ROYAL INSTITUTE OF NAVIGATION

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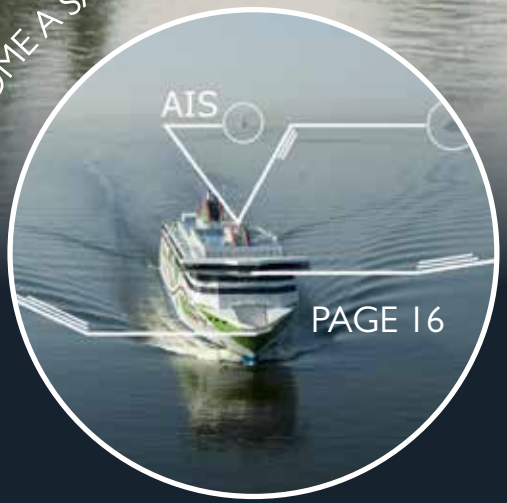

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NAVIGATION NEWS
JULY / AUG 2020

As I write this we're well over two months into the UK "lockdown" for COVID-19. I hope that, as you read it, the situation continues to improve, wherever you are in the world. The Institute's aim has been to keep our doors virtually wide-open during this period. We have worked hard, with much support from members, to offer a varied programme, albeit not able to meet face-to-face. We have delivered a range of content to keep the wheels turning.

Our involvement at a policy and strategic level has increased during this period too. Your Institute is directly contributing to work to support a more resilient UK positioning, navigation and timing infrastructure. The realisation of the pandemic risk has shone a light on how items on a risk register are more than theoretical. Positioning and timing vulnerabilities on risk registers are, rightly, getting increased attention.

We are taking the opportunity to "get ahead" in planning for late 2020 and 2021 events. Clare Stead is leading this, along with a project to present information online more clearly to meet differing needs of members and website visitors.

I should also like to take this opportunity to congratulate our award winners and newly elected Fellows. Each has made a significant contribution and this year's awardees truly reflect the breadth of the Institute, from insights in natural navigation to new sophistication in embedded receiver software.

Taking account of the impacts of the pandemic, the decision was made to not increase membership subscriptions for the coming membership year, which runs from 1 July. We have also emphasised that, as a caring and listening Institute, we will do what we can to support members temporarily affected financially by the pandemic – while many members are not impacted in this way, we want to recognise the reality that some have been and extend a helping hand where we need to.

Thank you for your continued and active support of the Institute.

Best wishes,

John Pottle, Director RIN

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The cover image:
HMS Ocelot underway in 1989

IN THIS ISSUE

FEATURES

REGULARS

Drone Obstacle Avoidance System Inspired By Mosquito Night Navigation

Recent research published in Science (Nakata et al. 2020) has shown that mosquitos detect surfaces using the flow fields caused by the movement of their own wings and have translated this process into a collision-avoidance approach for detecting surfaces near a flying quadcopter.

The research was carried out by an international team of scientists, led by Professor Richard Bomphey at the Royal Veterinary College (RVC) in London. Their research studied the sensory mechanism of the male Culex quinquefasciatus mosquito to mimic the insect's ability to detect obstacles using airflow.

Mosquitos can navigate nocturnally through mechanosensing, i.e. sensing obstacles by responding to mechanical stimuli using their wings, antennae and airflow.

In the same manner as other flying animals, mosquitos fly by accelerating the air around them. This creates fast jets beneath each flapping wing, changing shape in the presence of obstacles. These changes in airflow pattern are detected by the mosquito thanks to the Johnston's organ, which is a sensitive array of receptors at the base of the antennae on the mosquitoes' heads. The researchers called this "aerodynamic imaging" and examined how it was carried out by analysing high-speed recordings of its flight using computational fluid dynamics simulations.

The team found the Johnston's organ's position to be ideal for measuring the pattern changes because the pressure differences were the greatest above the mosquito's head.

Dr Simon Walker, from the School of Biomedical Sciences at Leeds, said: "Mosquitoes represent an outlier within insects with their elongated wings and extremely high flapping frequency. We already know that they use unconventional aerodynamics during flight and this research provides another piece to the puzzle of their evolution as well as inspiring technology for use by engineers."

The researchers then transferred the aerodynamic imaging concept to a miniature quadcopter, fitting the vehicle with a bio-inspired sensor. This sensory device was made from a variety of probe tubes that were connected to differential pressure sensors. The researchers identified locations of maximum sensitivity by measuring airflow around the quadcopter, finding that the sensors performed best when paced in areas of greatest change in airflow when approaching surfaces, as was the case for the mosquito. After tethered and piloted test flights the device was flown autonomously near the ground and walls.

The aerodynamic imaging model detected surfaces and successfully raised the alarm at distances that the team claimed were sufficient for collision avoidance when approaching the ground and walls. The researchers assert that unlike previous surface-sensing quadcopter studies, this model requires only basic thresholds with little to no processing to function.

Professor Richard Bomphrey said: "It's important to understand how such a significant group of insects navigate around the world. If we are to live in a future where ever more work is done by flying vehicles and drