[34] it will become commercially viable to target niche markets, maybe even marine pilots. As a result, Class D navigational simulators will become more common in the coming years.

Conclusion

In maritime, simulators can provide a high-quality training and assessment environment for many technical skills marine pilots rely on. Unfortunately, marine pilots are only a tiny fraction of the target market for simulators, so it's no surprise that both manufacturers and regulators target the larger audience of STCW courses.

Accessible simulators can democratise training. Soon, companies will use digital twin technologies and Class D simulators to familiarise crew with new ships, cadets will drill with simulators rather than flashcards, and marine pilots will practice at home using consumer VR headsets. While simulation will never be perfect, it will continue to advance, improving training, assessment and safety in maritime.



Captain Nic Gardner

Marine Technology Analyst

References

1. *UK Ship Register. (2020). New simulator training experience approved for seafarers. Maritime & Coastguard Agency. Retrieved 14 October 2021, from https://www.ukshipregister.co.uk/news/new-simulator-training-experience-approved-for-seafarers/*
2. *Oosterveld, W., Key, D., Bates, G., Bray, R., Chambers, W., Friedrich, H., Gainer, C., Hammer, N., Koevermans, W., Rolfe, J., Schulz-Helbach, Smith, J., Staples, K., & Young, L. (1980). Fidelity of Simulation for Pilot Training. Advisory Group for Aerospace Research and Development (AGARD). https://www.semanticscholar.org/paper/Fidelity-of-Simulation-for-Pilot-Training-dwELECTE/85b5efd42f60b46b27f110fcf164a8316e1b95eb*
3. *Tangermann, V. (2019). A Guy Trained on Video Games Just Beat a Formula 1 Driver on a Real Track. Futurism. Retrieved 14 October 2021, from https://futurism.com/sim-racing-virtual-motorsport-beat-formula1*
4. *Lee, J.D. (2004). Simulator fidelity: How low can you go? Proceedings of the 48th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica, CA. https://www.nads-sc.uiowa.edu/dscna/2007/papers/Section%208%20-%20Simulator%20Fidelity%20and%20Validation/Severson.pdf*
5. *Dahlstrom, N., Dekker, S., van Winsen, R., & Nyce, J. (2009). Fidelity and validity of simulator training. Theoretical Issues in Ergonomics Science, 10(4), 305–314. https://doi.org/10.1080/14639220802368864*
6. *Waag, W. L. (1981). Training effectiveness of visual and motion simulation. PsycEXTRA Dataset. Published. https://doi.org/10.1037/e420722004-001*
7. *Beckman, W. S. (2013). The Effectiveness of Microsoft Flight Simulator as a Training Aid for Private Pilot Training and Proficiency. 17th International Symposium on Aviation Psychology, 38-43. https://corescholar.libraries.wright.edu/isap_2013/104*
8. *South Tyneside College. (n.d.). Marine Simulation. Retrieved 14 October 2021, from https://stc.ac.uk/page/marine-simulation*
9. *McLean, K. (2014). Piloting the UK's new Aircraft Carrier. The Pilot, 317. http://ukmpa.org/wp-content/uploads/2016/06/Pilots-Mag-317_weba.pdf*
10. *Cardboard Cockpits. (2021). Cardboard Cockpits. Retrieved 19 October 2021, from https://www.cardboardcockpits.com/*
11. *Aviation Simulator Technology (AST). (n.d.). Simulator Levels Explained. Retrieved 29 September 2021, from https://www.ast-simulators.com.au/start-here/simulator-levels-explained*
12. *Federal Aviation Administration. (1983). Airplane Simulator and Visual System Evaluation (AC 120–40). https://www.faa.gov/about/initiatives/nsp/ac/media/120_40.pdf*
13. *Federal Aviation Administration. (1969). Aircraft Simulator Evaluation and Approval (AC 121–14). https://www.faa.gov/about/initiatives/nsp/ac/media/ac-121-14.pdf*
14. *Federal Aviation Administration. (2010). Class II and Class III Visual Airport Model Evaluation under Flight Simulation Training Device (FSTD) Directive 1 (FSTD Guidance Bulletin 10–03). https://www.faa.gov/about/initiatives/nsp/bulletins/media/10-03.pdf*
15. *DNV. (n.d.). Certification of Maritime Simulator Systems. Retrieved 29 September 2021, from https://www.dnv.com/services/certification-of-maritime-simulator-systems-2862*
16. *DNV. (2021, June). Maritime simulator systems (DNV-ST-0033). https://rules.dnv.com/docs/pdf/DNV/ST/2021-06/DNV-ST-0033.pdf*
17. *DNV. (2021, June). DNVGL-ST-0033 Maritime simulator systems. https://rules.dnv.com/docs/pdf/DNV/ST/2021-06/DNV-ST-0033.pdf*
18. *Muirhead, P. M. (2006). STCW and assessment of competence by simulator: Ten years on: Why no global acceptance of the practice. Paper presented at the International Conference on Marine Simulation and Ship Manoeuvrability, 2006*
19. *Former, N. (2021). Never waste a good crisis. Xpirit. Retrieved 18 October 2021, from https://xpirit.com/never-waste-a-good-crisis-how-covid-19-drove/*
20. *EGGS Design. (n.d.). The new era of maritime training. Retrieved 18 October 2021, from https://eggsdesign.com/work/case/the-new-era-of-maritime-training*
21. *Wärtsilä. (n.d.). Wärtsilä Voyage Cloud Simulation via the Ocean Learning Platform. Wartsila.Com. Retrieved 19 October 2021, from https://www.wartsila.com/voyage/insights/webinar/wartsila-voyage-x-otg*
22. *VSTEP. (n.d.). Behind the simulator. VSTEP Simulation. https://www.vstepsimulation.com/?s=behind+the+simulator#*
23. *Digital Projection. (2016). Kongsberg Ship's Bridge Simulation Centre. Digital Projection EMEA. Retrieved 18 October 2021, from https://www.digitalprojection.com/emea/dp-case-studies/laser-technology-turns-tide-kongsberg-ships-bridge-simulation-centre/*
24. *South Tyneside College. (2020). World-leading maritime training centre invests in new systems upgrade. Retrieved 18 October 2021, from https://www.stc.ac.uk/news/2020-12/world-leading-maritime-training-centre-invests-new-systems-upgrade*
25. *Bridge Command. (n.d.). Bridge Command. Retrieved 18 October 2021, from https://www.bridgecommand.co.uk/*
26. *Nic G. (2021, October 19). Flying Tugs [Video]. YouTube. https://www.youtube.com/watch?v=jvjg9gCMnA4&feature=youtu.be*
27. *National Transportation Safety Board. (2010). Loss of Thrust in Both Engines After Encountering a Flock of Birds and Subsequent Ditching on the Hudson River (NTSB/AAR-10/03 PB2010-910403). https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1003.pdf*
28. *FAAC. (2021). The Three Traditional Theories of Simulator Sickness and their Implications for Scenario Design. Retrieved 21 October 2021, from https://www.faac.com/blog/2021/02/01/the-three-traditional-theories-of-simulator-sickness-and-their-implications-for-scenario-design/*
29. *de Winter, J. C. F., van Leeuwen, P. M., & Happee, R. (2012). Advantages and Disadvantages of Driving Simulators: A Discussion. Delft University of Technology. https://www.measuringbehavior.org/mb2012/files/2012/ProceedingsPDF(website)/Special%20Sessions/Measuring%20Driver%20and%20Pilot%20Behavior/de_Winter_et_al_MB2012.pdf*
30. *Immerse. (2021). QinetiQ: Moving naval submarine training on to firmer ground. Immerse.Io. Retrieved 18 October 2021, from https://immerse.io/case_study/qinetiq-virtual-reality-training-case-study/*
31. *Kongsberg Group. (2021b). K-Sim Navigation, Cargo and Engine become first cloud-based solutions to gain new DNV class D certification. Kongsberg Digital. Retrieved 18 October 2021, from https://www.kongsberg.com/digital/resources/news-archive/2021/k-sim-navigation-cargo-and-engine-become-first-cloud-based-solutions-to-gain-new-dnv-class-d-certification/*
32. *Wärtsilä. (n.d.-a). OTG X Wärtsilä Voyage. Wartsila.Com. Retrieved 19 October 2021, from https://www.wartsila.com/voyage/simulation-and-training/otg-x-wartsila-voyage*
33. *ShipInsight. (2021, September 20). Kongsberg to provide cloud-based simulator training for Philippines. Retrieved 26 October 2021, from https://shipinsight.com/articles/kongsberg-to-provide-cloud-based-simulator-training-for-philippines/*
34. *Little, A. (2019). Changing Training Paradigms. SAIC. Retrieved 26 October 2021, from https://www.saic.com/blogs/virtual-simulators-in-DOD-military-training*

MARITIME TRAINING

ON THE DOORSTEP OF THE GREAT BARRIER REEF

The Great Barrier Reef International Marine College (GBRIMC), in partnership with TAFE Queensland, is at the forefront to deliver maritime training in accordance with regulatory requirements and the Australian Maritime Safety Authority (AMSA).

Located in Cairns – North Queensland, our modern training facility offers a comprehensive range of training qualifications and certificates.

Training complies with the requirements of the International Maritime Organisation Standards of Training, Certification and Watchkeeping for Seafarers (IMO STCW).

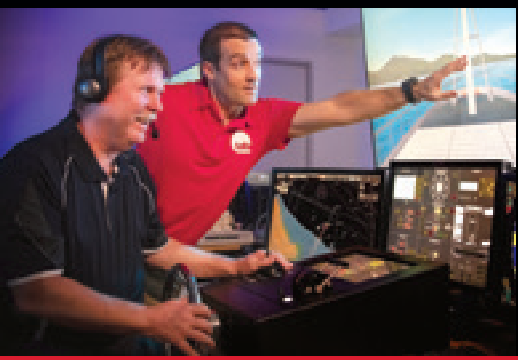
Staff at GBRIMC have extensive industry experience, hold current maritime qualifications and are experts in their field.

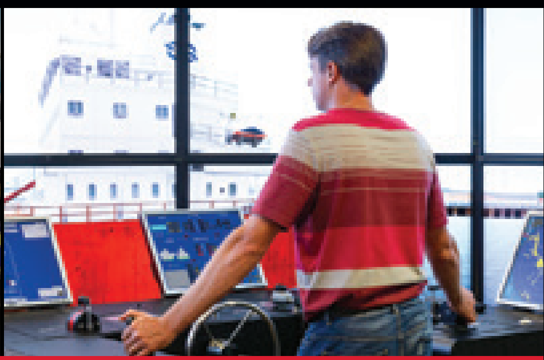
We are flexible in our approach to training, with delivery on campus or off-site at an agreed location.

FACILITIES

Clients have access to a Full Mission Bridge simulator (Kongsberg Polaris) with preprogrammed digital models of ports from all over the world. Our tug-optimised bridge offers highly flexible navigational operations with a 360 degree field of vision.

This simulator can work in conjunction with or separate to, the full mission bridge simulator as well as eight other Kongsberg Polaris desktop simulators for full electronic navigations.





TRAINING

- **ECDIS – Use an electronic chart display and information system to navigate safely** MARH009^
  STCW Reg II/1 & II/2
- **Coastal Pilots Continued Professional Development**
  As per MO54 section 61(1)(c)***
- **Transmit and receive information by the global maritime distress and safety system** MAR0011
  Marine Emergency Care, Craft and Communication (GMDSS) STCW Reg IV/2
- **Global Maritime Distress Safety System (GMDSS) Revalidation****
  Relevant competencies from STCW Table A-IV/2
- **Tug and Barge Master General Operators Course****
- **Train the Simulator Trainer and Assessor*****
  STCW Reg I/6, STCW A-I/6, STCW Reg I/12, STCW A-I/1 VI/5

** Non-accredited training
*** AMSA Approved
^ Qualification currently in transition, course code subject to change.

gbrimc.com.au
1300 308 233 (extension 5)

Great Barrier Reef International Marine College

MAKE GREAT HAPPEN

tafe Queensland

RTO 0275

3344

The Changes in Piloting *over 18 years*

When I started as a pilot with the Newcastle Port Corporation in 2002, things were quite different to today. Newcastle at that time (and still is to this day) was regarded within the Australian industry as one of the premier pilotage ports in the country, a difficult pilotage certainly, one that always demanded great skills by its pilots.

Although there have been numerous changes in pilotage over the years perhaps a summary of some of the major changes I have experienced over the last 18.5 years would be worth highlighting. Many of the changes that occurred in Newcastle would be similar in many other ports around the country.

In 2002, Newcastle had 12 pilots, in the financial year 2002-2003 some 76.8 million tonnes of cargo moved through the port, 71.4 million tonnes being coal exports. Newcastle at that time was the largest coal export port in the world, as it is to this day.

In 2002, there were some 1400 ship calls to the port, 2800 pilotages between 12 pilots. Pilots would average some 250-300 pilotages each per year. The port was far smaller than today, with only 5 coal berths and 8 general cargo berths. BHP had closed down in 1999 and the old steelworks site was a vacant area, designated to become a large container terminal in the future.

The port has grown immensely over the last 18 years and in 2021, Newcastle has 24 pilots, 164.5 million tonnes of cargo (2020 figures) moved through the port, including 158 million tonnes of coal. There were 4400 pilotages conducted in 2020.

Pilot Training:

Pilot training and licence progression has always been a very robust system in Newcastle and pilots had to, and still must, follow a designated marine pilot development program (MPDP). This is a living program that is amended and updated as training reviews take place. This program included initial simulator training at the AMC prior to initial licencing, as well as additional Panamax and Cape upgrade training when progressing to larger class of vessels. The periodical 'bumps and grinds' were done every 3 years (as they are today), and all pilots had to do the Bridge Resource Management (BRM) and Advanced Marine Pilot Training (AMPTC) courses that were run by Ravi Nijjer at that time. Pilots were, at commencement, also required to attend Port Ash and undertake manned model training.

The TNT Carpentaria and TNT Capricornia, both steam turbine ships, were on regular runs to Newcastle in 2002 and of course required specific exposure and training by the pilots due to the particular characteristics of steam turbine ships and the usual lack of power when going astern. Steam ships are of course rarely seen today, and pilots generally have little exposure to them.

Taking vessels on and off the Newcastle floating drydock, 'Muloobinba', required a cool nerve and very good ship handling skills and all of the younger pilots became very proficient doing this (they were normally given these jobs!). Some of the larger vessels on the dock would only have some 1 metre clearance down both sides. The drydock left Newcastle in 2012.

All of the pilots were sent to the Star Cruises simulator in Malaysia (prior to its closing) to do the Competency Audit Course, an exceptional course that taught us how to interact and work closely within passenger ship bridge teams. Prior to doing the course, most pilots on passenger vessels piloted the way they did on non-passenger vessels, i.e., generally not having too much interaction with the Master and bridge team.

At this time, more frequent passenger vessel calls were occurring in Newcastle and our methods of BRM and integration with the bridge teams changed dramatically for the better. In many recent years, feedback from senior Masters would be that Newcastle pilots 'do it as good as anywhere in the world'.

With every newer and larger class of passenger vessel scheduled to call, thorough assessment and trialling was made at the AMC simulator to verify that the vessel could be safely handled in the port. As the passenger vessels got larger over recent years, some over 300m in length, a small group of designated pilots only were allocated to pilot these larger vessels. This was to ensure a constant familiarity and competence in piloting this type of vessel with advanced propulsion systems. This was also in response to feedback from some senior passenger ship masters who preferred to see a small number of experienced pilots on their vessels, whereby a certain level of trust and repour could develop between the pilots and bridge teams with frequent calls.

Although the simulator training, at the time, was conducted quite well by the attending Check pilots, there was no real structure (as is the case today) in how the exercises were conducted, reviewed, and debriefed. In those days if a simulator exercise did not go too well, generally you were just told you 'Stuffed up' with not a great deal of learnings coming out of the exercises or experience.

In recent years, the Check Pilots developed specific simulator exercises for initial and upgrade licence levels. A great deal of work went into formulating a full matrix of various scenarios that covered nearly every conceivable emergency possible on all vessel types. Each exercise had specific critical 'must do' elements identified that were all part of the debrief. The lessons of operating at correct speed, effective use of tugs, engines and rudder in an emergency, methods to kill rudder lift etc and to operate always within the dynamic risk management area of the 'Safety Space' were reinforced with every exercise. Pilots would come away from the training knowing that if they 'followed the rules' and reacted to an emergency correctly as trained, the situation could be dealt with safely and effectively.

The port in 2002. Newcastle Port Corporation 2002 annual report. Note that the PWCS terminal has not been extended and NCIG does not exist. There is no Mayfield 4 and 7 berths and no passenger berth (channel berth).

The Check Pilots undertook specific training and effective debriefing methods which incorporated the latest human factors training and learnt how to achieve the best learning outcome and experiences during each exercise. Every actual significant incident that had occurred in Newcastle (ship failures etc) were incorporated into the exercises as well.

It was important for the pilot to get the maximum benefit out of the simulator training. One of the great benefits of the current Newcastle simulator training system was that there was a transparent consistency by the Check Pilots no matter which Check Pilot went to the simulator or who was being assessed and trained on the simulator. Today there is no such thing as 'what are we going to do now', which was sometimes common when I first started. It is now getting maximum 'bang for buck', a proper program to follow, proper determined and measurable outcomes and no wasted time.

Even the pilot's exams in Newcastle have evolved over recent years, with in addition to the blank chart, a system of extensive oral examination at initial, Panamax and Cape licence levels.

Although MR tankers had been calling at Newcastle for years, 3 years ago various operators were pushing for LR1 and LR2 tankers to call. This required a whole new risk assessment, and it was identified that these vessels would all require 'Active Escort'. A great deal of simulator assessment was undertaken to identify the upper operational swell limits (both for UKC and dealing with failures) for these movements and the safest approach paths to the entrance. An additional pilot boarding ground (Charlie) was established for the tankers, to ensure correct timing and rate of turn approach could be made as per the risk assessments.

The pilots were all required to train on the AMC simulator for active escort of loaded tankers. This usually involved a tug master also attending and being actively involved in the exercises by driving the escort tug on the simulator. Pilots were trained on various vessel failures (e.g., engine, rudder, full blackouts etc) and how the active escort tug was to be used, standard communication phraseology etc.

The recent changes in the simulator training took a more modern approach to dealing with emergencies and understanding accident causation, i.e., abort entry if safe to do so, if committed, utilize all assets to manoeuvre the vessel into a safe position in the channel and then stabilize the situation and hold the vessel until the problem is sorted or further consultation occurs with the Harbour Master.

There was certainly more of an understanding by pilots of pivot points, wind and tidal effects and effects of rudder lift on various vessel sizes and how important it is not to 'drift towards failure' by moving outside the 'safety space' and shifting towards the 'Zone of Coping Ugly' where saving an incident depends more on 'luck'. All this information was integral to the simulator exercises.

Picture courtesy of Port of Newcastle 2021. Note the additional coal stockpiles at the terminals.

As the port expanded, particularly the coal terminals, additional coal loading berths were built and compared to 2002 when the furthest berth was Kooragang 6 at the PWCS terminal, around 2010, extensions at PWCS developed Kooragang 7 and the new coal terminal, NCIG, commenced building berths that would go as far as Kooragang 10.

In the early stages of the NCIG development, there was only a 90m wide temporary channel to Kooragang 8 and pilots would do specific simulator training in backing vessels to the new berths. Extensive research and simulator assessments over many years were undertaken at this time by the Harbour Master and pilot group in the development of the channel extension, berths and proposed swinging basins including designing amazing rear facing leads that could be utilised by standing on the port bridge wing and looking astern whilst backing astern up the NCIG channel. It was a major phase in the development of the port. Once the NCIG terminal was completed, pilots were backing Cape size vessels 1 mile astern in a 180m wide channel, certainly a rarity in piloting around the world today.

Pilot training and simulation always had to keep pace with the change in vessel mix that called at Newcastle, including the ever-larger passenger vessels, larger car carriers and Ro-Ro vessels. These types of vessels were always specific endorsements on a pilot's licence.

One of the identified problems during pilot training has always been the perceived differences in expectations from the various Check Pilots. Rather than have a subjective way of assessing a pilot, a very descriptive objective assessment system was set up, with all elements (operational, procedural, and critical) of a pilotage identified with proper assessment codes. This enabled the trainee pilots to know exactly what is being expected from them during a check and gave greater rigor and transparency to the assessment system.

Cape size ship in Newcastle

Adapting to the changing environment:

One of the great advancements over the last 18 years has been the refinement and information exchanges that have been incorporated into the BRM and AMPTC courses. They were always particularly good courses, but today are quite exceptional, keeping pilots up to date with advanced technology and learnings from accident analysis. Many of the issues discussed in depth at these courses (e.g., effective challenge and response, the latest passage plan standards, effective MPX, maintaining situational awareness and the world of 'big data' etc), have been the catalyst for changing what we do locally and adopting best practice where possible. In the near future there will be a move towards electronic MPXs and passage plans integrated with PPUs as is the practice in some ports today.

There has, over recent years, been more involvement by pilots in the work of AMPI and the NI, by both attending conferences and participating in various forums. This two-way flow of information benefits the pilot group and is a particularly good mechanism for CPD. The pilots of today are far more informed than years ago, keeping up with technological developments and continually critically assessing what we do, and how we can do it safer and better.

When I first started, there was no DUKC system in Newcastle and as far as assessing if a loaded Cape could sail, it was generally based around time proven experience, that in these particular conditions, the vessel got out ok! I was always told that departing Newcastle an 8°-10° roll on a Cape would have the bilge very close to the bottom at the entrance. This was based on 'increase in effective draught with roll angle' tables. The object was to get out of the roll as quickly as possible by getting around to starboard as quickly as possible in the prevailing southerly swells. Many a time we would watch the roll increase, staring at the inclinometer, seeing 8° come and go and sand welling up astern, quite an uncomfortable feeling!

Of course, the adaption of a DUKC system changed all that, and we suddenly realised how the 'seat of the pants approach' from the past had been quite dangerous to say the least. The DUKC system at Newcastle (called SAUCS) is as in most ports today, fundamentally integral to ensure that optimum use of the channel in made in the safest manner for the vessel in the prevailing weather conditions.

In 2011 a new pilot cutter came into service, the 'Henry Newton', a purpose-built vessel (16.8m 28kt with its state-of-the-art Camarc design) which made pilot transfer a far safer undertaking. The Harbour Master and pilots were heavily involved in the final delivered product that was based on experience gained from the older cutters that were in service at the time.

As the port expanded and demands for industry increased, it was necessary for the Harbour Master and pilots to assess and review the ship handling guidelines (SHSG) on a regular basis. One could call it 'creep' but the pilots have had to adapt to these changes, the rolling stone gathers no moss so to say. In 2002, the largest ship that entered the port at night was 250m, today it is 290m. These increases were all the result of extensive trialling by the pilot group to determine the maximum environmental conditions etc that apply to these movements.

The bias change of Panamax to Cape size vessels has significantly shifted over recent years, far more Cape vessels calling now than in years gone by and placing ever increasing demands on the pilotage team. This has certainly resulted in increased fatigue, workloads and pilotage skills where a shift for a pilot could result in up to three very long and complex pilotages to the furthest berths in the port. Most of the pilotage movements today are far longer than in earlier years.

Always one of the most difficult pilotages in the port was loaded handy vessels inbound with a swell running at the entrance. Although there was nothing definitive about when not to do the job, after extensive review, all the pilots of the day had their own personal criteria for deciding if a job was too dangerous to do. These criteria were formulated into a consistent approach and adopted as an operational guideline (Harbour Master Instruction now) which has served us safely for many years now. Such is the benefit of collective experience.

PPU's have been another wonderful adoptive innovation in recent years and as has been demonstrated in numerous accident reports, it is an important tool and one of many sources of information feed that a pilot today is expected to utilise to maintain full situational awareness. There has of course been a slight difference in opinion between the older and younger pilots regarding the extent of reliance on any one item of equipment, but of course that is an issue to be dealt with during the training.

Over recent years the adoption of personal voice recorders, use of PPUs, AIS and radar monitoring and recording at the Vessel Traffic Centre have all enabled any incident to be thoroughly reviewed and examined.

The 'Pasha Bulker' grounding in 2007 resulted in profound changes in how vessels arrived and anchored off Newcastle and the NSW coast. A VAS (Vessel Arrival System) was implemented and was a safety model adopted by many bulk ports around the world. Although not directly effecting how pilots operated, it was certainly part of the changing environment. In the next year a VTS will commence in operation at Newcastle (replacing the Vessel Traffic Information Centre) and the pilot group will have to adapt to the procedures and requirements that operating within such a system requires.

In 2014, all of the ports within NSW were brought under the single operational banner of the Port Authority of NSW. This resulted in structural changes and alignment within the Authority on systems and many procedures and the pilots were required to adapt to these changes then, as well as on a continual basis to this day.

There was a serious pilot accident in Newcastle 2 years ago (me unfortunately) which following investigation and review, was a catalyst for many changes to take place. These included, PPE standards, modifications to pilot cutter design, rewriting and updating of various work instructions and development of training videos for pilot transfer.

Changing of the Guard:

Although Newcastle currently has 24 pilots and when I started there were 12, over the last 18 years some 38 pilots in total have come and gone. Some have retired, many have moved to other ports, and some are still there. Only 3 of the pilots who were there when I started are still there.

Such a change of pilot numbers of course has resulted in almost continual training stresses as long as I can remember. If I remember correctly, in all that time there might have been only a few short months where every pilot was 'unlimited'. There has always been a major demand on the supervising and check pilots to do this massive never ending training task.

In my time at Newcastle, I have had the privilege of working under 4 Harbour Masters (Captains T. Turner, P. Dwyer, J. Drummond and V. Bangia). Each of them brought a unique style, experience and set high expectations for the pilot group.

Of course, the wide spectrum of age within the pilot group means that views and ideas vary from the very traditional time established thoughts on some things (the younger ones might call it something different!), to the more 'lateral' thinking ways of some of the younger pilots.

Of course, a healthy and robust system cannot be extremely biased one way or the other, and it is this mix of various views and ideas that make the group dynamic and enable the pilots to adapt to the ever-changing pilotage industry both today and into the future.

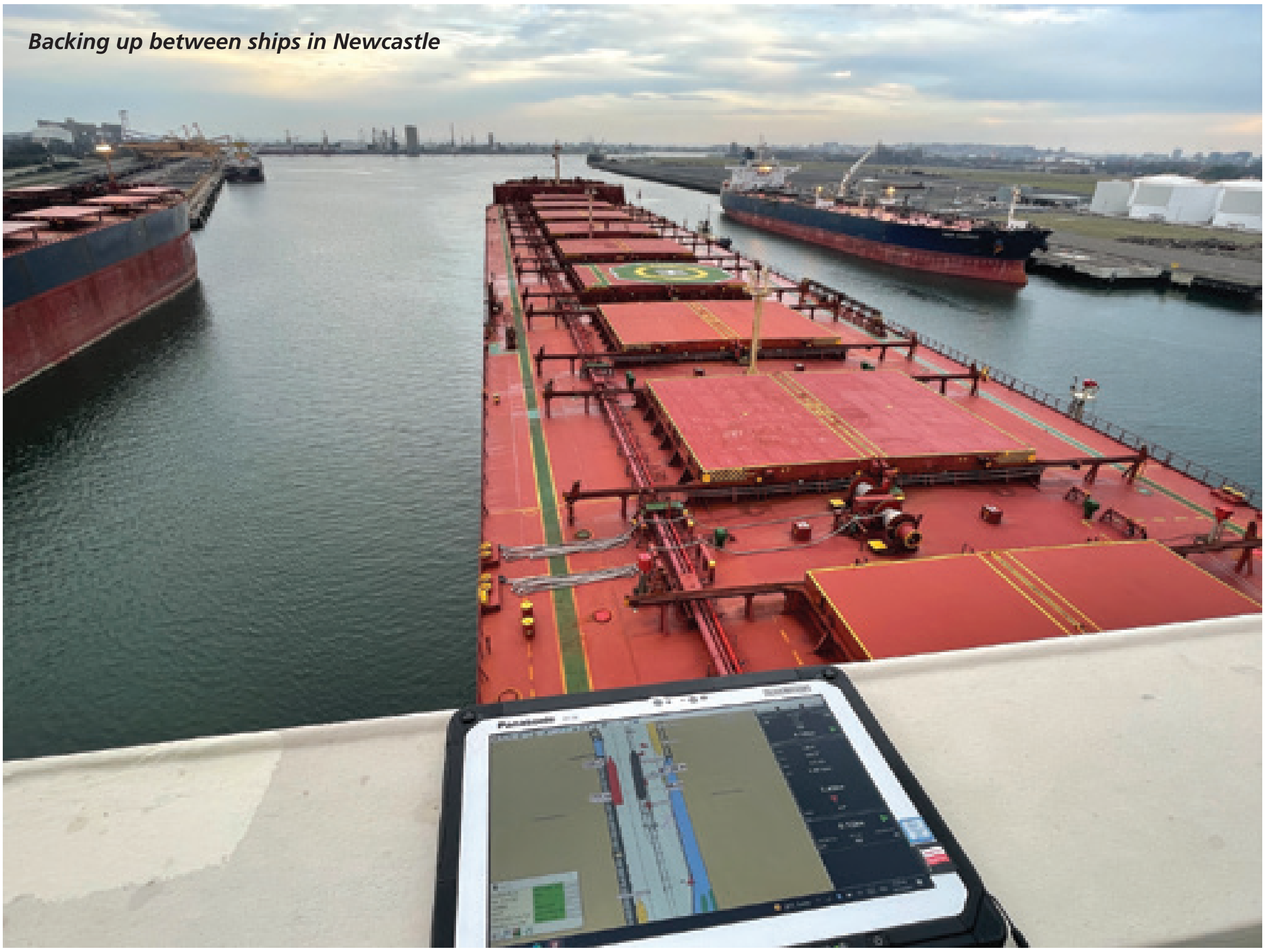
I was extremely fortunate in my time, to witness and be a small part of the evolution of the Newcastle pilot service and what it has become today. All professions must move with the times, be open and adapt to necessary change, stay up to date and operate at best practice, none more important than in pilotage.

I have been fortunate to have worked with many extremely talented and gifted individuals and to have learnt from every person I worked with, both young and old. To this day, the Newcastle pilots do a remarkable, difficult, technically demanding, and challenging job day in and day out that is appreciated and admired by all who visit the port.

Captain Malcolm Goodfellow

Newcastle Pilot | 2002-2021

Backing up between ships in Newcastle



AMPI Position Paper

THE USE OF SIMULATION TO REPLACE LIVE TRAINING IN INITIAL PORT PILOTAGE TRAINING

It is without a doubt that simulators nowadays have become important tools for training piloting skills that range from bridge resource management (BRM) skills (non-technical skills) to emergency response training (technical skills). The first skill mentioned, BRM, is a non-technical skill that simulators are ideal for but the second skill, emergency response training, is partly a technical skill that relies on the simulator being able to predict forces that may or may not be correct.

Indeed "some of the world's leading computational fluid dynamicists … generally acknowledge that simulators are not perfect and, no matter how advanced their programming, simulators simply cannot replicate the marine environment with all its chaotic complexity" [1] and as Professor Odd Faltinsen, who is one of the world's leading hydrodynamic theorists, put it: "computer prediction may be pretty good but it is not and cannot be, completely satisfactory" and "there is always likely to be a difference between computer modelling and reality, no matter how good the computer and models are". [2]

So if simulation is to be expected to enable the rich complexity of real-world operations to be brought into a highly controlled training environment [3], how can it be harnessed if it is to be used extensively in the development of technical skills that are required for marine piloting [3].

Simulations and simulators enable this rich complexity to exist by using mathematical constructs and algorithms and as such will convey a perfect electronic world that is capable of being replicated over the course of many simulations. This perfect world will of course not represent the real world of ship handling but the reality is that simulators are starting to be seen as that. [1]

This reliance on the technical issues of simulation and not on the social issues of the simulation has led to differing approaches being taken by the engineers and computer scientists who focus on the technology and that of the psychologists who concentrate on understanding the acquisition of knowledge, skills and attitudes in a number of complex domains. [4]

This has meant that whilst the simulations and simulators have evolved the simulation training has not and thus there has been no consideration of what has been learned about individual and team training and cognition.

Dion, Smith, and Dismukes [5] once boldly stated that "the closer the similarity - the fidelity between the simulator and the aircraft - the more effective the instruction" [5]. Many believe in this statement and think that the higher the fidelity of the simulation the better the training will be. They work on the old adage that if it "looks and feels like the real thing, people learn." This is in fact putting the cart before the horse in some respects as they are allowing the state-of-the-art simulation to specify the training device [6] and ignoring the fact that just because the training is conducted in a high-fidelity simulator doesn't mean that successful training will take place. [4]

Flexman and Stark[7] have stated that "complete physical fidelity is rarely required for effective training and transfer" [7]. Fidelity then should be dictated by the cognitive and behavioural requirements of the task, not people's opinions. If this is done then there should be transference of learning.

One of the problems with simulation usage is in how the simulation is evaluated. If this is evaluated by trainees' reactions to the training there may be a bias in gaining a favourable evaluation for high fidelity simulation because the trainees typically like the "bells and whistles" of high fidelity simulation; so high fidelity simulation will appear to be highly effective for training. [4]

Training research clearly shows that there is not a significant relationship between trainee reactions and learning and subsequent performance [8]. Ideally, the determination that the training is effective should come from the trainee's performance rather than the performance of the simulation. However, many of the simulation evaluation techniques that are currently in use evaluate the "machine," that is, the system's characteristics and parameters and not the "person's" or the trainee's performance. As a result, because the simulation is judged favourably, the training it provides is judged to be good as well. [4]

One of the advantages of simulation though, is the ability for the trainee to learn through repetition to gain the required outcomes. These outcomes though also come from experience and not just simulated environments. This is because adults learn better through experience and also knowledge retention is better with experience. It is for this reason that initial training via a simulator is only part of the training process.

Simulation when used properly should enable effective training to take place in the marine pilotage environment and should be able to do the following:

1. The simulation must be realistic. This is sometimes difficult in ship simulators due to the vast array of outside influences that are at play when piloting ships. Realism in simulation is critical.
2. Enable an authentic learning environment to be created.
3. Allowing learning in the same context of real-world operations will allow the transference of new knowledge and skill to effectively take place.
4. Allow skill development to take place in a suitable environment that carries no risk to the outside world. Simulation also allows below par performance and errors to occur without fear of consequence and the learning's from this can then be used to raise the performance level and prevent the re-occurrence of the errors, which as stated above is without risk to the equipment or participants as well as the general public.

5. Allow for the use of instructional techniques that are much more difficult to achieve in the real world. These techniques can be run time and time again to embed the techniques.
6. Allow for the use of scenarios, which will help in the development of non-technical skills such as decision-making and situation awareness. Non-technical skills are the cognitive and social skills that complement technical skills. There are also educational benefits in learning the importance of hazard identification and risk management.

As BRM is critical in what pilots do then simulation should strive to create a team environment, which can then be transferred to the outside world. Teamwork and the identification of each team members areas of strength is also necessary as is the understanding of why effective communication must be used during the simulation in order to do it effectively on a bridge in the real world. [3]

There can be doubt that simulation has now become a crucial aspect of marine pilot training and to learn these piloting skills there must be an opportunity to learn and practice in an appropriate context. This context must not only provide essential performance cues but also ensure the safety of the trainee and the instructor, however, the best simulation in the world does not guarantee learning [9, 10]. It is of concern that "that the way the context looks (i.e. the simulation) seems to have become more important than the instructional features embedded in the simulation to support learning" [4].

It is critical therefore that learning be enabled with regards to simulation training and this can be developed by promoting systems that allow this. This can only be achieved by shifting focus from the designing of simulation for realism and (hope that the learning occurs) to the design of human-centred training systems that support the acquisition of complex skills. [4]

In summary, liking the simulation does not translate to learning. Although user consideration is important it is not the only source of learning. In evaluating the effectiveness of our simulation-based training system, we have to go beyond reaction data and obtain data that allows the essential, diagnosis and evaluation of requisite Knowledge, Skills and Attitudes (KSA's). [4]

To determine if the simulation training has been effective then the decision must be based on whether the trainee has learned the required skills and then used them on the job [11]. By doing this an ongoing appraisal of the simulation training can be achieved which in turn will determine whether adjustments need to be made to the amount of training given.

This discussion paper has hopefully given the reader an insight to some of the issues that simulation and simulators have introduced to the world of marine pilot training. It would appear that the use of simulators is ideal for non-technical skill training as these skills are the cognitive and social skills that complement technical skills and are more easily replicated on a simulator. Technical skills whilst still replicable are not as easily managed due to the difficulty in being able to predict forces that may or may not be correct. There are also problems with learning transference, and it needs to be determined that the skills have actually been learned.

The problems in determining whether knowledge transference and skill learning have in fact occurred is probably partly the reason why **IMO A960 (M) (2004 Version) Section 5.2** in part states that the practical experience gained by the trainee pilot "may be supplemented by simulation, both computer and manned model …" [12] and **IMPA Resolution 7.1 (2000): Use of Shiphandling Simulators** resolved that " … the use of simulators to evaluate or predict a pilot's performance in the real world for licensing purposes to be an inappropriate use of an otherwise valuable technology" [13] and **IMPA Resolution 7.2 (2002): Simulators** resolved that … "the sole use of simulators for training and certification to be inadequate in validating the appropriate levels of competence required for navigating in pilotage waters …" [14]

Still it has been determined that "there is no question that simulation can be an effective tool for training complex skills. … But it is only a tool. As with any tool, in order to be effective it must be used appropriately." [15]

REFERENCES

1. *McArthur, P.J., Piloting at the Edge of Chaos, in The Pilot. 2016, New Zealand Marine Pilots Association: New Zealand. p. 15-22.*
2. *Falstinsen, O., Modelling of manoeuvring with attention to ship-ship interaction and wind waves, in 2nd International Conference on Ship Manoeuvring in Shallow and confined Water: Ship to Ship Interaction, P. B, et al., Editors. 2011, The Royal Institute of Naval Architects: Trondheim Norway.*
3. *Thomas, M.J.W., Principles of Training Non-Technical Skills, in Training and Assessing Non-Technical Skills: A Practical Guide. 2017, CRC Press: London.*
4. *Salas, E., C. Bowers, and L. Rhodenizer, It Is Not How Much You Have but How You Use It: Toward a Rational Use of Simulation to Support Aviation Training. The International Journal of Aviation Psychology, 1998. 8(3): p. 197-208.*
5. *Dion, D., B. Smith, and P. Dismukes, The cost/fidelity balance. Modern Simulation and Training: The International Training Journal, 1996. 2: p. 38-45.*
6. *Roscoe, S., Transfer and cost effectiveness of ground-based flight trainers, in Aviation Psychology, S. Roscoe, Editor. 1980, Iowa State University: Ames. p. 194-203.*
7. *Flexman, R. and E. Stark, Training simulators, in Handbook of Human Factors, G. Salvendy, Editor. 1987, Wiley: New York. p. 1012-1038.*
8. *Tannenbaum, S. and G. Yuki, Training and development in organizations. Annual Review of Psychology, 1992. 43: p. 399-441.*
9. *Salas, E., C. Bowers, and J. Cannon-Bowers, Military team research: Ten years of progress. Military Psychology, 1995. 7(2): p. 55-76.*
10. *Salas, E. and J. Cannon-Bowers, Methods, tools, and strategies for team training, in Training for a rapidly changing workplace: Applications of psychological research, M. Quinones and A. Ehrenstein, Editors. 1997, American Psychological Association: Washington DC. p. 291-322.*
11. *Kraiger, K. and K. Jung, Linking training objectives to evaluation criteria, in Training for a rapidly changing workplace: Applications of psychological research, M. Quinones and A. Ehrenstein, Editors. 1997, American Psychological Association: Washington DC. p. 151-175.*
12. *International Maritime Pilots' Association and International Maritime Organisation, IMO Resolution A960: Recommendations on training and certification and operational procedures for maritime pilots other than deep-sea pilots. 2004, International Maritime Organisation. p. 7.*
13. *International Maritime Pilots' Association. IMPA Resolution 7.1: Use of Shiphandling Simulators. in The XVth IMPA Congress. 2000. International Maritime Pilots' Association.*
14. *International Maritime Pilots' Association. IMPA Resolution 7.2: Simulators. in 16th General Meeting of the International Marine Pilots' Association. 2002. International Maritime Pilots' Association.*
15. *Salas, E. and C. Burke, Simulation for training is effective when … BMJ Quality & Safety, 2002. 11(1): p. 119-120.*

02/2021 – The Use of Simulation to Replace Live Training in Initial Port Pilotage Training. Date Published: 30th of September 2021.

Introducing Poseidon Sea Pilots

"Intelligence is the ability to adapt to change"

STEPHEN HAWKING

History tells us that, as a species, we tend to fear change. How many scientists and deep thinkers have been persecuted through the ages for daring to challenge the current dogma? Change can be scary, but in recent times, it's encouraging to see the growing number of people tending to the view that, scarier still, is allowing the fear of change stop us from growing, evolving and progressing.

There's a lot of "noise" concerning the emergence of Poseidon Sea Pilots and much of that is driven by fear of, what is perceived by many to be, change to the pilotage environment – an environment with which we've all grown comfortable.

Pilotage, certainly since the mid-1990's, has been in a state of continual change. There are those who might argue that the rate of change lags that of other maritime industry sectors, or indeed, that of other professions but nevertheless, it is fair to say that the pilotage profession accepts that change is part of its being.

There were two, almost coincidental, watershed events that triggered change in pilotage in the 1990's: the first was the emergence of technologies that enhanced real-time positional accuracy and the second was the introduction of competition policy into the global public policy arena. If the former wasn't going to signal the end of pilotage as we knew it, the latter certainly would.

These "fearful" events jolted pilots out of their pre-Copernican view of the world. There came the realisation that pilots weren't the centre of the universe and tragically, what was happening, was outside their control. The immediate question was how to deal with the situation and the response was a measured, disciplined approach to wrest control of the pilotage profession from those dangerous ideologues who knew nothing about it.

Up until this time, and probably because pilotage was regulated by the states, pilots lived, worked and operated in silos and never communicated with those outside their own port.

The first thing we did was to form a national professional association, the Australian Marine Pilots Association (AMPA, subsequently rebadged as AMPI) to create the structure that would allow pilots to work collaboratively in developing appropriate responses to existential issues.

AMPA's founding philosophy was built on four pillars:

1. Initiate dialogue with the broader industry to develop a deeper mutual understanding of the needs and drivers of all stakeholders. This would create the platform upon which to build an industry-wide collaborative approach to shaping the future of pilotage and, at the same time, ensure buy-in from those whose views had a history of misalignment with our own.
2. Provide consistency in service delivery across all jurisdictions by standardising procedures and systems.
3. Take control of, and gradually raise, standards to a level that was well beyond anything being proposed by those outside the profession.
4. Become the nation's acknowledged and respected authority on anything to do with marine pilotage.

This was a uniquely Australian response: to remain ahead of the curve and to be the best of the best. While other countries built defensive structures to maintain the status quo and keep usurpers out, we saw our approach as being one that would have the support of industry and regulators. It did. So long as we acted responsibly in shaping, modernising and managing our profession, they wouldn't interfere.

These were heady days. We achieved a lot, and we were leaving others in our wake. I know that my own organisation, BMP, was the first pilotage organisation in the world to achieve QA accreditation, the first to develop passage plans, the first to introduce a formalised MPX, the first to include the use of DGPS (the pre-cursor of the PPU) as part of its SOP's and, in collaboration with MSQ, the first to introduce check and mentor pilots. It was the time when Ravi Nijjer introduced BRM to the industry, when we were researching fatigue and developing the first pilotage SMS's. There was also a lot of lobbying to get sensible changes to laws and regulations to enable progress in the modernisation of our profession.

At the same time, we took a strong stance against competition in pilotage. We engaged the best economic and legal minds to help develop our arguments. We lobbied against it, spoke at countless fora, across many industries, against it and showed examples of its continuous failure. But the steam roller kept rolling and the ACCC's "compromise", if you can call it that, was its 2010 decision in respect of Brisbane where it acknowledged that, although competition in pilotage within the port would not best serve the public interest, competition for the contract to provide the service, would. This should have put everyone on notice that the pilotage environment in Australia was about to change. And it has.

It was only a matter of time before the contract for Brisbane pilotage went to tender and those with an interest in tendering had a long time to prepare. It is against this background that Poseidon Sea Pilots (PSP) came into being.

Pilotage in the 21st century – in the age of advanced digitisation - is going to be different. PSP believes the near future will necessarily usher the gradual transformation of pilotage organisations from a pool of pilotage expertise to a fusion of pilotage and technological expertise.

During the course of the last decade, the parties that came together to form PSP – pilotage expertise merged with expertise in maritime technology - have been heavily involved in developing pilotage technologies and modernising pilotage processes and systems. They have been carefully monitoring pilotage, especially in Australia and New Zealand, where there have been a lot of developments and have identified the opportunity for consolidating these into a set of best practices that will form the operational framework to prepare for the future. Preparing pilots for the age of advanced digitisation and big data requires a reconceptualisation of pilotage.

By definition, a reconceptualisation is not the throwing out the old and replacing it with the new. It is to conceptualise the existing in a new way and, from our perspective, the new way must take account of the existing environment - an environment that is always changing – and integrate it with the emerging environment.

A "concept" is context-specific and application-oriented and stems from a "philosophy" which is more general and belief-oriented. It can be said that philosophy is the study of questions concerning the nature of reality. So, PSP's reconceptualisation of pilotage is built on our philosophy, and our philosophy is quite simple; it's based on projecting today's reality into the future.

Today's reality can be summarised as follows:

1. THE PILOT

The ubiquitous 80% human error has been attributed to accident causation in most industries, including marine pilotage. The universal response, across all industries, has been the introduction of layers of precautionary measures and/or tools to reduce the risk of human error. These precautionary measures act to enhance the quality of decision making and reduce the reliance on the operator using his/her experience/intuition to make decisions. Despite this, recent investigations have consistently shown pilotage accidents to be caused by pilots relying on their experience/intuition instead of properly using the tools at their disposal.

2. THE ACCIDENT INVESTIGATOR

At its most basic, pilotage is about the prevention of maritime accidents and when they occur, it's the Accident Investigator that delves into the cause.

The problem is that both sets of professionals tend to look at the pilotage task from different perspectives and, in an ideal world, this should not be the case.

In the execution of their role, pilots tend towards an over-reliance on visual pilotage while not fully exploiting the technologies at hand and not fully appreciating the potency of the information those same technologies can provide to investigators following an accident.

This dissonance is potentially harmful to the pilotage profession and needs to be addressed. Accident investigators want pilots to know how to use and manage these technologies and are frustrated by what appears to be a sluggish acceptance of the modern reality.

Pilotage is on the ATSB's "watchlist".

3. THE REGULATOR

Against the backdrop of 2 (above), pilotage organisations and regulators have a choice:

(a) they can do nothing and risk bringing both the pilotage profession and the regulator into disrepute if there's a major accident, or

(a) introduce those changes necessary to align pilotage practice and training with community expectations and modern-day reality.

A regulator cannot ignore the fact that pilotage is on the ATSB's watchlist and therefore, cannot accept the status quo.

4. WHAT OTHERS ARE DOING

Another reality not fully appreciated by the pilotage industry is the extent to which new and emerging technologies, as well as new knowledge emanating from the safety sciences, has been incorporated into the operational and training methodologies of other industries. This has brought, into the public domain, knowledge that cannot be ignored. It is knowledge that informs public opinion and, in turn, government action.

A glimpse into the future is provided by the reality emerging in today's world:

1. THE AGE OF BIG DATA

Those who have recently done a BRM course will have heard Ravi Nijjer talking on this subject.

Knowledge is power and we have seen how today's tech giants have been able to amass data, turn it into knowledge and use this to derive their power.

But big data is also used in so many other ways. It's helping us better understand the world around us and, because of this, we're able to improve the way we live. Big data is responsible for the enormous progress in the health sciences, in renewable energy, in communications, entertainment, banking, education, transport and many other aspects of our life.

In pilotage, big data has a number of applications but especially in safety analysis, safety management and safety training.

So, all this means moving into an evidence-based world which is data-driven. It requires a pro-active approach to collecting and analysing data with the aim of identifying lead indicators that will help improve safety and efficiency.

It recognises the growing role of the digital economy and its ballooning application across industry. Apart from feeding into our Learning Management System (LMS) to target training needs, PSP use the data to achieve a number of diverse goals including, for example, assisting shipping companies meet their green targets.

2. EMERGING TECHNOLOGIES

We have already seen a number of jurisdictions in Europe where remote pilotage has been introduced. We've seen autonomous ships successfully complete trials. HHI is about to send a 300m LNG tanker on an autonomous transoceanic passage. We've seen Mitsui OSK continuing its development of autonomous berthing systems after successful initial trials using a passenger/ro-ro ferry. We're about to see the integration of geosynchronous satellites with low earth orbit satellites and terrestrial 5G and this will revolutionise how ports (and ships) are managed.

Thinking about modern-day pilotage in terms of today's reality, PSP considered the rhetorical question. "If we have the means to safely land, manipulate and manoeuvre a vehicle on a distant planet from earth, then don't we have the capacity to bring together the necessary technologies, layers of appropriate precautionary measures and the redundancies for the pilot to safely manoeuvre a ship in pilotage waters?"

The answer, of course, is, "Yes".

It is our view that any organisation tendering to provide a pilotage service into next 10 years must take account of all of these developments, and build them into its solution. More of the same is no longer an option.

There are advantages in starting with a blank canvas and building a new pilotage organisation from the ground up. One of those advantages is being unencumbered by tradition – "the way we've always done things around here" – and capturing the ideas across people from diverse backgrounds and experience.

PSP's team is well credentialled. Its members are very experienced pilots with a long history of being at the vanguard of modernisation and change. The company fully expects the innate reserve towards new organisations that enter established domains will emerge and play out. It, nevertheless, looks forward to working closely with AMPI to ensure that the marine pilotage profession continues to grow and transform itself in parallel to the needs of the industry it serves and to provide career paths to those with the appropriate essentials.

Steve Pelecanos
Director, Poseidon Sea Pilots

3DPortGuard *Docking Aid*

INTRODUCTION

Frontier Automation is a technology and engineering company focused on the development and implementation of performance improving automation software based on 3-dimensional sensing instrumentation and industrial computer hardware. We specialize in the implementation of industrial project solutions using real time high precision and high resolution machine vision technologies.

Several mature products in mining, industrial, and commercial shipping applications already deployed and operational on customer sites are available as ready-made offerings. The company is also capable to develop and has a successful track record in delivering complex customized solutions to new customer automation needs.

Our company is fully independent and not aligned to any third party OEM or equipment vendor interests, which allows us to prioritize only the best customer outcome. Established in 2011, Frontier Automation is headquartered in Perth, Western Australia, but operates Australia-wide and globally if required.

3DPORTGUARD

3DPortGuard is our company's solution for port operators looking to stay in control of a ship's movements while approaching, departing, or mooring at a berth. As for all Frontier Automation control systems, it uses machine vision to automatically detect and track in real time shipping vessels within range of a berth by providing information on critical distances to mooring infrastructure, on vessel speed, and on vessel movement directions and orientations. This data is used by pilot or port operators to maintain control of a safe mooring or departure procedure or to establish root causes during incident investigations.

Our dedicated drift detection algorithm allows bulk material, container, cruise ship, tanker, or any other loading terminals to ensure safe operation and to avoid very costly damages to loading or port infrastructure or through spills by facilitating automated alarms and shutdowns in case a vessel exceeds safe loading movement parameters or breaks its moorings.

Our ultra-low maintenance sensor instrumentation is custom designed for deployment in the harsh maritime environment and provides high-resolution three-dimensional data independent of lighting conditions that eliminates the risk of detection errors typical for competing systems.

As published by the Australasian Marine Pilots Institute (AMPI) Pty. Ltd. in its *PPU Code of Good Practice for the Implementation and Use of Portable Piloting Units* 2nd Edition released in 2020, 'the use of PPU is now generally viewed as "good practice", which comes with a degree of legal implication.' In other words it is the duty of pilots to ensure best available PPU technology is used to ensure safe berthing of vessels.

Figure 1. Docking Aid 3D sensor station permanently mounted on the wharf allowing the system to be always available without any manual setup required by pilots.

AMPI's PPU Code of Good Practice is based around on-board GNSS systems, because that has been the state-of-the-art technology available for docking aid purposes to date. However, this has now changed with the development and successful deployment at major ports of 3DPortGuard, a shore-based automation system utilizing 3D LiDAR data instead of GNSS data.

As evidenced by the accuracy classification of GNSS based PPU systems by AMPI, GNSS based systems are subject to signal degradation. Only PPU Class A, *Very High Accuracy Independent Heading Berthing Systems*, can be used for docking and berthing operations where defined maximum fender landing speeds are specified. It can however be argued, and there have been ample examples provided by practitioners that regardless of Class, GNSS based docking aid systems have inherent accuracy limitations that prevent them from being always reliable / always accurate.

LIMITATIONS OF GNSS DOCKING AID SYSTEMS

In order to enable ship heading to become aligned well to the docking aid system, two or more dedicated high accuracy GNSS or GPS antennas need to be set up on-board with a long baseline in-between them, otherwise the determination of the heading offset will be inaccurate, potentially prohibitively so. This is often impractical to achieve at accessible locations on-board, hence pilots resort to short baselines, thereby already introducing an error into the docking aid system.

Satellite based positioning systems can only function to any acceptable accuracy when their antennae are not physically obstructed, and when the pilot has enough time to properly set-up the PPU system by entering antenna positions and identifying the ship's gyro heading offset. PIANC Working Group 145 suggests that 'the mounting location of the primary (position) GNSS antenna relative to the vessel's bow/stern and port/starboard sides should be accurately established.' It could be argued that this is in practice impossible to achieve without introducing a notable error to the coordinate system in use.

The reason why aligning the on-board high accuracy GNSS antennas with the ship's coordinate system is problematic is because that firstly requires valid and accurate knowledge of the applicable offsets of the ship's coordinate system to the antenna mounting position, which is at best difficult but in reality likely impossible to obtain and pre-plan to have at hand in situ. Secondly, even if such offsets can be established, there is always an error between design and as-built dimensions of a vessel's features that the antenna is mounted on. These are likely in excess of several cm or more, depending on where exactly the antennas are placed. This may appear a small error, but it will result in significantly larger errors regarding the tracked position of a vessel's bow or stern relative to fenders, potentially in excess of several metres.

At many port locations, the approaching and berthing pilotage phase is short, so there often is not enough time to set up an advanced PPU system. Regardless of timing, the biggest issue with these systems is manual error, which they are highly prone to in the high-pressure process of docking a large vessel, where many other tasks and considerations have to be taken care of by the pilot and any other support crew. Fatigue is also a major factor, particularly during night shifts. This leads to distractions and the potential for erroneous on-board system set up, which is worse than not having a docking system at all, since it may provide a false sense of security for the docking maneuver that in actual fact may lead to an unanticipated collision.

Further compounding the problem, the total error budget of on-board GNSS docking aid systems consists of a number of additional components that are explained below. A comprehensive explanation is also available in the Guideline for Control Surveys by GNSS, published by the Intergovernmental Committee on Surveying and Mapping.

Additional obstructions other than the highest portion of the vessel itself frequently come into play in constrained ports in form of port infrastructure such as ship loaders, cranes, buildings, and even other vessels, all of which result in much more inaccurate determination of the antenna positions placed on the vessel than sufficiently accurate Real-Time Kinematic (RTK) or Differential GPS (DGPS) systems are capable of providing otherwise. Any change in direction of the vessel during approach changes the horizon obstructions which can lead to further or changes to degradations and time delays to regaining signal accuracy, which is unacceptable when seconds count during a berthing process.

It is also pertinent to point out that even latest generation survey grade RTK equipment and antennas are limited to horizontal positional Survey Uncertainty (SU) of < 4cm, which is only achievable if best practice in RTK specific survey data collection is observed. Such best practice requires recording and averaging of positions for an absolute minimum of 1 minute after the rover has successfully initialized, i.e. after ambiguity resolution. This is impossible to achieve in a dynamic application such as tracking moving vessels with an on-board GNSS system and means that horizontal positional accuracies of an on-board RTK vessel tracking system are by default worse, potentially much worse than 4cm for each of the antennas installed on-board, leading to combined baseline inaccuracies and misalignments much worse than advertised.

Table 1 below summarizes all factors affecting on-board GNSS docking aid system accuracy described in the preceding paragraphs as a list of error budget items. Rather than quantifying these errors at the source such as the PU of antennae for example, their effective magnitude is expressed as the resultant potential difference between actual and displayed distance of vessel bow or stern sections to fenders, since that is the truly relevant criterion when using docking aids.

A group of maritime engineers published an article titled *Laser-Based Aid Systems for Berthing and Docking in the Journal of Marine Science and Engineering* in May 2020. They investigated berthing data of a large vessel in order to quantify the magnitude of actual inaccuracies of on-board docking aid systems. For a ship of the large size investigated, the authors state that GNSS orientation errors detected could mean a deviation of up to 10 m from where the pilot and captain think the bow of the vessel is. This matches what has been expressed in the error budget summary in Table 1 and all but renders this method a highly problematic docking aid tool.

Table 1 Error budget summary of relevant factors negatively impacting on-board GNSS docking aid system accuracy, expressed as the difference between actual and displayed vessel bow or stern section distances to fenders, which is the relevant criterion for docking aids.

Error Description	Magnitude
Short on-board antennas' baseline	Up to metres
Coordinate system offsets	Up to metres
Berth (chart) reference generalization	Up to metres
Vessel 2D display generalization	Up to metres
Antenna horizon obstructions	Up to metres
RTK antenna never static for > 1 min	Up to metres
RTK signal degradation	Up to metres

More anecdotally but nevertheless highly relevant for real-life scenarios, these authors report that marine pilots have observed sudden jumps of the vessel or tug in certain areas on their monitoring equipment, which in effect shows the ultimate outcome of signal degradation in GNSS or GPS positioning devices or other detrimental effects as listed in Table 1 and described in preceding paragraphs. Whilst the severity varies between locations, it does mean that unfailing reliability is never achievable if this data is to be used to mitigate to a satisfactory extent potentially catastrophic events caused by such large vessels.

3DPORTGUARD COMPETITIVE ADVANTAGE

Frontier Automation's permanently installed LiDAR docking aid system is intended to be a set and forget solution. It fully autonomously tracks every single mooring cycle of all attending vessels, without the need for any error prone manual input and therefore any operational personnel, and without the need for any equipment to be brought on board the vessel.

3DPortGuard tracks all vessel Approach data remotely, with vessel ranges, speeds, and approach angles numerically reported in real-time, and visualized in a 3D viewer. It is important to note that unlike GNSS docking aid systems relying on charts to define the distance of the vessel relative to berth, which risks overlooking the potential for collisions with actual berth elements including fenders which are typically not shown in required detail, 3DPortGuard measures and has in its field of view all actual berth infrastructure near the quay line, including fenders. It can therefore report on actually applicable critical distances between all portions of the vessel and all portions of the berth. Critical distances are automatically selected and displayed.

Frontier Automation have carefully designed an intuitive PPU display that provides all critical information to pilots during the berthing process as per AMPI specifications in the *Software section of the PPU Code of Good Practice for the Implementation and Use of Portable Piloting Units* on pages 15-17. The display is configurable depending on the terminal layout and features all alarming and day / night display options as prescribed by AMPI. Figure 2 below showcases the PPU display.

All approach events are automatically recorded in a data base external to the PPU that can be searched and recalled to replay as a video and numerically assess any docking event. Figure 3 below showcases the Graphical User Interface (GUI) to search a data base for such events. Historical data can be displayed numerically, as graphs, and as a 3D video play back including vessel motions, and motions of all other tracked mobile infrastructure such as ship loaders, access ladders, cranes etc. The 3D replay can be viewed from any angle as showcased in Figure 4.

Figure 2. 3DPortGuard Docking Aid display featuring all AMPI requirements contained in the Software section of the PPU Code of Good Practice for the Implementation and Use of Portable Piloting Units.

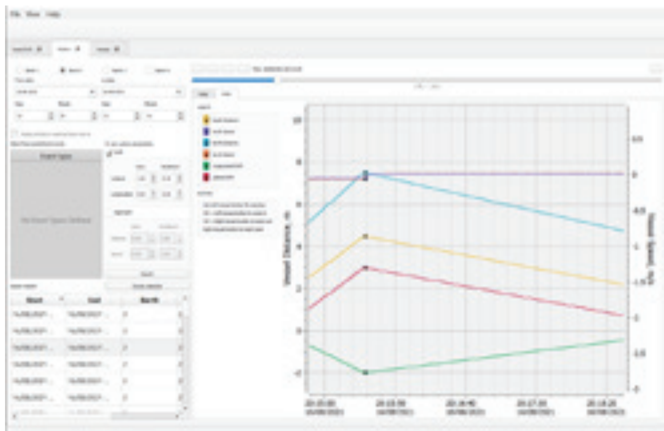


Figure 3. 3DPortGuard Docking Aid historical data base tool to search and replay any docking events.

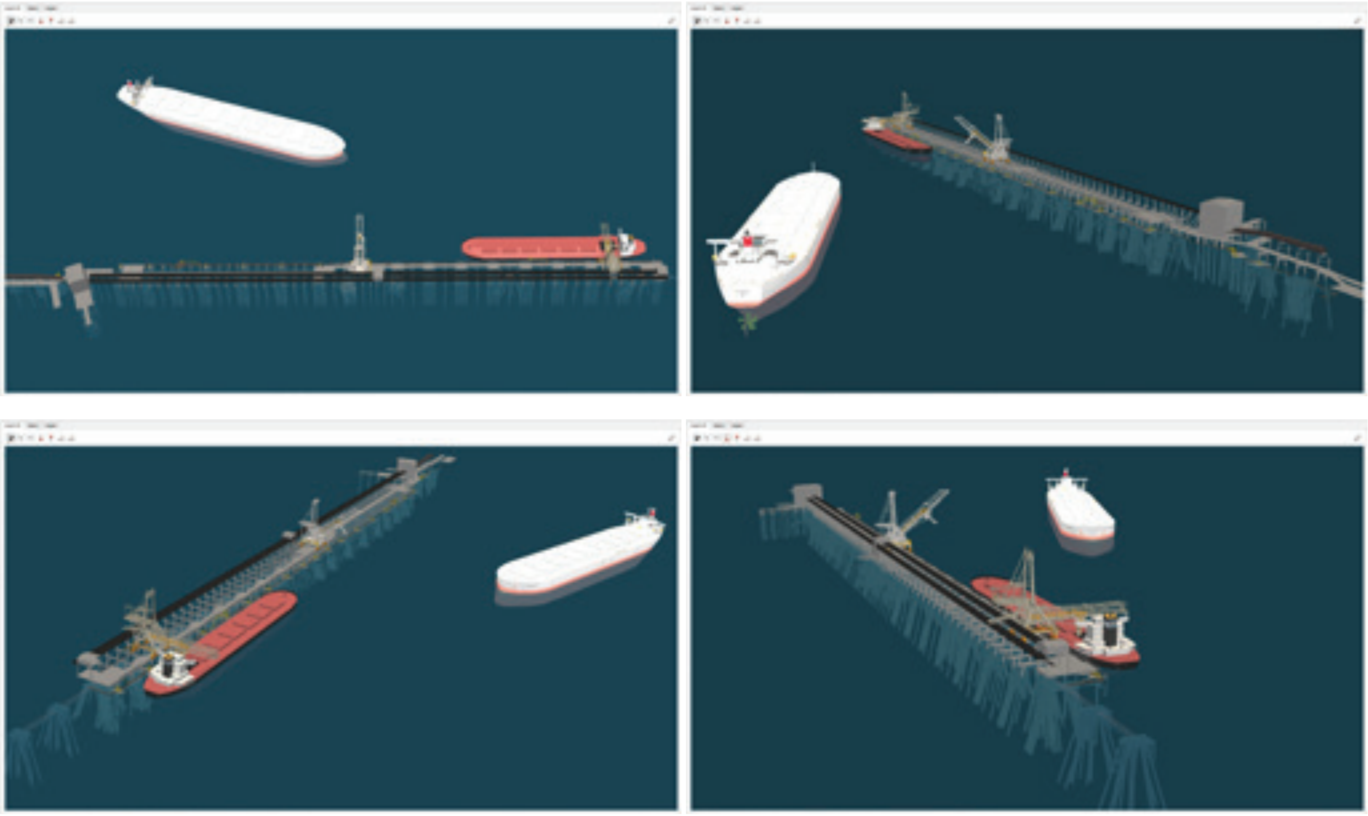


Figure 4. 3DPortGuard 3D replay view examples for a docking event tracked in the historical data base.

WHY DOES IT MATTER TO PILOTS ?

The value proposition for 3DPortGuard from a pilot's perspective is that it makes a pilot's core activity of berthing large vessels simpler, safer, and provides piece of mind when compared to the use of conventional GNSS docking aid systems because:

- Pilots don't need to bring anything on board other than their PPU, i.e. no weighty or bulky docking aid system transport by the pilot for set up on the vessel which can be a hazard during the ladder transfer from tug to vessel, because the system works remotely
- Pilots don't need to set up anything on board the vessel, which can be error prone for GNSS based systems if the piloting phase is stressful due to:
- Limited time window to do so
- Difficulty to complete the set up on vessel because of adverse conditions such as night-time darkness, foul weather, distractions from other tasks
- Fatigue due to excess work hours caused by delays or extension of shifts, particularly night shifts
- The system is 100% reliable and is not susceptible to the intermittency of accuracy creating a collision risk that GNSS based docking aid systems are known for
- The system is always on and available to the PPU display whilst in range of the berth pocket, it does not need any manual intervention by pilots at all to make it available
- Full 3D replay and numerical assessment of historical docking events provides the platform for safe procedure development and training

It is worthwhile to point out that 3DPortGuard can either fully replace GNSS PPUs for a marine pilot, or both systems could be used in parallel as fully independent systems. In larger ports and estuaries, the availability of a fully independent system is critical, and secondly, larger ships are being pushed into ports that have not increased in size. The margins for collision avoidance in these circumstances are much smaller, even when simply turning a large vessel inside port, and increased accuracy is becoming imperative. Thirdly, redundancy is increasingly becoming a key aspect of pilot operations, single point failures are no longer tolerated as they were 20-30 years ago.

Jochen Franke

Chief Executive Officer

Facts and Furphies
ABOUT PORTABLE PILOT UNITS

INTRODUCTION

History teaches us what to expect from any Portable Pilot Unit (PPU) today.

Possibly inspired by an apple, Isaac Newton developed a principle for inertial navigation that uses angular rate measurements to predict the future path of an object in motion. In WWII Germany used this technique in the 'Vengeance 2' ('V2') missile program. The program employed an iterative process to review the current inertial course and adjust the programmed path in flight. Lacking a position source to constrain the drift error that all inertial systems suffer, the missiles were destructive yet strayed from their intended targets.

The cold war accelerated the pace of research and development in the field of navigation prediction. In 1960 Rudolf Kalman first presented his famous set of equations for blending two independent yet complementary sources of measurement (Figure 1). Theoretically, Kalman's matrix could be used to constrain drift error. In practice, exactly what the definitive and independent measurement was not clear until the late 1970s when the USA launched its Global Positioning System (GPS). Today, the worldwide explosion in space development has delivered us the Global Navigation Satellite System (GNSS). Satellites do not behave like Newton's apple. Their forward velocity precisely balances the pull of gravity toward the earth, and they remain in orbit.

For a pilot using a PPU today, small form gyroscopes measure the subtle changes in orientation required to correctly determine course-taken and to predict future course. The increasing drift (position) error in the gyroscope is offset by the high accuracy position benefits of GNSS. In Kalman blends the best of satellite positioning and inertial measures to arrive at the optimal navigation solution without significant limitations (Figure 1).

THE PILOT'S CONCERN

It is in a pilot's interest to understand the facts of navigation physics upon which all PPU's must operate. Without factual knowledge it is too easy to fall for the Furphies that diminish use of the PPU as a navigation aid. A pilot who understands the theoretical principles behind GNSS and inertial measurement systems can predict the expected performance from any PPU and make an objective judgement about its relative worth as a navigation aid in different situations on different vessel types under different external environmental challenges that affect navigation.

This article lays out the basic facts required to dispel a common Furphy associated with the PPU.

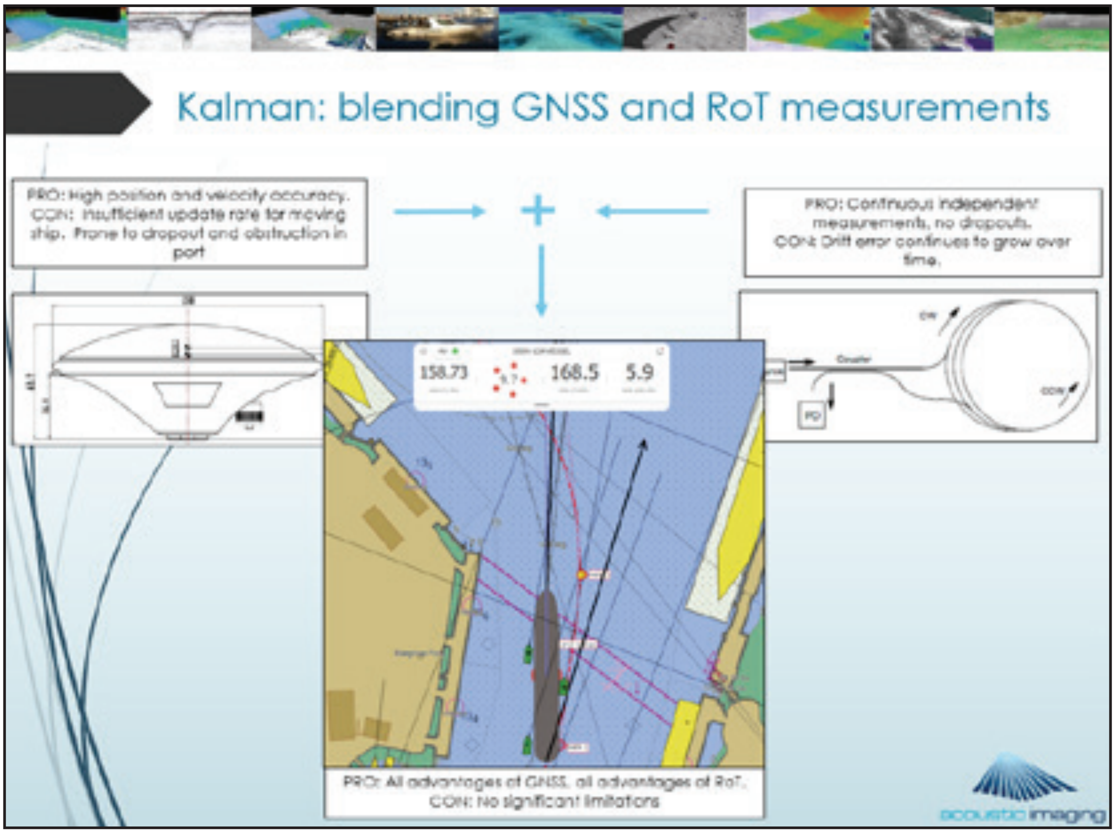


Figure 1: Historical Premise for the Modern PPU prescribed by Kalman. Blending GNSS and Inertial Measures.

A Furphy is slang for a widely held belief in an erroneous yet believable story that has found a place in history as fact. Australian and NZ Soldiers coined the term telling stories around the Furphy family water tanks deployed to the front in WWI (Figure 2).

Figure 2: Photo of the Furphy Family water tank (taken from www.furphyfoundry.com.au).

FACT: ACCURATE PPU GNSS HEADING IS INESCAPABLE

Of the measurements made by a PPU to determine the navigation state of a large, slow-moving ship correctly a measurement of highest probability and confidence of being correct, accurate and trustworthy is required to initiate the blending of other less unique measurements.

Of the candidates for use as the single unique value, , high accuracy GNSS position and GNSS speed measurements are unsuitable. Both can be accurate, but neither is unique as an infinite number of answers to the possible direction and orientation of the ship remain. Angular rates from a gyro are unsuitable. Rate of Turn (RoT) from a gyroscope can be highly accurate but position drift error grows with time as per the V2 missiles example.

Using data from Automatic Identification Systems (AIS) in a PPU to estimate the navigation state of the ship is dangerous. The accuracy of the ship's sensors is unknown. Rarely are they well-calibrated, nor aligned within the ship's frame of reference. The update rate of an AIS is far too slow to resolve a large, slow, subtly moving object such as a ship in a heavily trafficked environment such as a port.

This leaves PPU measurement of heading as the single unequivocal value that if engineered correctly in a PPU removes the maximum variation in Kalman's Equations.

GNSS Heading requires two antennae. Satellite observations from each antenna are used to compute the separation (difference in position) or 'baseline' between them. The normal to the GNSS baseline is the true heading of the ship. There are no other viable solutions to GNSS heading. It is the only unequivocal value that can eliminate the ambiguity in the navigation equation (Figure 3).

A PPU with a single antenna or without antennae is incapable of measuring heading and incapable of providing a high confidence estimate of the location of the ship's bow. It is a dubious tool for successful navigation ai on a ship of any size.

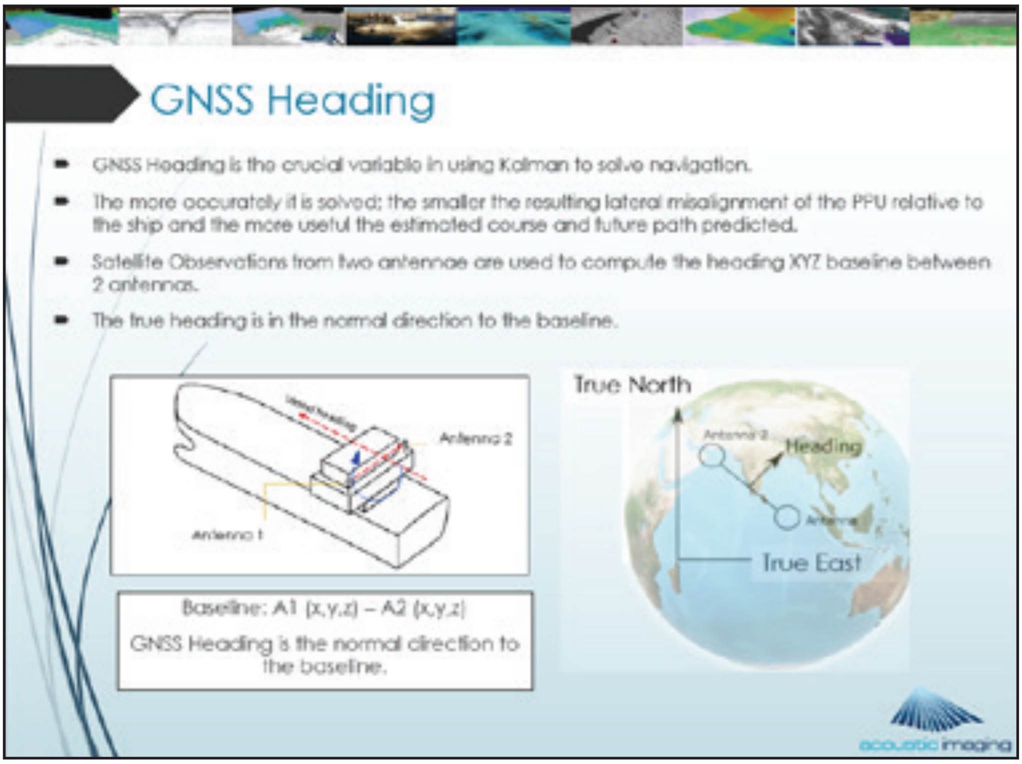


Figure 3: GNSS heading provides the only unambiguous starting point for blending GNSS and Inertial measurements in a PPU.

FACT: SHIP SIZE MAGNIFIES HEADING ERROR AT THE BOW

The heading accuracy resulting from two GNSS antennae significantly improves by separating the antennae to a maximum distance. Most conveniently this is bridgewing-to-bridgewing. Accuracy of each antenna's location is further improved through use of GNSS antennae and receivers capable of processing position from all satellite constellations (GPS, Glonass, Galileo, QZSS, and Beidou). Whilst not having an orbit of our own in Australia, New Zealand, and the South Pacific; we have in our favour low background radiation levels and a clear sky view of all other nation's constellations (perhaps except for Glonass which is at high polar inclination relative to the earth). The effect of viewing all constellations is to maximise antenna positioning success under gantries, cranes, bridges, and other infrastructure. GNSS Heading accuracy improves when 'multi-constellation' antennae (and receivers) process 'multi frequency' signals. Cheaper GPS and Glonass antennae operate on a single frequency (usually 'L1' band). More sophisticated multi-frequency ('L1', 'L2','L5' band) antennae have a higher statistical probability of the measured position being as close as possible to the true position. These antennae also offer protection against GPS jamming' events (for example, from 'drone killers') in ports.

Plotting the relationship of heading accuracy to antenna separation in Figure 4 shows that heading in fact becomes more accurate on larger ships because of the increased separation of the antenna baseline across the bridgewings. Separated by 50m on a 300m LOA ship this is less than 0.01 degrees (blue line). In contrast, the heading derived from two antennae on a ship fixed 1m baseline will always be 0.5 degrees (yellow line), irrespective of ship size. The PPU with one antenna or without antennae cannot compute GNSS Heading and the possible heading error at the bow is both large and unknown.

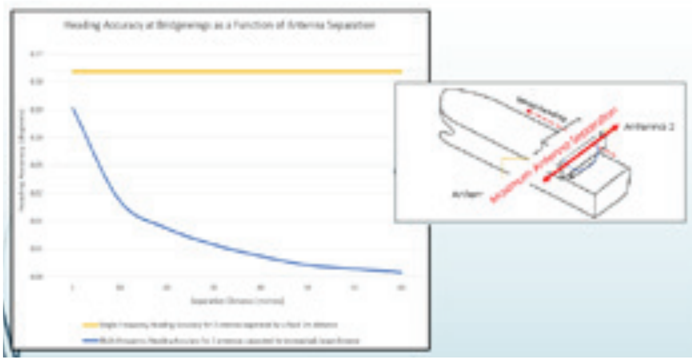


Figure 4: Heading accuracy for a fixed short separation between antennae versus heading accuracy for two antennae as a function of separation distance.

There is good reason to minimise heading error on larger ships. With the PPU antennae at the port and starboard extremities of the bridgewings, the exponentially decreasing heading error balances out the exponentially increasing distance of extrapolation to bow (B2B). The resulting position estimate at the bow is where Course Over Ground (COG) estimates of the path taken are made and from which future path is predicted (Path Prediction).

In Figure 5: convenient placement of port antenna and starboard antenna across the bridgewings on 55m separation baseline.

The impact of heading accuracy computed at the bridgewings on possible lateral offset of the bow is expressed as a function of B2B distance in Figure 6. The short baseline PPU (yellow line) results in a total lateral misalignment of six metres for a 300m B2B distance. (3m to port or 3m to starboard). The PPU with antennae spanning bridgewings balances the 300m B2B distance against decreasing heading error. The long baseline PPU (blue line) results in a lateral offset on the bow of only centimetres.

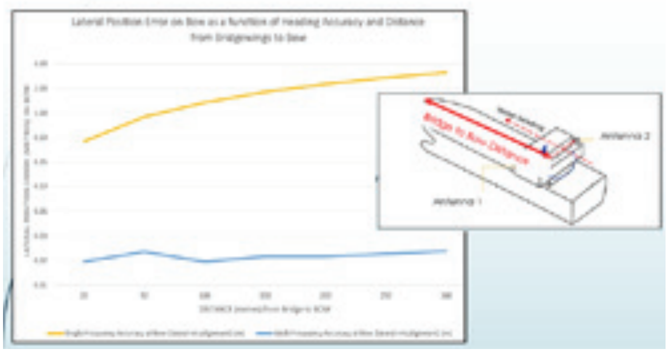


Figure 6: Lateral Position Error on the bow as function of heading accuracy and distance from bridgewing to bow.

FURPHY: AN RTK 'CORRECTION' CAN 'CORRECT' HEADING MISALIGNMENT ERROR

All PPUs with at least one antenna make use of GPS (most often), GPS and Glonass (often), or ideally full GNSS GPS, Glonass, Galileo, Beidou and QZSS constellations. Although standalone GPS can provide a position accuracy of 2-2.5 metres, when aided by GPS RTK it can provide a sub-5-centimetre accuracy. Similarly, standalone GNSS can provide a position accuracy of ~1 metre but when aided by GNSS RTK that can be reduced to 1 centimetre.

The 'correction' RTK delivers to the PPU antenna is simply the difference between the measurement made by the stationary RTK 'base station' antenna on land and the 'roving' antenna on the PPU aboard the ship. The RTK 'correction' removes errors common to both base station and rover.

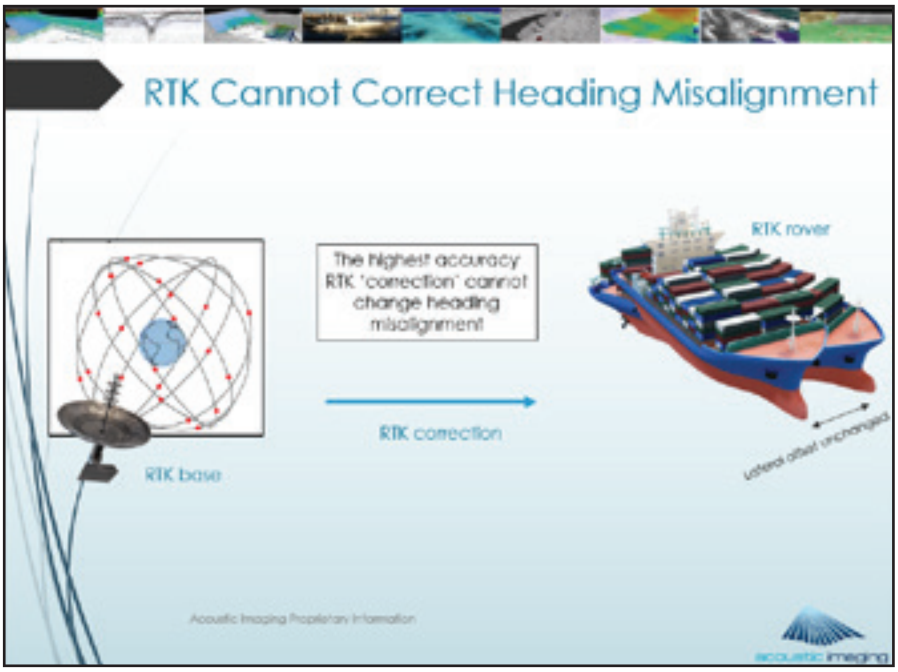


Figure 7: RTK cannot 'correct' heading misalignment.

Figure 8: Networked RTK base stations across Australia, NZ and the Pacific.

Figure 4 shows that heading is solely a function of separation distance between two antennae. The highest accuracy multifrequency RTK correction can provide extremely high accuracy position and speeds to a multifrequency PPU; yet the fact remains that RTK can do nothing to improve the misalignment error of the computed heading and the consequent lateral misalignment at the bow.

For a PPU with a large heading error RTK provides a potentially dangerous and misleading interpretation of the navigation aid to the pilot. Visible accuracy on screen reflects RTK position only yet the large lateral offset at the bow (Figure 7) is unchanged and the COG and path predictions are equally poor.

One fact of RTK in Australia, New Zealand, and parts of the South Pacific is that extensive and sophisticated networked RTK service exists. If a PPU has two antennae separated over a maximum distance this RTK service provides stable reliable centimetric accuracy to the position and speed of the correctly estimated heading at the bow. However, the key point here is antenna separation.

SUMMARY

Two inescapable facts of PPU Aiding are that:

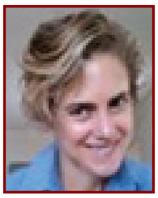
i. the more accurate, dependable, and trustworthy the initial GNSS heading measured by the PPU, the higher the probability that PPU data displayed on screen is a correct interpretation of the ship's current course as well as the best prediction of its future path.

ii. the less accurate, dependable, and trustworthy the initial GNSS heading measured, the greater the probability that the PPU data displayed on screen is an incorrect interpretation of the current situation and an implausible prediction of the ship's future course.

One common Furphy associated with PPU Aiding is that:

iii. an RTK correction can correct GNSS heading misalignment at the bow.

Furphies can creep into all industries and can become confused with facts by users. Armed with the fundamental physical principles upon which all PPUs must operate, a pilot can determine in advance the suitability of any PPU as an aid to addressing the navigation challenges particular to any port environment.



Nicole Bergersen
Lead Scientist / Marine Geophysicist

Simulation & Reality

1. Introduction

Nowadays ship manoeuvring simulators are regarded as invaluable tools in both the design of port infrastructures and the training of maritime professionals. The level of realism of simulations has certainly increased dramatically in the last few years, due to the ever-increasing computational power available, impacting on both mathematical modelling and visual performances. The use of technology, with the introduction of improved positioning systems (Pilot Portable Units) is facilitating port operations with ever decreasing margins, given the trend of increasing ships' size (FAL, 2020).

Is technology and its advancement the only factor underlying safe and efficient port operations? What is the difference between simulation and reality? Would the use of a simulator, alone, be able to provide the level of training required to conduct vessels proficiently and safely in a port?

To explore those questions, this article starts with a simplified analysis of what ship simulators are and how they generally operate. Strengths and weaknesses are considered, with the aim of gaining a better prospective on how simulator training may fit in the broader framework of pilotage training.

2. Ship simulators

It is certainly not the scope of this article to provide a detailed and accurate technical description of all the components included in a Ship Simulator. The brief diagram provided in Figure 1 should be only considered as a simplified map, useful to guide our conversation around several topics that will be better discussed in the following paragraphs.

The first block that can be found starting from the left of Figure 1, is dedicated to the Shiphandler. The shiphandler would be the person (or the personnel) directly participating to the simulation, from the bridge of their own virtual ship. One of the most important inputs that the shiphandler would directly manage are the Ship's Controls (rudder, engine…). These controls will depend on the ship model in use. In a simple bulk carrier, for example, those controls would only include an engine and a rudder, in case of a cruise ship they might include more than a single engine (i.e. azipod propellers), bow and stern thrusters, etc… Acting on those controls, will have a direct impact on how the ship behaves.

The shiphandler would have also the possibility to control other external forces: directly, for example, giving orders via radio to tugs in assistance, or indirectly, managing speed and position and exposing (or not) the vessel to forces developing from the interaction with other vessels.

Other critical inputs deeply affecting the simulation, are the environmental conditions such as wind, current and tide level. Those parameters are generally controlled by the simulator operator and may be altered at will, depending on the scope of the simulation. Those elements translate as direct forces acting on the manoeuvring vessel (wind and current) or can have an indirect effect on how the vessel will behave when interacting with the port model (the tidal level, for example, will have an impact on the available under keel clearance, which in turn will affect how strongly the vessel will experience other hydrodynamic effects).

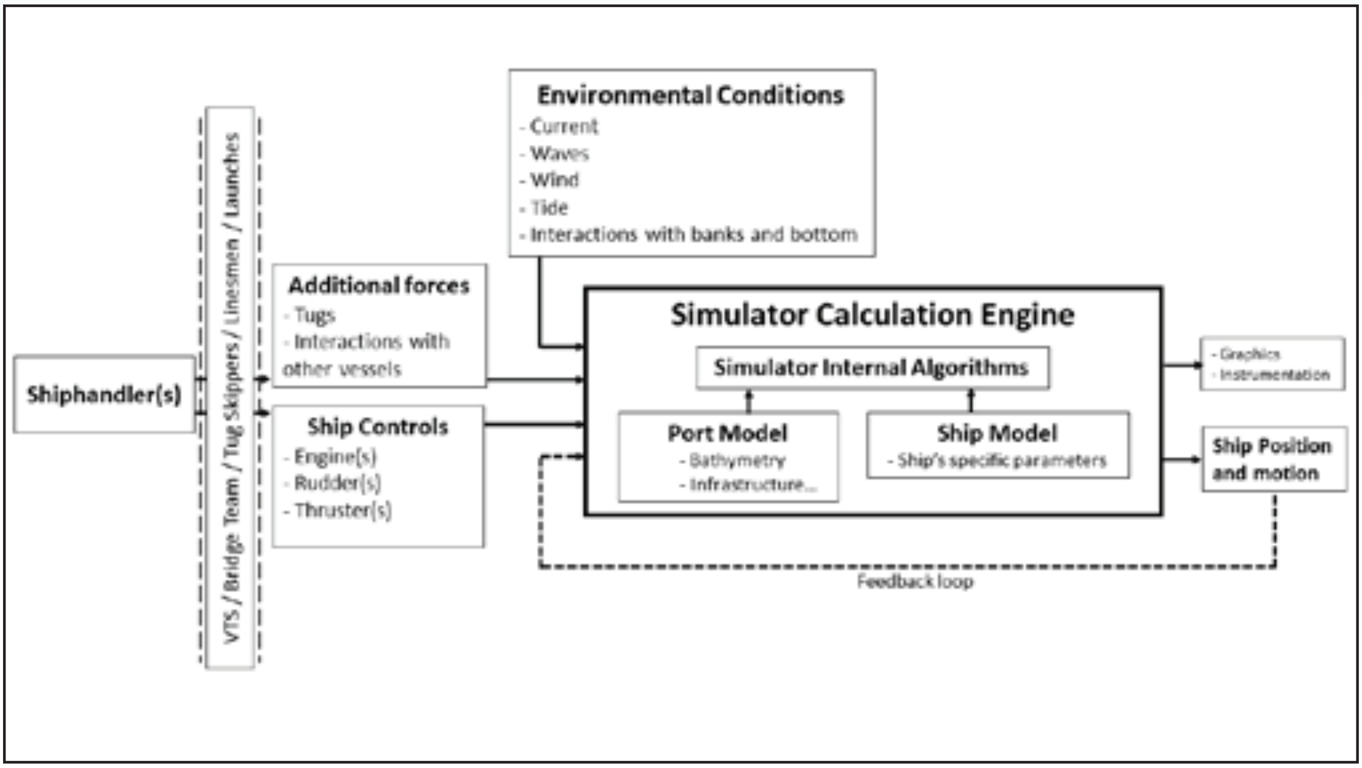


Figure 1 – Simplified operating diagram of a generic ship simulator.

All those inputs constantly feed data into the main Simulator Calculation Engine while the simulation is running.

For the purpose of this article, the main “Simulator Calculation Engine” is a simplification and an abstraction encompassing all the software and hardware components accomplishing all the calculations and data processing needed to run the simulation. In a general sense, the main Simulator Calculation Engine can be considered the brain of a simulator. Depending on the level of fidelity and realism sought, a shipping simulator could be running on a single laptop or may require complex networks of computers, each one dedicated to different tasks. In simulation centres, some computers may be dedicated to the calculation of hydrodynamic forces and own ship motion, other computers may be dedicated to generate all the signals that will feed the simulator bridge equipment, other computers may be dedicated to compute the behaviour of the other simulated vessels that take part to the scenario (i.e. vector tugs in assistance). In more complex scenarios, where the simulator centre offers the opportunity to combine multiple virtual bridges (or own ships) in the same scenario, the computer network will need to expand accordingly, to allow multiple vessels to realistically interact in the same exercise.

To create and run a specific scenario, or, in other words, to be able to answer to customers’ specific needs and questions with regards to a specific vessel operating in a specific port, the Internal Algorithms that power the main Simulator Calculation Engine, in addition to the inputs already mentioned (Ship Controls, Additional Forces, Environmental Conditions), will have to be provided with a vast number of other parameters.

All those parameters, necessary to mathematically define and describe own ships and ports, are generally collated in databases that are called “Ship models” and “Port models”.

Differently from the inputs described before, a Ship and a Port model cannot be changed while a simulation is running. They must be selected and loaded at the beginning of an exercise, since all the parameters that they contain will deeply affect the initial setup of the simulator. To give an example, selecting the ship model of a particular cruise ship instead of a bulk carrier, will imply that the whole bridge instrumentation and controls configuration will have to change, to accommodate for the chosen model: controls for bow, stern thrusters and a second main engine will have to be activated, the indicators and the gauges present on the bridge, the offsets of antennas and vessel dimensions loaded on radars and ECDIS will have to be modified accordingly, etc… A huge amount of customisation will have to take place to reshape, as much as possible, the simulator bridge consistently with the chosen ship model. It is important to notice that the parameters included in the ship model are not simply aesthetic. Most noticeably, the data in a Ship model will include all those mathematical coefficients required to hydrodynamically and aerodynamically describe how that specific ship will behave once the simulation is running.

Similarly to ship models, port models contain all the information needed by a simulator to replicate a specific port. For example, port models will include bathymetries, current and wind maps, tidal tables, berths, fendering, etc… Similarly to ship models, port models will contain data that is used purely for aesthetic purposes, such as 3D graphic modelling information (buildings, trees, berths infrastructures, cranes, lights and beacons etc…). This information will be used to draw the background and all the element included in it, that will be projected on the screens of the simulator. This data, even though adding realism to the visuals, may have no effect in the way the port model will interact with the ship model. On the other hand, other data included in the port model (such as bathymetries, current and wind maps), will be fundamental to process the interaction between the port and the ship model, basically how the ship will behave in that specific port. Simulator manufacturers can offer extensive libraries of port and ship models to choose from. Based on their needs, clients can even require manufactures to build fully customised ship and port models. As imaginable, the quality or the level of details and accuracy of those models can vary significantly as well as their cost.

The “Simulator Calculation Engine” with its internal algorithms, will compute all the calculations needed to run the simulation, combining the parameters contained in the ship and the port models, with the inputs coming from ship controls, additional forces, and environmental conditions. The output (…among many other things) will result basically in how the ship moves and behaves.

It’s important to notice how the output also feeds back into the system at every reiteration of calculations (refer to the feedback loop in Figure 1). Second after second, the calculation engine repeats the computations, taking in consideration any change that in the meantime may have occurred in the inputs and recombines those inputs with the most recently obtained ship position and motion.

To provide realism to the simulation, the results of those calculations are constantly provided to graphic 3D engines (in charge of creating the visuals shown by projectors or screens), and to bridge instrumentation (to allow them to operate as if they were installed on a real ship). Sound effects would also be dependent on calculations results.

In the next paragraphs we will re-examine the blocks reported in Figure 1 in more details, highlighting similarities and differences between simulation and reality, and providing some comparisons between shipping and other industries.

3. Ship Controls

These are the hardware, the wheel, the tillers, the levers, and buttons that are available to shiphandlers to interact with ship’s propulsion and steerage. Depending on the type of simulator, this interface could vary, from a simple image on a computer screen, mimicking actual controls (the shiphandler would have to use a mouse or a touch screen to change their position) to the very same controls that could be found on board. It is important to notice that on board of a real ship, it would be rare for a pilot to directly touch those controls. The crew present on the bridge, would normally comply with pilot's orders and apply those commands directly on controls. Generally, the Captain or the Officer of the Watch would access the engine controls, and the helmsman would generally steer the ship. This is for example a significant difference from the airline industry, where airplane Captains (and their co-pilots), have always direct access to plane controls. Moreover, those controls are plane specific and rigorously standard (the cockpit of a Boeing 747 is always absolutely the same, regardless of the airline company managing the plane). Airline pilots are licensed to operate only specific models of aircrafts. For this reason, one of the objectives that can be pursued in an airplane simulator is to train the "muscle" memory of air pilots, using the exact same controls and switches that will be present in the cockpit of the real plane.

In the maritime industry, the context is quite different. On real ships, there is very little consistency in equipment location, functionalities, or controls… Even though the presence of a certain piece of equipment is mandated by regulations (number and type of radars, number of ECDIS, echo sounders, ROT indicators, etc…), each device could be purchased by tens of different manufacturers, each one satisfying the required performance standards, but each one potentially offering very different user interfaces and additional functionalities. As a result, each real ship bridge is a unique juxtaposition of different instruments of different brands, potentially installed at different times in different locations, often in response to the promulgation of different regulations. All those individual pieces may or may not be electronically integrated with each other in what is known, on more modern and sophisticated vessels, as an Integrated Navigation System (INS). Integrated Navigation Systems, though, are not the norm nor the standard in shipping.

To this date, even extremely large vessels (exceeding 290 m length over all and exceeding 100000 t of displacement), in their most rudimental form, might be simply equipped with only the individual pieces of equipment strictly required, without any form of integration or automation. It is virtually impossible to find a bridge equal to another, even in "sister" ships (ships belonging to the same class).

In a shipping simulator, for obvious reasons, the bridge layout cannot be substantially modified. Instruments (or mock-up instruments) are often replicated by images on computer screens. In this way they can change their appearance and functionalities, simply via software modifications, but rarely they can change location nor can replicate the myriad of different combinations of shapes and forms they can assume on the bridge of a real ship.

As anticipated, Ships also greatly vary in terms of their capacity to implement different levels of automation. All the ships on the planet will have manual steering and engine controls, meaning that every ship will provide the crew with tillers, wheels, levers to manually and directly act on rudder angles, engine RPM, thruster direction and power, etc.

Of course, some specialised vessels, developed and built to perform highly skilled tasks, can exploit extremely high levels of technology and automation. Consider for example dynamic positioning vessels utilised in the offshore industry. The navigation and propulsion systems of those vessels can be programmed to execute extremely complex manoeuvres that could easily include fully autonomous berthing and unberthing from a terminal (…probably more accurately than any pilot would be able to do!). The technology required to achieve such level of automation, though, can be extremely expensive, so, at this stage, its implementation on any other commercial vessel other than those operating in those specific contexts it is not viable. Some commercial ships may have autopilots able to automatically steer them on a track, but those systems often become ineffective under a certain speed.

To this date, the absolute majority (if not the totality) of the vessels manoeuvring within the constrained waters of every port in the world (regardless of dimensions, draft, displacement, loading conditions, etc…), are conducted in an entirely manual fashion, meaning that no use of automation in steerage is involved. All Marine Pilots in the world use the same very basic tools: orders to the rudder(s) (requiring the helmsman to follow a heading or apply the ordered rudder angle) and orders to the engine(s) (simplified and arbitrary amounts of power expected to be developed by the engine while thrusting in a desired direction). For those that may not be with familiar with the details, let's have a look, for example, at what a typical engine order could be, regardless of the vessel or the port (…or the pilot) when this order is given:

"Engine Half Ahead" …These thee words mean that the pilot is asking a crew member to move an engine lever to an arbitrary position on a telegraph that allegedly should direct the engine to provide half of the maximum available manoeuvring power, with the propeller shaft rotating to thrust the vessel ahead…!

It might be worth mentioning that, since every vessel is different and equipped with different types of engines, the same order "Engine Half Ahead" could result in extremely different outcomes: On a container ship, half ahead could often translate into a speed exceeding 14 knots, while on a bulk carrier it would rarely exceed 9 knots…

The example above might help to understand why real ships are required to provide the pilot with a "pilot card", a brief document that summarises relevant ship's manoeuvring characteristics, such engines and thrusters power, a table with engine settings and expected speeds, etc…

The catch is that sometimes those pilot cards might not provide the correct information. They could be copies of pilot cards developed for sister ships, or, more often, they might not be relevant anymore, given the reduction of performance that ships suffer in time (bow thruster available only up to 90% of its original power, effective speeds slower 1 or 2 knots than tabled, etc…).

Returning to the comparison between airline and shipping industries: airline pilots specialise in the knowledge and skills required to fly their specific aircraft. Airline pilots have direct access to plane controls, which are fully standardised across the industry for each plane model. Airline pilots must be extremely familiar with all the functionalities and peculiarities of all the systems available to them in the cockpit. Those systems are exactly the same and are expected to behave in the same way across the same plane model.

Marine Pilots, instead, are asked to quickly adapt to any vessel they might be conducting, even though they might never be fully familiar with all the equipment present on the bridge. Marine pilots can count only on the availability of a certain number of instruments (as required by regulations), that, even though satisfying mandatory performance standards, may dramatically vary for user interface and functionalities.

Marine pilots can overcome the difficulties raised by the lack of familiarity with the bridge layout or equipment, engaging the ship's bridge team to accomplish the desired tasks or provide the needed information, but this may raise a whole new level of communication challenges. In reality, only through experience and prolonged exposure, marine pilots reach a comfortable level of familiarity in the use of the most common equipment found on bridges, enough at least to perform basic operations, but rarely permitting advanced trouble shooting.

In light of the above, it could be argued that the sole use of shipping simulators may not only reduce the possibility of achieving exposure to the great variety of controls and equipment that the real ships offers, but, most importantly, may reduce the opportunity of interaction with an even more unpredictable variable: the ship's bridge teams.

Allegedly STCW standards require bridge team members to be fully qualified for the role they are covering on board, and to be proficient in a certain number of tasks on the bridge. The reality found on board may dramatically vary from this assumption. Different ships, involved in different trades and flying different flags, may show enormous differences in the level of training and proficiency of their crews… cultural and language barriers, fatigue and commercial pressure, can greatly interfere with how any communication between a marine pilot and the crew is exchanged, acknowledged and acted upon. Again, this is another major difference between the maritime and the airline industry: in an airline cockpit there are generally two individuals, trained on the specific equipment and the aircraft they are flying, both belonging to the same airline company, hence required to thoroughly know and abide by a shared common safety management system. Tasks, roles, responsibilities, and expectations for those two individuals are clearly defined in the context of a fully shared and defined safety framework. In the maritime industry you have a pilot trying to seamlessly interface and adapt to a variety of different instruments and integrate to an ever-changing pool of other individuals with unknown levels of competencies, having to quickly establish a common framework within which everyone is asked to operate.

In a shipping simulator, this fundamental and challenging aspect of the "real" job might not be considered at all. Due to the costs that extra personnel would add to simulations, or simply because the presence of a bridge team would not be relevant or could be even counterproductive for certain simulation goals (i.e. port development), it is often preferred to limit the "bridge team" simply to a helmsman, if anyone at all.

4. Additional Forces

Commercial vessels are designed to efficiently and (… most importantly) economically transfer cargo from A to B. Commercial gain is achieved only while conducting this basic operation. Based on this extremely simplified logic, machinery onboard must run for long periods of time, requiring minimal maintenance, and utilising the minimum amount of energy possible. To achieve this, shipping machinery must be relatively simple and sturdy, not overpowered for its task and, ideally, it should work at that steady pace that allows to reach the most economical ratio between the outcome sought and the resources consumed. Any redundancy (emergency steering, emergency generators, etc…) is mandated by international safety regulations (promulgated generally only after major accidents have occurred…). Vessels need to comply only with those minimal requirements, while anything else in addition, is often considered by ship owners as an unnecessary expense for an unquantifiable advantage.

It might be also worth to remember that increasing the dimensions of a vessel results in an increase of its volume by the cube and its surface by the square. The volume of a vessel is directly related to its loading capacity (paying cargo), while the vessel surface is directly related to the resistance that that vessel is going to encounter against its motion (fuel consumption). As an obvious result, the trend in shipping has always been to maximise ships' dimensions, keeping machinery design to minimum standards and optimising performance for what ships need to do almost all the time: sail in open waters at an optimal, steady, economical speed. Most of the automation introduced in shipping engines has been focused on the reduction of fuel consumption, both for economic and environmental reasons, resulting in loss of power redundancy and manoeuvring elasticity. Loading programs dictate the rate at which engines will be able to increase or reduce their RPM, not only at sea speeds but often also when on manoeuvring, resulting in engines that, for example, can reach selected power settings only when the speed through the water is less or more than a certain amount.

The above would work an absolute treat if, unfortunately, ships didn't have to deliver their cargo entering ports: places with generally very little room available for manoeuvring and a lot of stuff around that can be damaged!

Manoeuvring big vessels in a relatively small port ideally requires the exact opposite of what ships are generally optimised for: redundancy, efficacy at low speeds, reserve of power and elasticity in steering means and propulsion.

The solution to this conundrum? …enter the Tugs!

Berthing vessels rarely can be achieved in isolation. Once the speed through the water reduces, conventional rudders lose their efficacy and the effect of environmental forces, such as wind and current, becomes predominant. In those conditions, a vessel without the assistance of extra internal manoeuvring means (effective bow and stern thrusters, azipods, etc…) or external towage in assistance, would become uncontrollable, ending up in damaging itself, port infrastructures and putting human lives and environment at stake. In reality, even the presence on board of extra manoeuvring means (such as bow and stern thrusters) may not be sufficient to counteract the environmental conditions acting at the time. It is often a deliberate economical choice not to install those extra means in a first place (bulk carriers) or to limit their power to a minimum, to ensure manoeuvrability only up to a certain intensity of weather conditions. Another important consideration is also that the nominal performance of those means might be very different in reality from what declared on pilot cards, due to aging, malfunctions or simply vessel loading conditions. Last, but not least, all those systems can fail at any time, leaving the ship at the mercy of the elements.

For all the reasons above, in almost every port of the world, a towage service is often provided, not only to assist ships while manoeuvring, but also to ensure redundancy, hence protection, to vital port infrastructures.

As ships are all different, even more so are tugs. It would be again well out of the scope of this article to try to explain in details those differences. Suffice to say that the variety in towage is immense, considering the different types of propulsion, line recovering means and bollard pull, hull shapes, deck spaces and equipment… the list is endless.

Marine pilots must be fully conversant on what those differences are and what they mean in terms of manoeuvring advantages and limitations. Even more importantly, marine pilots must be fully aware of the specific characteristics, operational limits, safety envelopes, details and idiosyncrasies of the tugs working in their own port. Each single tug is different, and sometimes extremely so, and, if that was not enough… tug skippers are different too!

In real life Marine Pilots do not control tugs pushing buttons (…well, maybe sometimes!), but giving orders via a VHF radio.

Like we did for ships, let's have a look at what an order to a tug would look like:

"Tug Aft, square up and prepare to lift, no weight"

This simple order is asking the tug skipper to move the tug from its actual position to a new position (the side of the ship is often omitted when self-evident) where she will be able to exert a lifting force perpendicular to the vessel. The tug is required to achieve this, without applying any force on the line while repositioning. It is completely left to the tug skipper to decide how he or she is going to achieve that, if the tug is going to change position slacking extra line, driving ahead or flipping on the spot and driving stern first… what the tug will do will be also extremely dependant on what the assisted vessel is doing: the same order may require completely different techniques, depending whether the vessel is stopped in the water or sailing at 5 knots… the same order might be impossible to be executed, putting the tug in danger, when

Port Kembla

forced to perform outside her operational limits (Jayarathne Nirman, Ranmuthugala Dev, & Leong Zhi, 2019)…

As anticipated, not only all tugs are different, but it is also different the level of training and experience of the tug skipper involved, this having an enormous impact on how the orders will be performed.

In light of all the considerations above, even though the execution of the order is left to the tug skipper, that does not exempt the pilot from being perfectly aware of what the tug will have to do, to comply with any order, especially in terms of risks and dangers involved…

Advanced simulation centres can provide full mission bridges completely dedicated to replicate the bridge of a real tug, with seats and controls, indicators, and instruments as close to the real thing as they can be. Those tug bridges can be included in the same exercise of a ship, practically allowing the tug to participate to mooring operations, similarly to what would happen in real life. In this case, the realism of the tug behaviour will be heavily dependent on the accuracy of the tug's "ship model" adopted (more on this topic in the next paragraphs). The level of complexity of the algorithms adopted in the simulator will also dictate the level of realism in the hydrodynamic interactions between the ship's and the tug's hulls (Jayarathn, Ranmuthugala D, & Fei J, 2014). Simulator centres may charge different prices based on the accuracy of the tug's ship model, as well as additional rates for the use of extra manned bridges. The obvious downside of involving multiple manned tugs, is that simulations may result in a very expensive exercise…

The compromise that is generally adopted in simulations is the use of "vector" tugs. Vector tugs are virtual tugs that are added to the simulation without involving extra personnel or requiring the existence of any additional bridge. Vector tugs allow the simulator operator to apply external forces on the ship's hull as if a tug was there to do the job. To provide visual realism to the simulation, vector tugs appear on the screen looking like a selected model, but they might not necessarily replicate that model exact manoeuvring characteristics. They are directly controlled by the simulator operator via very simple commands: following pilot's orders, the operator can shift those tugs with the click of a mouse, change the intensity of the force they are applying simply pressing buttons. Even though they might look like tugs working around the ship, they certainly do not have the same effects: there is no interaction between hulls nor constrains in their manoeuvrability considering that the time required for a shift can be set at will. For the purpose of many simulations, especially for those that do not require the highest level of realism, the use of vector tugs is perfectly acceptable.

It is important to understand, though, all the implications that may derive from such a choice:

Voice communications and tug procedures, for example, are port specific (different ports may adopt different conventions in the use of tug orders). Certain berths in a port might be

Hoegh Shanghai - Port Kembla

particularly challenging, given the little room available and/or specific current or wind conditions that may develop on site. In those instances, the use of a vector tug might give the illusion that a real tug would provide a level of assistance not obtainable in reality. On the other hand, real tugs, or better to say, tug skippers in real life, can provide support in a way that would be beyond the scope of a simulated environment: prompts about the position and or the tendency of the vessel, prompts about other vessels, prompts about the behaviour of the crew on deck, prompts about anchors position, prompts about lines, prompts about orders that may not be correct… In real life tug skippers become effective members of the team. A simulator operator may provide all that information, but out of the context of the procedural framework specifically in place in a particular port.

5. Environmental Conditions

The environmental conditions are all those meteorological parameters that can be manipulated by the simulator operator (throughout the whole simulation) to provide context and to explore their effects in ship's manoeuvres.

Generally, those parameters can be easily set by the operator as fixed values (i.e. constant current with a fixed intensity and direction), or could be selected among tailored options as provided in the port model (as it will be better explained in following paragraphs).

In this paragraph we will consider current, waves, wind and bottom and bank interactions, as the majority of manufactures would generally make them available in their simulators (Donatini Luca, Vantorre Marc, Verwilligen Jeroen, & Delefortrie Guillaume, 2019).

5.1. Current

Currents are present in almost all the environments where ships operate. Currents are a very significant parameter to be considered to improve the realism of simulations and their outcomes. In many simulators, the current is represented as a two-dimensional field of speed vectors. This field can be imagined as a geographical grid overlaying the navigable areas. At each grid intersection a vector indicates, in that location, the current speed and direction. Very few simulators use a more advanced 3D vector representation of current which includes a vertical speed component. Depending on simulators, the vector grid may vary in size and density. The horizontal resolution is on average between 20m and 100m, even though, in some cases it can go as low as a couple of meters in coastal areas and as high as 500m in offshore areas. To obtain values of currents in locations between vectors, different types of interpolations may be adopted. Manufacturers, though, will rarely disclose how those calculations are carried out. For simplicity, the ship hull is subdivided in smaller sections. For each time step, the relevant current vectors (or their interpolated value), are adopted to perform calculations on each of the ship's longitudinal sections. The calculations are carried out separately on each of those sections, and then the results are recombined.

It is important to remember that current vectors not only change depending on their position, but also depending on time. This is an option that may or may not be present in the simulator. The time intervals for current field updates, range between less than a second to hours. Between time intervals, generally, a sine function is fitted to provide current field values, even though, depending on the manufacturer, many other different algorithms may be adopted.

Manufacturers may offer very different solutions on how current fields are utilised to calculate hydrodynamic forces and moments acting on the ship. There could be significant differences between simulators in the number of degrees of freedom which the current effects are accounted for. Two degrees of freedom will consider surge and sway. Three degrees of freedom may include also the yaw. Four degrees of freedom will add roll. Fewer manufacturers may consider current effects in all six degrees of freedom (providing squat).

In the real world the presence of currents is an extremely important factor, especially for those ports where the current flow is strong and extremely variable, depending on time and location. River navigation often provides a good example, with eddies and counter currents around bends and infrastructure. Ships may be heavily and unexpectedly affected, with important implications for their safety. Marine pilots learn by experience the effects of currents at different locations. This knowledge allows to pre-empt those effects instead of simply react, where spatial constrains would not allow enough room to recover. If and how well simulators can replicate those specific conditions will depend on simulator algorithms, but most importantly will depend on the fidelity of the current data introduced, how relevant and accurate are current studies, if any, conducted in the port. In addition, in reality, extreme conditions may occur related to particular events (i.e. dam releases). Difficult to say how much those conditions would be replicable in a simulator.

5.2. Waves

Very broadly, wave effects can be split into two main categories: wave effects inducing mean drift forces, and wave effects inducing oscillatory motions. Based on this distinction, wave induced drift loads may heavily influence ship's manoeuvrability (and that is extremely relevant to simulation results), while oscillatory motions may be included in simulators mainly to improve realism. Often, in simulators, waves can be introduced in the frequency domain (using wave spectra and response amplitude operators – RAOs), even though many other (and simpler) options to introduce waves can be provided.

Like currents, waves may also require to be defined in space (different areas of the port may be exposed to different wave conditions), even though this option might not be common among many manufacturers. The temporal variability of waves is generally neglected, considering that the time needed for significant changes in wave (usually more than 30 minutes) is longer than the common duration of a real time simulation. Generally, waves can be considered steady during the whole simulations. The wave data is generally introduced in the simulation from three main sources: wave measurements, numerical wave models and user defined wave parameters. Simulators generally consider wave induced effects on the ship in all six degrees of freedom, even though that is not necessarily the rule.

The difference between reality and simulation, may be found not necessarily in the way waves are simulated, but rather in the implication that waves will have on the real job. The first example that comes to mind, is the use of towage. Ports exposed to the environment, such as terminals built offshore without the protection of obstructions, would take all the brunt of wave conditions. One important implication is that tugs may not be able to push a vessel, given the considerable heave movements that may occur while the tug is on the hull, with serious risks to part lines, damage fendering and, ultimately, ship's and tug's structures. Another example that comes to mind is pilot transfers… to the knowledge of the author there is no pilot ladder simulator, replicating the joys of a transfer in a few meters of swell…

On real ships, with considerable swell, things on the bridge tend to fly around… sometimes including the breakfast had in the morning. That doesn't always result in the most relaxing Master Pilot exchange.

5.3. Wind

As for current, a ship can be subject to wind in all its operating environments. When wind acts on the superstructure of a ship, a force in the horizontal plane and a yawing moment are generated. Due to the vertical distance between the point of application of the wind force and the point of application of the resisting hydrodynamic force, a heeling moment is also originated. The resulting heeling angle, which can be large, changes the geometry of the hull, and therefore also the manoeuvring behaviour of the ship. The effects of wind on the ship manoeuvring behaviour can be relevant, especially for ships with tall cargo and/or superstructures, like container vessels, cruise ships and car carriers. Like the current, the wind can be modelled as a two-dimensional field of speed vectors. The vectors in the field can be spatially and time dependent, or the whole field could simply consider a constant value in speed and direction. Time variation can be modelled, even though often the simulator operator discretionally changes intensity and direction according to the purpose of the exercise. In addition, wind fields may also include turbulent random fluctuations in both speed and direction. Rarely the vertical variation of the wind field is taken into consideration.

Simulators generally model wind induced forces and moments in four degrees of freedom: surge, sway, yaw and roll (heel) even though some are able model the effects in all degrees of freedom. Similarly to the current, also the wind might be calculated on several discrete positions on the ship, interpolating the input wind field on a number of points along the ship length and then calculating an average wind vector. The relative wind vector (considering the ship's motion) is then combined with wind coefficients to provide aerodynamic forces and moments. In another case, the ship superstructure is modelled through a voxel approach (a voxel is an arbitrary unit of volume), and the force exerted by the wind field on each voxel is integrated over the whole superstructure. Some simulators may also take into account the vertical variability of the input wind field in the calculations.

Few simulators consider the sheltering effect of the ship in the wind field. One way this can be done is modifying the input wind field inside a box which travels with the ship and is reshaped according to the incident wind speed and direction. The sheltering effect becomes particularly relevant when the simulation focuses on ships' interactions. When, for example, a high volume and light ship (like a car carrier) berths in vicinity of other high volume ships already alongside, there is an interesting combination of wind fields generated by the sheltering directly behind each vessel alongside and the funnelling between those vessels (where the manoeuvring vessel is going to berth). On real jobs, the appreciation and the expectation of those effects is part of the local knowledge that a pilot must build around the port.

In real life, considerations around the wind may not be specifically limited to the realism of the simulation. In a marine pilot mind, the increase of wind conditions should prompt not only considerations around the effect that the wind is going to have on his / her own ship, but most importantly, what are the consequences for the whole port. Increased wind conditions can easily delay other movements that may be sharing the same services. Extreme wind conditions can cause vessels alongside to part lines and require emergency towage to assist. This is to say, that in real life, ship movements do not take place in isolation, but, especially in bigger ports with long transits, they must be safely merged with all the other movements (and potentially unexpected events) that are taking place at the same time. Differently for a simple shiphandler, the horizon of a marine pilot does not end at the bow or the stern of his/her own vessel, but must extend in space and time, to include events that are or will occur, having important implications for the safety of the conducted ship. That is when and where contingency planning becomes fundamental.

5.4. Tide

When the water depth is comparable with the ship's draft, the ship's manoeuvring behaviour is significantly influenced by the under keel clearance (UKC), which is defined as the minimal distance from the keel line to the sea bottom. Due to these effects, changing water levels need to be taken into account in order to achieve realistic manoeuvring simulations in shallow water. Most simulators consider a temporal variation of the water level during the simulation, more rarely accounting for spatial variations of the water level over the simulation domain.

Often simulators model the hydrodynamic effects on the ship of water level by using different mathematical models for predefined under keel clearance values. Usually, the water level is interpolated at different locations, and the UKC value affecting calculations is obtained from the ship's draft at different ship positions. The forces acting on the ship are then calculated according to the mathematical model corresponding to the calculated UKC. In certain cases a single mathematical model can be adopted to obtain direct calculations of corrections to the hydrodynamic forces in confined water.

UKC calculations are extremely important in real life, especially when the movement is subjected to tidal windows, outside which the available level of water would not allow the vessel to float. The hydrodynamic effects deriving from reduced UKC, will be better explained in the next paragraph. Here we would simply like to remind how the consideration of tidal conditions is another critical element, not only in the conduction, but most importantly in the preparation of a transit. A pilotage job, does not start with the conduct of a vessel. It is a thorough process that starts many hours before, at the time when the job is allocated. A marine pilot, well before boarding, would start looking at all those details that are specific to the job (vessel, berth, environmental conditions, tugs allocated…). Tide levels and UKC, understandably, would have an enormous impact on how (and if) the job will be conducted. Not having enough water under the keel can be a real show stopper…! Constrains and limitations around UKC are so important, that in some ports, the calculations are fully delegated to third party specialised software. These solutions, starting from actual environmental data acquired from sensors available in the port and real loading and stability conditions received from the actual vessel, are basically able to run an entire simulation and provide the dynamic UKC expected throughout the entire transit. This whole topic would require a separate article. In real life, Marine Pilots would have not only to be able to execute transits according to those calculations, but, most importantly, need to have a full understanding of the implications, should the transit cannot proceed according to such plan.

5.5. Bank and Bottom Effects

Especially in restricted waters, the manoeuvring and course keeping of ships may be affected by the interaction between the ship and the boundaries of the navigation area. These effects should be included into the mathematical model of simulators, especially in those situations in which distances between ship's hull and these boundaries are expected to be relatively small. The effect of the bottom is usually reflected by introducing depth dependent hydrodynamic coefficients. In addition, there are bank effects to a ship navigating parallel to banks and quays and there is interaction with other sailing or moored ships. The realism of simulations carried out in confined waters and the reliability of their results is highly depend on the accuracy of the mathematical modelling of the hydrodynamic forces and moments due to those interactions (Lo, Su, & Chen, 2009). Very little is disclosed by manufacturers in terms of algorithms they may be using for obvious commercial reasons. Those calculation can be extremely complex and the outcome more or less

Port of Melbourne

accurate depending not only on the algorithms employed but also on all the other relevant parameters such as: updated and accurate port bathymetries or infrastructures (i.e. locks) and the inclusion of other vessels (Vantorre, Verzhbitskaya, & Laforce, 2002) in the simulation. In addition to the calculations automatically performed in the background, some simulators may offer the opportunity to manually introduce bank effects in the port model. These artifacts may be overlayed to bathymetries to indicate to the calculations that stronger effects should be accounted for in those specific geographical locations. The intensification of the effects can be controlled using gain factors. The important aspect to keep in mind is that those additions are completely arbitrary and left to the simulator operator. Generally, the simulator operator will manually introduce those effects simply based on users' feedback, on a trial and error basis.

In real life, witnessing bank effects can be a pretty exciting experience… depending on the speed, those effects can be sudden, and the loss of steerage can sometimes be unrecoverable… Marine Pilots that work in channels and in constrain waters have to learn pretty soon how to read prodromic signs, which include, among others things, "unusual" vibrations of the ship… rarely shipping simulators are able to replicate those effects and audio effects are not quite the same. Another important tool is the monitoring of the rudder indicator. Only experience can tell if the helmsman is starting to use wider rudder angles than expected and if the whole ship is behaving sluggishly… unfortunately there are no absolutes in this matter and most will depend on pilots' experience and sensitivity in perceiving those changes.

6. Simulator Calculation Engine

As anticipated in the introduction the main "Simulator Calculation Engine" is a simplification and an abstraction encompassing all the software and hardware components accomplishing all the calculations and data processing needed to run the simulation. It is probably the most well-guarded secret of simulator manufacturers, given that the accuracy, fidelity, and reliability of those "Internal Algorithms", will give them the edge against competitors. From the point of view of a user, it is the black box that contains all the processes that will generate the simulation outcome. Simulator operators (let alone users…!) have little possibility to intervene in the mechanics of those processes. If changes or improvements are sought, they would generally start as proposals to simulator manufactures. Those changes would be then introduced into following versions of the simulator software. It is important to remember that simulators, to provide the highest level of fidelity and realism, are composed of any extremely high number of moving parts. Each part could be a software module dedicated to the execution of specific tasks (i.e. signal processing for bridge instruments) or a piece of hardware able to perform a specific operation (i.e. line controls in a tug simulator to slack and lock the towing line). All these parts are inextricably interconnected and must harmoniously interact and operate in sync in a network of hundreds of computers and electronic devices… not an easy endeavour, ask any simulator system manager!

So, in this context, what can be controlled by simulator operators and or by users?

…enter Port and Ship Models!

Port of Townsville Container Terminal

6.1. Port and Ship models

Port and Ship models are databases, a collection of information in the form of datafiles, tables, coefficients, parameters, able to mathematically define and describe a specific port or a specific ship.

They are generally sold (or leased) by simulator manufacturers separately and individually. In other words, a simulator centre, based on its scope and the needs of its clientele, will obtain from the manufacturer a certain number of ship and port models. Once those models will be made available into the simulator, at the beginning of an exercise, the simulator operator will be able to select from a list of options, the desired port where the simulation will be set and the ship or ships models that will take part to the simulation. These would be the minimum requirements to define an exercise and conduct a simulation.

Given the costs involved in terms of time and specialised knowledge required, accuracy and scope of the data collection needed to create ship and port models, many centres simply rely on manufacturers' off-the-shelf libraries. Some simulator centres, though, may develop the capacity to internally develop or modify those models, using dedicated software. Modifying those databases though it's not an easy task and, not being fully aware of how those parameters and modifications may interact with the simulator algorithms, might cause unforeseen and time consuming issues.

Let's have a closer look at what ship and port models contain. A ship model defines a ship in her static and dynamic characteristics. Static parameters would include: shape, dimension, colour of the hull and superstructure just to mention some. Dynamic parameters will define how the ship will behave and interact with the surrounding environment: resistance coefficients, engine characteristics and power, RPM – speed tables, aerodynamic and hydrodynamic coefficients… the list is endless. The amount of data that will populate the database will obviously have an impact on the level of accuracy, which in turn will have an obvious bearing on the cost of the ship model. As you can well imagine it is not simply a matter of quantity, but often and most importantly a matter of quality of the data included in a ship model. How and from where is that data obtained? Sometimes manufacturers and simulator centres may provide clients with some information, in the form of ship model booklets. In those booklets it might be reported if the ship model proposed was obtained, for example, from a full-scale trial at sea (best and most rare scenario) or using models in a wind tunnel or in a towing tank. It is not rare at all to have ship models simply derived from other models (scaled up or down) with dynamic characteristics based on software calculations…

Similar considerations can be made with regards to port models. Those too are databases, collating all the information necessary to recreate a port in a simulator. A port model will include, among many more other details, bathymetries, current, wind and tide maps (as seen in previous paragraphs, available to the operator during the simulation). This data will have an extremely deep impact on the outcome of the simulation, being directly fed to all the algorithms that are processing the ship behaviour. Other information might be less relevant for ship motion calculations, but still extremely important for the overall realism of the simulation. An example is the 3D rendering of the objects that are present in the port, such as buildings, trees, and elements specifically relevant to pilotage, such as navaids lights and beacons. Again, the richness and accuracy of those details will have an impact on the port model cost. As per ship models, also for port models the same questions would arise: How accurate, relevant and up to date is the information included in the model? As it can be easily imagined, a difference for example in bathymetries between simulated and real port would dramatically change any ship behaviour, regardless of the fact that the port might look aesthetically very similar. Same considerations would apply for example to wind, tide, and especially current maps.

Understandably, validation is an important issue for both ship and port models. Very often, models are judged simply using "face validity" criteria (Sargent, 2010), which basically is asking people knowledgeable about the system whether the model and or its behaviour are reasonable… basically Pilots and Ships Captains are asked to play with ship and port models and provide their feedback. After few reiterations, models may be refined based on feedback, but to the knowledge of the author, to this date, there is no absolute and or standardised measurement to define the accuracy of a port or a ship model as a whole or as a combined measurement of other elements.

7. Conclusions

The previous paragraphs have provided a general description of what are the components of a generic shipping simulator and their role. For each one of those components, identified as separate blocks in Figure 1, we have highlighted differences between simulation and reality, providing specific practical examples.

One of the obvious considerations that was mentioned was that shipping simulators are extremely complex calculators. Thanks to the most recent advances in technology, these calculators can simulate with high levels of realism, complex manoeuvring scenarios. To this date, though, it has not been clearly defined nor measured what "high level of realism" actually means. There is no absolute measure providing an indication of to what extent a simulation is able to replicate reality. Simulator manufacturers, operators and users, simply agree on the fact that what they are sharing is as good as it gets, and it is the best possible option other than risking crashing a real vessel in a real port.

As any other calculator, to obtain correct results, simulators require the introduction of correct data. In case of simulators, the sources of data could be many and the reliability not always perfectly known. This should be very well considered, before launching into a simulation and make important decisions based on simulator outcomes (such as deciding a new process, procedure, a change in safety limits, a reduction in tug numbers or to mitigate a PIANC requirement). Results are strictly dependant on the accuracy of the algorithms and the parameters adopted. Given that the algorithms are not accessible, failing to at least address the need to adopt the most updated and comprehensive data, relevant to the scope of the simulation, may lead to absolutely no benefit to conduct the simulations at all.

Fine tuning ship and port models is a reiterative process that can be extremely time consuming and still based on subjective criteria (face validity). This process virtually never ends and might often translate into non negligeable recurring costs.

In the end, by definition, models are simplifications and, as such, can only replicate reality to a certain extent. Not only ship and port models are simplifications, but so are simulations as a whole. A simulator exercise is a simplification of a shipping movement carried out in very specific and controlled conditions. The duration of an exercise can be measured in number of minutes. This undoubtedly can offer an enormous advantage in training, because exercises can be repeated at will, isolating specific shiphandling effects, under well-defined circumstances, in the comfort of a nice air-conditioned environment. In this context, the simpler the better, since simplicity allows trainees to effectively focus and absorb the content that was meant to be conveyed through the simulation. Similar considerations could be extended to port development studies, where the problem needs to be well circumscribed, and conditions and parameters need to be limited by the scope of the simulation.

Can we extend the same logic to any "ordinary" day on the water or any "ordinary" pilotage job? Ecological validity examines whether the results of an activity can be generalized to real-life settings (Andrade, 2018). Put simply, reality, compared to a simulator, can be much "noisier", meaning that it is limitless the number of interfering and unexpected events that could suddenly become part of the equation: from the most exotic leisure boat coming out of the blue and not responding to radio calls, to the classic blackouts and engine failures… in some ports, transits can last hours, increasing the probability of those unexpected and unpredictable events, especially when the attention might not be at its peak. Reality is "messier" than a simulator, considering for example the joys of being out on a bridge wing, shouting orders in a handheld, when it's howling and bucketing rain… Errors in a simulators are inconsequential, while sometimes life changing in the real world… No pressure there!

Can a simulator be ecologically valid to the point that it can entirely substitute training on the water? Lacking objective measurements in this regard, any argument towards or against it can only be regarded as an opinion. If in doubt, though, it might help to consider that training on the water, with real ships, in a real port, might actually be able to provide the highest level of realism possible…! (Even though not the focus of this article, let's not forget that another important training option available on the market are man models…)

So far, we might have only considered the shiphandler as an individual, concerned only about the conduction of his / her own vessel. Is this what a Marine Pilot really is? A simple shiphandler? Referring to Figure 1 it is possible to notice a buffer between the "Shiphandler" block and the "Ship Controls" and the "Additional Forces" blocks. In that buffer it is possible to read the names of some of the other fundamental participants that, in reality, take part to port operations. In this context, and as well detailed in paragraphs 3 and 4, a Marine Pilot is part of a much more complex organism. Shiphandling is only one of the many tasks that the pilot is carrying out. Monitoring traffic and future passing with other vessels, monitoring communications with VTS, monitoring and prompting changes in services allocation should meteorological conditions require, monitoring movements of local traffic in the port… these are all tasks that a marine pilot must seamlessly accomplish, while assessing and adapting to the ship's maneuvering characteristics and the crew level of competency… Based on pilot's experience, early and pre-emptive actions can avoid the development of dangerous situations well before the risks become evident to most. That is why experienced and proficient pilots generally prefer not to demonstrate outstanding shiphandling abilities trying to avoid last second disasters…

The irony is that the most proficient pilotages are actually the most inconspicuous!

As explained in paragraph 5.3. and 5.4. the job of a pilot does not simply start when he / she arrives on board, but much earlier, when the job is allocated and critical decision may be required in terms, for example, of towage and timing. At its peak, during a manoeuvre, there could be a lot going on, considering the need to, not only conduct the vessel, but also effectively and safely coordinate the actions of all the other participants, like tugs, linesmen, and launches. The increase in complexity and number of tasks at hand, increases mental workload and this may take a toll on the capacity to effectively maintain situational awareness (Orlandi & Brooks, 2018). Through exposure and deliberate practice (Ward, Hodges, Williams, & Starkes, 2004) (Krampe Ralf Th & Anders, 1996) pilots gain familiarity with the port and its local processes and idiosyncrasies , shifting many of those tasks to an automatic execution (Logan, 1985) (Singer, 2002). Automaticity, in turn, allows a reduction in pilots' workload (McKenna & Farrand, 1999), freeing mental resources to potentially manage the unexpected. This amount of automatic processes and implicit knowledge, become what in the industry is known as "local knowledge". It is important to understand that this learning and those adaptations do not happen overnight.

The use of technology, in the form of PPUs, can certainly help the pilot in some of those tasks, though, it might be worth to remember that, as per today, no PPU on its own has been able to drive a ship (yet). Who knows what the future will bring…! The abrupt introduction of major changes carries its own risks, especially when there is little consideration of how those changes are going to integrate within the whole system already in place. Technology on its own might not be enough without people actively taking part (Dekker S, 2008).

In the meantime while autonomous vessels are starting to appear at the horizon (…but this is a topic for another article!), as thoroughly discussed in paragraph 3, pilots around the world are still conducting their vessels giving rudder and engine orders.

Dr. Luca Orlandi
Brisbane Marine Pilot

References

Andrade, C. J. I. j. o. p. m. (2018). Internal, external, and *ecological validity in research design, conduct, and evaluation. 40(5), 498-499.*

Dekker S, H. E., Woods D, Cook R. (2008). Resilience Engineering: New directions for measuring and maintaining safety in complex systems. Retrieved from https://pdfs.semanticscholar.org/a0d3/9cc66adc64e297048a32b71aeee209a451af.pdf

Donatini Luca, Vantorre Marc, Verwilligen Jeroen, & Delefortrie Guillaume. (2019). Description of hydro/meteo data in ship manoeuvring simulators: A survey on the state of the art. Ocean Engineering, 189, 106344.

FAL. (2020). Ongoing challenges to ports: the increasing size of container ships. Facilitation Of Transport And Trade In Latin America And The Caribbean, 3(Bullettin 379).

Jayarathn, B., Ranmuthugala D, & Fei J. (2014). Accuracy of potential flow methods to solve real-time ship-tug interaction effects within ship handling simulators. TransNav: International Journal on Marine Navigation Safety of Sea Transportation, 8.

Jayarathne Nirman, Ranmuthugala Dev, & Leong Zhi. (2019). Safe tug operations during ship-assist manoeuvres. The Journal of Navigation, 72(3), 813-831.

Krampe Ralf Th, & Anders, E. K. (1996). Maintaining excellence: Deliberate practice and elite performance in young and older pianists. Journal of Experimental Psychology: General, 125(4), 331-359. doi:10.1037/0882-7974.3.2.122326825010.1037/0882-7974.3.2.1221988-29162-001

Lo, D., Su, D.-T., & Chen, J.-M. J. T. J. o. N. (2009). Application of computational fluid dynamics simulations to the analysis of bank effects in restricted waters. 62(3), 477-491.

Logan, G. D. (1985). Skill and automaticity: Relations, implications, and future directions. Canadian Journal of Psychology/Revue Canadienne de Psychologie, 39(2), 367-386. doi:10.1080/00140137808931800 10.1037/0033-295x.84.2.127.

McKenna, F., & Farrand, P. (1999). The role of automaticity in driving. In G. B. G. (Ed.) (Ed.), Behavioural Research in Road Safety IX (pp. 20-25). Crowthorne: Transport Research Laboratory.

Orlandi, L., & Brooks, B. (2018). Measuring mental workload and physiological reactions in marine pilots: Building bridges towards redlines of performance. Applied Ergonomics, 69, 74-92. doi:https://doi.org/10.1016/j.apergo.2018.01.005

Sargent, R. G. (2010). Verification and validation of simulation models. Paper presented at the Proceedings of the 2010 winter simulation conference.

Singer, R. N. (2002). Preperformance state, routines and automaticity: What does it take to realize expertise in self-paced events? Journal of Sport & Exercise Psychology, 24(4), 359-375.

Vantorre, M., Verzhbitskaya, E., & Laforce, E. J. S. T. R. (2002). Model test based formulations of ship-ship interaction forces. 49, 124-141.

Ward, P., Hodges, N. J., Williams, A. M., & Starkes, J. L. (2004). Deliberate practice and expert performance. Skill acquisition in sport: Research, theory and practice, 231.

Port Kembla Dusk

The Captain's Finger

$270,000 USD in Cash – That will do nicely.

Saga Ruby was nearing the final part of her US and Canadian cruise. An unusual cruise for Saga, with the ship departing Southampton on the 18th September 2009. The ship made a traditional trans-Atlantic crossing to New York with seven full days at sea, followed by a 14 day cruise to New England and Canadian ports. The plan was to then to return to Southampton with another trans-Atlantic crossing. In total this was a 30 day cruise.

Customers had already had one call to New York and this was to be the second before the final crossing back to the UK. The ship had called to Newport, Rhode Island the day before and entry formalities into the US had been completed there.

The New York river pilot had been picked up at the Ambrose pilot station at 04:00 hrs and the vessel made her way up the Hudson without incident. Many customers had woken early to be on deck to watch lower Manhattan slip past as Saga Ruby navigated up the Western side of the island.

As the vessel approached the passenger piers the docking pilot joined the ship via a shell door just above the waterline. New York is unusual in the practice of the docking pilot works for the tug company that docks the ship. By ordering your tugs for berthing, you employ the docking pilot, who is an associate of the tug company.

Pier 88 was the destination, on the South side of the pier. To achieve docking on these piers, that are at right angles to the Hudson river, passenger ships need to stem the current and then swing smoothly to starboard, while starting to move ahead into the basin and driving the stern up into the river. This is not a manoeuvre for the faint hearted. Too little power and the vessel will drift down onto the next pier, too much power and the ship will end up closer to Manhattan than planned!

Both the docking pilot and the Captain had berthed on this pier before but had not done so for many years. Since their last visits the apron of the pier had been widened considerably to make the berth more functional for loading large modern cruise ships.

The ship started the starboard swing with two tugs assisting. The trick was to keep the bow as close as possible to the corner knuckle and once passed, then as close to the berth as possible. This way ground was not lost drifting onto the lower pier. The deck officer on the forecastle relayed distances to the bridge, who were also observing the passenger terminal roof top immediately in front of them.

Judging distances as a ship swings is always tricky, you have to estimate how close the swing will take you to the closest point, in this case the corner knuckle.

"Clearing 10 meters on the corner" The deck officer passes to the bridge.

"10 meters on the corner" replies the bridge, in what is know as closed loop confirmation.

This is a manoeuvre that if the bow clears the knuckle by a small distance, the manoeuvre is hailed as great feat of seamanship, watched by admiring customers from the boat deck.

Another six inches and this would have been one of those great manoeuvres, close but forgotten. As it was it was six inches too short.

An immovable object met an unstoppable force. The immovable object was a new steel bollard built on the corner of the new apron, while the unstoppable force was a 24,000 GRT ship, built of highest quality British steel, swinging rapidly to starboard.

For a fraction of a second, the huge forces pitted themselves against each other, before the stem of the ship fractured spectacularly. The sound could be heard at the other end of the passenger terminal as a 190 m tuning fork was struck.

In the last moments before impact, the bridge team and docking pilot realised what was about to happen. Orders were passed to the attendant tug on the starboard side which summoned full power, resulting on a plume of black funnel smoke.

"How bad?" was the radioed message from the bridge.

"Bad enough" was the short reply. There was no closed loop given.

****

An hour later the ship had been cleared for customers to go ashore. Having entered the United States the day before formalities were quick.

Passengers were streaming ashore for their day in Manhattan. They were looking happy, their cruise that had been drawing to a close, was being extended by the minute. There were rumours of days to be spent in New York while repairs were made and the prospect of complementary tours, or even a cruise credit.

Strutting the other way down the passenger terminal was a contingent of US Coast Guard Officers, looking grim faced and smart in their crisp white shirts with medal ribbons. This ship was going to be detained and a USCG inspection would take place through the day to add to the ship's woes.

Any ship with a large hole in its hull is not seaworthy and will not be allowed to move. The harbour master placed a manoeuvring restriction on the ship.

Urgent meetings were held on board with the senior officers and the Operations Director, who was in New York for this call. The port agent was tasked to find available options for a repair facility, either remaining on this berth or elsewhere in the New York Metropolitan area.

It now became apparent that the timing of this incident was about as bad as it could be. It was a Saturday, with cruise ships booked onto all passenger piers for the next two days. Not only that but this was a long holiday weekend with the following Monday being Columbus Day, a New York State and a Federal holiday.

By mid-afternoon the options were becoming clear. The only repair facility was the Bayonne Drydock & Repair Corporation, to be found down the river and on the other side from Manhattan. The yard sent a manager over to Manhattan to assess the scope of the repair. Classification and insurance surveyors attended the ship.

The yard manager left the ship and a while later an estimate was received. It was a long list, berthing on the Cape Liberty Cruise berth where the repair could be conducted $, security $ weekend overtime $ tugs $ longshoremen $ freshwater $ garbage $ repairs $$$. The amount to the repair yard alone came to over a quarter of a million dollars.

This was not a known cruise client to the ship yard. They had regular American cruise ships in their facility, principally Royal Caribbean, but this was an unknown British company operating a classic (old) cruise vessel. They were taking no chances; it was to be payment upfront.

Calls were made back to the UK about transferring this sum of cash but being the weekend the banks were closed and the earliest date of a bank transfer would be the following Tuesday! This would be three lost days, followed by the

time to make the repair, this could push the cruise back by six days, eating into the next cruise.

Would they take cash? Yes that would be very acceptable. The Chief Purser was asked how much cash was held in the ship's safe, normally used for paying the ship's crew part of their salary.

Permissions were obtained to have the detaining order lifted, with a strict set of conditions put into place for the short move down the Hudson.

And so early the following morning the Saga Ruby left Pier 88 in Manhattan, vacating the berth for the next cruise ship to arrive and steamed down the river. The Manhattan skyline was on their port side and to Starboard was a grandstand view of Ellis Island and the Statue of Liberty.

The ship berthed on the Liberty Cruise berth which is immediately adjacent to the Bayonne Repair facility. This was a perfect combination, customers could safely disembark into coaches to be taken on complementary tours, while equipment, cranes and welders had easy access the ship. The cruise berth had superb views across the Hudson to Manhattan and the area around the berth is a memorial park to those who lost their lives in the Twin Towers.

The duty dry-dock manager came on board to collect the payment for the work to be undertaken. He was the typical blue-collar American manager, stocky and dressed in jeans with a checked shirt. He was taken to the Chief Purser's office and the door was closed and locked before the ship's large safe was opened. The Chief Purser started to expertly count out bills, making stacks of $10,000 a time. Slowly her desk was covered in stacks of varying sizes depending on the denominations used. Given this was going to empty the whole safe, and some of the stacks consisted of small bills, some of the stacks were high. This was all outside of the experience of all involved and the dry-dock manager's professional manor gave way to chuckles, followed by laughter and eventually tears as the final sum was reached. A receipt was printed and signed by the manager, while wiping tears away. The Purser found a large plastic bag and all of the cash was bundled together with elastic bands, placed in the plastic bag which was then taped up. The dock manger left with a large plastic bundle under his arm, still chuckling.

Work continued throughout the afternoon, initially by building a working platform which was welded to the ship, before cropping out the damaged steel. Finally, new plates were inserted, and a neat weld made around the repaired area. Ships crew then applied two coats of paint and by the early hours of the third day in New York, the repair was completed.

Customers were dispatched on complementary tours for the third day. The ground handler and the shore-excursion team worked each day to design new tours for the following day and have these ready so the customers could make their choice the evening before.

Now repairs were completed all that remained was for inspections to be made by the Classification Society, Insurers, United States Coast Guard and the final approval given by the UK flag of the vessel, for the vessel to depart New York and head east across the North Atlantic.

Seven days later the Saga Ruby arrived in Southampton, only 40 hours behind schedule, and was able to commence the following cruise the following day.

New York bash delays Saga Ruby - Captain Greybeard

All photographs taken by the author.

Capt. Grant Laversuch

Head of Group Safety & DPA at P&O Ferries

News from Smartship

Despite the continued impact of COVID travel restrictions, it's been a busy few months at Smartship.

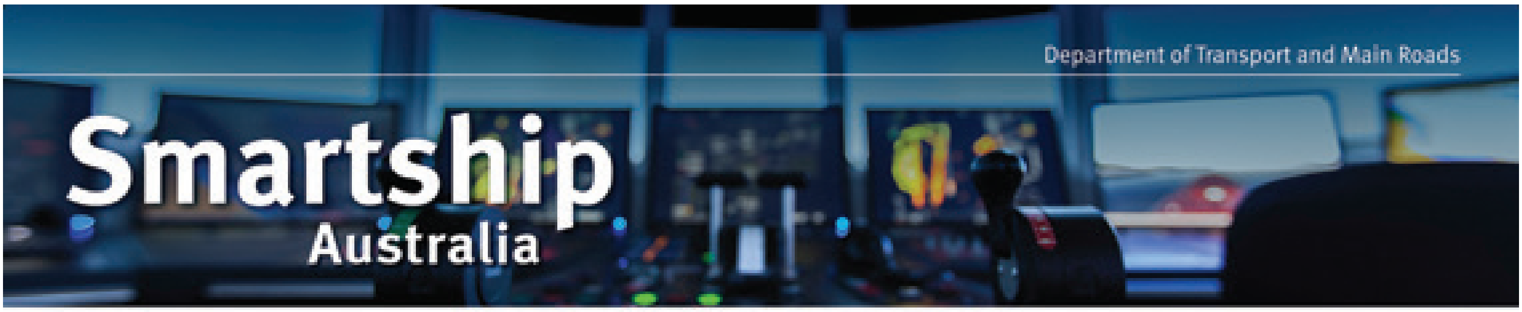
Following the COVID lockdown in late July/early August, the first AMPT in the new meeting facilities were conducted. By December, the facilities will have hosted three BRMs, a further AMPT as well as a number of bespoke workshops and seminars.

The seminars have included two examining the marine investigation process. These seminars have been well received and provide a baseline of understanding about the core concepts of marine investigations and what to expect from the process.

The room is equipped with a state-of-the-art audio/visual system which provides an excellent teaching and learning resource. The restrictions on travel have resulted in a stronger focus on Queensland pilots, ensuring training is up to date. As travel restrictions ease, we expect strong re-engagement with inter-state and international customers.

Tug operations have been in full swing with several tug companies undertaking contingency training for their Tug Masters. This work will progress further once borders re-open.

Ship technology



"A world-class ship simulator centre serving the global maritime industry".

Services include

- Advanced Marine Pilot Training
- ECDIS
- Bridge Resource Management
- Ship Handling and Bridge Team Management
- Check Pilot training
- Azipod Training
- Tug Handling

Smartship provides cost and risk effective solutions that deliver a range of economic and safety benefits for its customers and their stakeholders.

About us...

A purpose-built, state-of-the-art maritime simulation and training facility with a core focus on pilotage professional training and development, advanced ship handling and port development.

Pricing and timing of courses

For the latest dates and current pricing, see Smartship's website for details or contact Smartship.

Booking contact: **Peter Listrup** peter.listrup@smartshipaustralia.com

Location
Da Vinci 3.03, Boronia Road,
Brisbane Airport, QLD 4009

Phone
General enquiries +61 7 3358 9300
AEDT during business hours

Website
www.smartshipaustralia.com

News from Port Ash – October 2021

With brief exception, the Winter weather was good but alas with few courses to take advantage of it! Spring has been typical – a mixture of calm days and windy ones - a bit of rain thrown in with temperatures alternating between summer and winter levels. A La Nina is forecast which means higher than average rainfall for spring and summer.

While Newcastle and the Hunter Valley continue to have Covid cases, our particular area has had mercifully few. Stay-at-home lockdowns due to the delta variant ceased recently and are being further eased. The Pacific Highway visible through the trees, is slowly coming back to life after being virtually empty during lockdowns. Whatever else might be said about the pandemic, it has been a joy to drive on traffic-free roads with only the occasional large well-behaved truck as company. A parallel exists on the water where big ships behave themselves, but fishermen and pleasure boats are another story.

Despite all, the lake is full, the ships in good condition, the team is still together and the busy spring wildlife is beginning to wind down and prepare for the summer's heat.

We had a few courses over the winter months before the delta variant locked borders and the country again ground to a halt. One memorable course was a group from Toll Shipping whose modern twin-screw ro-ro ships run across the Bass Strait like clockwork. The course for them was one of general education and the revelation of 'oh – is that how it works' which I remember from my own introduction to ship models.

The New Zealand travel bubble was briefly open too but not for long, then weeks on care and maintenance with a handful of essential Navy courses delivered with borders firmly closed to pilots. Next year however is looking busy starting with US Pilots from Houston and Puget Sound booked for February.

There's been little drama in the shipping world lately unless we count the long queues of boxships at anchor around the world. The Ever Given quickly became ever forgotten as the world moved on but some good lessons on the girding of tugs appeared in a recent news clip. A large Brazilian three-masted training ship was washed beam-on to a bridge in a strong current. There appeared to be little damage and she was pulled clear by two tugs, the smaller of which was towed stern-first, then girded and capsized with no casualties.

As a towing incident, it is a world away from daily manoeuvres with modern omni-directional tugs. Towage incidents are largely a thing of the past in our world, but occasionally, small tugs are used for ship-assist or unusual

towage tasks. Their masters are often unused to ship-assist work, and on one dead-ship whaling vessel ('No whaling vessel Mr Pilot - fishing vessel'), I recall shouting to the after tug 'put a gobline on it'. There were blank looks but with a bit of explanation they bowsed/gobbed the towline down to the transom and we towed the tug stern-first towards the floating-dock in complete safety. Gobline is an old term and I don't know its origins – anybody?

I berthed a ship at Kooragang one day and while mooring, glanced over the water towards the (then) Steelworks area. A small tug was righting itself after being pulled over by a departing pilot-exempt tanker. Fortunately there were no casualties.

Towing with conventional tugs on long lines is largely a lost art in this part of the world and occasions such as this are rare. But in the last 20-odd years we have seen three girding capsizes in Australia, one with loss of life and all investigated by state bodies. Because of the rarity, it is quite possible that even the words 'gird/girt' and 'gobline' will be forgotten and tugs will continue be pulled over and capsized on rare occasions.

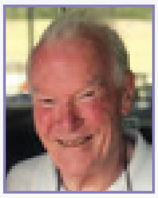
The subject is covered here briefly at Port Ash and is referred to in Henk Hensen's recent Fourth Edition of 'Tug Use in Port in which you will see a staged picture of a tug-model being girded.

Incident rarity is always a problem and use of anchors is another one. They are looked upon as 'old hat' by some and therefore not to be considered. The subject comes up occasionally when an incident occurs such as towing a dead ship back to the berth stern-first with a tug and short-stay anchor such as happened in Port Pirie a couple of years back. Rarity is of course the reason for practising these events in refresher courses.

Towing stern-first is something we demonstrate every course usually with the scenario of a dead ship alongside and a fire on the wharf, but there are other scenarios. Ideally, facilitators teaching here will have some experience in the use of anchors, but with the proliferation of tugs and thrusters it is increasingly rare.

The 9m long newbuilding model of the RAN HMAS Supply has been even further delayed when the builder's family was affected by the Covid virus and all concerned had to be quarantined for two weeks. He was unaffected but it is just another delay on other delays.

Wishing you safe ladders, smooth seas, a good lee, virus-free ships and – glancing at the calendar - a Happy Christmas!



Cliff Beazley & the Team
Port Ash – October 2021


Accurate
Realistic
Affordable
AMC Search simulation technology will bring your next maritime project to life.
www.amcsearch.com.au/simulation
AMCS
AMC SEARCH

News from AMC

For many years, the Australian Maritime College (AMC) has been designing and creating hydrodynamic models for use by commercial clients on projects in the Centre for Maritime Simulations in Launceston. These models have been used successfully to deliver training to pilots and other seafarers, whilst providing a platform to model new ports or to examine the impacts caused by changes to existing infrastructure.

Due to demand from the maritime industry on these services, and AMC Search's continual improvement and investment strategy, this model making capability has recently been extended by the employment of a full-time hydrodynamicist, Dr Zhen Kok.

Zhen is a recent graduate of the National Centre for Maritime Engineering and Hydrodynamics at the AMC, recently being conferred with a PhD following his thesis investigating Ship Squat.

The increase in demand on our services is coming from multiple angles within the maritime industry including working with clients looking at the risks associated with the introduction of larger tonnage in port or ships of novel design.

A recent model produced by Zhen is of a shallow draft trans-shipment vessel for a South Australian client. This model was based on a ship fitted with four shafts driving fixed pitch propellors, and two rudders fitted aft of the outboard shafts, plus bow thrusters.

The unique arrangement of propulsion and steering was modelled to behave as the real ship would to the satisfaction of the ship's Master.

This client operates from a small port, requiring the team at AMC to create an entirely new port model for the trials, which again met the expectations of the ship's Master.

These two models, ship and port, were highly accurate enabling the client to understand how the new vessel will behave and respond to conditions in her new home port which directly aids investment and design decisions.

This new model joins a series of other models recently developed at AMC including Rotor Tugs, Ro-Ro vessels, ice-breakers, and several new port areas.

This precision and accuracy is essential when producing models for use in simulated environments, but they are often out of reach to commercial operators due to the cost and time it takes to produce such models.

With the expansion of the internal hydrodynamics team at AMC Search, it has been able to significantly lower costs and rapidly increase turn-around time in the production of these models making them affordable and accessible to the maritime industry.

For further information about the AMC Search hydrodynamic vessel and area model making capability contact Captain Richard Dunham, Manager of Commercial Simulations richard.dunham@amc.edu.au

GENERAL NEWS

Flinders Ports achieves IPSO accreditation

Flinders Ports have announced that Port Adelaide and all of their regional ports, including the Spencer Gulf cape size passage route, are now officially accredited by the International Standard for Maritime Pilot Organisations (ISPO).

This is a significant achievement for Flinders Ports, as they represent one of just four Australian organisations to have this accreditation.

Darwin Port achieves ISPO accreditation

Darwin Port has achieved its International Standard for Maritime Pilot Organisations (ISPO) certification for its commitment to safety and quality management systems. ISPO is a standard of best practice for pilots and pilot organisations, which focuses on improving safety and quality.

Verified by Lloyds Register, the international accreditation is highly regarded with a certificate only awarded once strict safety guidelines have been met with Darwin Port the 30th pilot organisation to receive the accreditation.

Darwin Port General Manager Operations, Captain Ian Niblock, said "we were confident that our pilot service was operating at international best practice standard, and to have this confirmed by such a prestigious organisation verifies this and assures our customers of the high safety and quality pilot service we offer."

Darwin Port CEO Darren Lambourn said the certification endorses the Port's commitment to safety and continued focus to deliver an international standard of service to its customers.

"Achieving this International Standard recognises Darwin Port as a safe gateway for developing and expanding industry in Northern Australia," he said.

"As we expand our workforce and train new pilots they will benefit from training under this certification," he said.

Regional Harbour Master Captain Anil Chadha said the accreditation confirms Darwin Port's commitment to safety and quality.

"We're pleased to see Darwin Port Pilots have achieved their ISPO certification," he said.

"International accreditation ensures we are all working together to international best practice standard to make the Port a safer place to operate."

Port Authority of NSW brings in deeper container ships using OMC's DUKC

Port Authority of NSW's pilotage and VTS teams helped break records at Port Botany on Friday 15 October when they played a part in the safe arrival of the deepest and heaviest container ship ever at the port, and possibly the deepest container ship to berth at any port in Australia.

The ship, MSC Asya, came in with a draught of 14.8 meters and a displacement of 140,252 tonnes. The DUKC (Dynamic Under Keel Clearance) technology used by PANSW at the port allowed for accurate predictions of the under-keel clearance required to berth the ship safely, by factoring in all the complex conditions required including the ship's weight, dynamic motions of the vessel and live weather conditions.

Port Authority of NSW Sydney Harbour Master Myron Fernandes said Port Botany handles ships of similar lengths and capacity regularly, but the MSC Asya is the deepest and the heaviest containership yet to call at Port Botany.

"While the DUKC is an important part of what made it possible to bring a ship with a 14.8-metre draught into the port, the work of the pilotage and VTS teams in this achievement was equally as important," he said.

"We've now proven that Port Botany can accommodate ships with similar draughts easily and safely."

Myron noted an important aspect of this achievement is being able to safely manage ships with deeper draughts which means facilitating greater cargo carrying capacity.

"Through this recent achievement, PANSW has managed to showcase greater efficiency and capacity outcomes at the port without the need for significant changes in infrastructure," Mr Fernandes said.

OMC's CEO Peter O'Brien said as the containerships that call Australia get bigger, being able to manage ports more efficiently and safely is increasingly important.

"Risk mitigation is an important part of what DUKC does. It allows port managers to bring larger vessels in, and do it more safely, "Mr O'Brien said.

Pilbara Ports Authority has another record year

The Pilbara Ports Authority has achieved another record-breaking year, with a total annual throughput of 724.7 million tonnes.

This strong year-on-year performance follows Pilbara Ports Authority exceeding 700 million tonnes for the first-time last financial year and represents an increase of 14 per cent over the past five years.

Pilbara Ports Authority CEO Roger Johnston said the organisation's strong performance was a result of improved port efficiencies, which has helped to meet the strong demand for iron ore exports.

"The investment to increase the Port of Port Hedland's capacity is paying off, with the enhancements resulting in an expanded shipping window to enable more vessels to sail on high tide per year, as well as increasing the amount of product that can be safely loaded onto vessels," Mr Johnston said.

"Pilbara Ports Authority has contributed to Western Australia's enviable economic position, with the value of commodities passing through our ports in 2020-21 estimated to be in excess of $155 billion – this is a 29 per cent increase compared to the previous year.

"This is a testament to the ports continuing to operate at full capacity throughout COVID-19, with Pilbara Ports Authority navigating border closures and strict maritime regulations to deliver safe and reliable operations for the benefit of the resources sector and the State of Western Australia."

The Port of Fremantle handled its highest number of containers last financial year

The Port of Fremantle handled its highest number of containers last financial year, in spite of the COVID-19 pandemic affecting supply chains around the world.

In 2020-21, there were 807,061 TEU (standard container measure) handled at the port.

This represents a 3.0% increase since 2019-20 and included a full container trade increase of 0.7%.

Full container imports were up 5% with major increases due to people buying furniture (up nearly 23%) and household appliances (up 38%).

Full container exports were down as hay and animal feed, a major export in containers to Japan for its dairy and horse racing industries, slowed.

Wheat exported in containers was also down on the previous year as Western Australia had, in recent years, picked up some overseas markets usually supplied by eastern states that were affected by drought. Now that the eastern states have recovered from drought conditions, they are recovering their markets.

Largest bulk carrier to berth at Queensland Bulk Terminals in Brisbane

Recently Brisbane Marine Pilots were requested to assist with trials to bring panama-size bulk carrier to Queensland Bulk Terminals to load wheat for export. This is the first time a ship of this size has called at QBT and was the result of professional collaboration between Brisbane Marine Pilots, Queensland Bulk Terminals, Port of Brisbane and Maritime Safety Queensland.

Maneuvering a vessel of this size upstream in the Brisbane River required complex planning to establish safety parameters and validation of the results of work undertaken. To fully understand the complexities of this manoeuvre, a highly experienced group of Brisbane Marine Pilots worked collaboratively with key stakeholders to plan the execution of the movement and safety contingency responses.

Marine Pilot on the Radio

Queensland Bulk Terminal

Brisbane Marine Pilot's, Captain Peter Liley, was involved in the simulator planning and the arrival of the vessel on 20th October 2021 and shares his thoughts on the reality of ship-handling versus the results of simulator exercises.

A simulation of the vessel's passage was conducted using a hi-fidelity, full mission bridge simulator. The various scenarios were adjusted to test the working environmental limits for this type of manoeuvre.

The simulated model of the ship handled particularly well with almost no need for rudder adjustment or account for leeway. This was not consistent with our own knowledge of our port. These inconsistencies were noted, and conservative limits were set for the first visit.

As we expected from our experience in the river, a strong quartering wind and a full ebb tide made for a more challenging manoeuvre than the simulated forecast. Limits were set for the initial visit for the vessel to swing on the last of the flood tide and berth on high water.

Upon arrival, the real ship handled as we expected it to from our experiences on the river, not as forecast by the simulator. With an initially strong flood tide at the start of the river transit, the ship required close attention to set and drift, as any practicing Brisbane pilot would have expected.

The process of determining safe working parameters will continue as required by the BMP Safety Management process of continuous improvement as more ships of this size continue to call at the berth.

It was however experience in this port, knowledge of this class of vessel and the knowledge of the Brisbane river in practice is what enabled a safe passage on arrival and departure. Reliance solely on the simulation model could have led to close quarter situations in several instances.

This trial highlighted the value of simulators in contingency planning and safety management, however it is the days, months and years of navigating the Brisbane River that a Brisbane Marine Pilot brings to real world situations that allow for the safe and efficient management of the expanding vessel trade to the Port of Brisbane.

The expertise required to undertake such manoeuvres isn't achieved in 12 months. Nor is it achievable based just on simulated conditions. It is the result of years on on-water training and deep, historic knowledge of the port in all conditions, provided by our Brisbane Marine Pilots.

Pilotage isn't just about safety, but it is also about supporting trade opportunities whilst ensuring the safety of port infrastructure, the environment and the local community. It's what Brisbane Marine Pilots have been doing for over 33 years.

PAN PEER ASSISTANCE NETWORK

Caring for Marine Pilots and their families

WHAT IS PAN

AMPI established and continues to finance a Peer Assistance Network to give support to Marine Pilots and their families.

PAN Members are Marine Pilots who come from a variety of ports around Australia we are trained and committed to supporting the well-being of our peers.

SUPPORT NETWORK

PAN is designed to provide support over the phone. Initial contact can be made to a Marine Pilot peer who is on our list of trained PAN Members.

PAN Members are trained to listen and offer support in a non-judgemental way, AMPI also has retained the services of a professional counsellor who you may also wish to contact.

WHAT CAN I CONTACT PAN ABOUT?

Any issue at work or home that may be causing you difficulty. Common issues we see are relationships, problems at work, training and/or assessment problems, health, stress, fatigue and financial issues.

If you have ANY issue causing you concern you can talk to a PAN Member.

PAN IS CONFIDENTIAL

All PAN members sign a deed of confidentiality and they know that this is the main principle that ensures PAN continues to to work effectively.

The PAN network provides an independent confidential place for you to freely discuss your problems.

PAN MEMBERS

Kirk Whitman
Sydney - 0410 475 006

Neil McKenzie
Sydney - 0437 704 571

Lyndon Clark
Sydney - 0404 042 591

Jacqui Kenyon
Sydney - 0405 443 483

Jon Dicker
Melbourne - 0427 378 911

Bruce McMinn
Melbourne - 0408 558 486

Doug Dow
Adelaide - 0417 834 910

John Ball
Fremantle - 0418 939 236

Rory Main
Fremantle - 0437 870 007

Julian Thomas
Fremantle - 0418 949 817

Shannon Nicholson
Mid-West Ports - 0409 171 482

Ross Halsall
Mid-West Ports - 0478 011 372

Adam McPhail
Cape Cuvier - 0407 089 967

Peter Dann
Woodside - 0448 842 218

Glenn Attril
Woodside - 0407 948 735

Elliot Bibby
Woodside - 0459 979 758

Craig Eastaugh
Port Hedland - 0438 500 570

Matt Shirley
Port Hedland - 0427 197 272

Mick Wall
Port Hedland - 0400 085 988

David Murgatroyd
MSWA - 0437 288 300

Ben Ranson
Mackay - 0438 121 584

Peter Liley
Brisbane - 0407 655 926

Chris Kline
Brisbane - 0409 548 412

Geoff Dawson
Brisbane - 0418 714 058

Sean Liley
Brisbane - 0408 558 486

Scott Clinton
Newcastle - 0419 808 668

PROFESSIONAL COUNSELLOR

Marcus Romanic
0419 382 352
mromanic@bigpond.com

EXTERNAL SERVICES WHICH MAY BE OF ASSISTANCE

Beyond Blue - beyondblue.org.au
Black Dog Institute - blackdoginstitute.org.au

Photo: Tauri Minogue Photography

Why I am a member of AMPI

Like any professional organisation, AMPI requires a sound membership base and volunteers to operate effectively, basically AMPI is only as good as its membership.

While members are entitled to expect us to advocate the professional interests of pilots, AMPI relies on its members to give us direction. The Executive recognises that strong membership is the key to the success of AMPI, and will enable us to continue to be a respected voice in the Maritime industry.

We are often asked by pilots "what do I get for my AMPI membership" so below is a summary of 'the value of an AMPI membership'

- As an AMPI member you are part of an association that has the professional interests of marine pilots as its number one priority, working with other industry stakeholders, domestically and internationally, to ensure high standards are maintained in our profession.
- As a member of AMPI you automatically become a member of IMPA. AMPI has strong representation at IMPA which can lead to changes industry wide.
- An AMPI executive member is currently representing IMPA at the ISO committee, revising ISO 799:2004 Pilot Ladder standards.
- All AMPI members currently benefit from the recently revised IMO standards for rigging pilot ladders which was influenced largely by submissions from AMPI.
- AMPI has a good relationship with AMSA with mutual support with many endeavours to improve marine pilot safety.
- As the nationally recognised professional body, AMPI is able to develop best practice policies, set national standards, and influence international standards, on relevant aspects of pilotage. For example, PPU operations, pilot ladder hull magnets, helicopter hatch access, pilot boat design, competition in pilotage, pilot training (initial and ongoing), simulator use, PPE requirements, etc
- With its vast pool of maritime knowledge and experience, AMPI, with members input, has the ability to provide expert advice to industry on all pilotage related matters and many port operations and design issues.
- AMPI has developed an online Continuous Professional Development (CPD) program, that was recently launched in Queensland, and available to any pilotage jurisdiction that wish to participate. This program was developed to enable all pilots to be able to maintain minimum standards in all aspects of training that are relevant to pilotage.
- AMPI is host to the Pilot Training Advisory Board. This board is represented by many industry organisations and considers current and future issues relevant to pilot recruitment and training.
- AMPI has a peer support program available to all pilots. This program is supported by psychologists that understand our industry and are independent of any employers. A number of pilots from around Australia have undergone Peer Support training to enable them to further assist pilots at a local level.
- AMPI conduct two workshops every year at various ports around the country that are organised by local AMPI members. These workshops are reasonably priced thanks to industry sponsorship. At these two day events industry stakeholders and pilots hear from a variety of speakers that are experts in their field, enabling participants to keep up with industry trends and network with stakeholders.
- AMPI has also hosted two major international Pilotage and Port Logistics Conferences and one IMPA Congress. These major events have attracted stakeholders and decision makers at the highest international level and are an opportunity maintain the high profile of our profession while listening to the challenges of other stakeholders.
- AMPI members are entitled to discounts for registration at our workshops and conferences.
- The AMPI website www.ampi.org is becoming a valuable tool for members to stay connected with the Institute and have their say on any issues that concern them. The website is still being developed but currently contains:

  Information on workshops and conferences
  - Papers from workshops and conferences
  - Incident reports
  - AMPI position papers
  - Access to the CPD program
  - Chat forum (Voice)
  - IMPA notices
  - Memberships forms
- AMPI has a social media presence, members can stay connected with the AMPI Facebook page.
- Safe Passage is AMPI's quarterly magazine which includes news, views and articles on pilotage, shipping and port related topics, member input is most welcome.
- AMPI membership, as a professional organisation, may be tax deductable.
- An AMPI membership enables pilots to feel connected with a group of likeminded professionals and perhaps stay in touch with old shipmates and meet new ones.
- As an AMPI member you are represented by an enthusiastic executive who commit considerable time and energy to the profession. We need your support enable us to maintain the momentum.

AMPI EXECUTIVE

NAME	POSITION	TIME ZONE(S)	EMAIL	MOBILE
Peter Dann	President	Dampier & Gold Coast	president@ampi.org.au	0448 842 218
Bernardo Obando	Treasurer/Vice President	Darwin	treasurer@ampi.org.au	0419 500 927
Nic Fischer	Vice President	Brisbane	vp@ampi.org.au	0418 149 157
Marvie Rouse	Admin & Secretary	Newcastle	admin@ampi.org.au	0458 014 660
Josephine Clark	Director	Port Kembla	Josephineclark99@gmail.com	0406 065 317
Jeremy Brew	Director	Newcastle	jeremybrew@me.com	0467 791 810
Andrew McClymont	Director	Brisbane	Andrew.r.mcclymont@gmail.com	0427 983 062
Marcus Barrett	Director	Gladstone	marcusbarrett72@gmail.com	0416 370 432
Andrew, Shaun & Daniel	Web Admin	Brisbane, Port Hedland, Bowral	web@ampi.org.au	As Above
Shaun Boot	Director	Port Hedland	shaunboot@fastmail.com.au	0419 279 421
Ricky Rouse	Director / Editor Safe Passage	Newcastle	editor@ampi.org.au	0416 153 441
David Benyan	Director	Melbourne	dbenyan@ppsp.com.au	0409 248 018
Darren Corbett	Director	Melbourne	dcorbett@ppsp.com.au	0407 554 146
Damian Laughlin	Director	Melbourne	dlaughlin@ppsp.com.au	0408 577 150
Toby Shelton	Director	Melbourne	tshelton@ppsp.com.au	0427 549 923

Congratulations

We also wish to congratulate the following pilots on their retirement:

Captain Neil Farmer, PANSW Sydney
Captain Don Buckthought, PANSW Port Kembla
Captain Jake Pattison, PANSW Newcastle

Please submit your photos to editor@ampi.org.au

Snapshots

Sydney Harbour

Adelaide Container Terminal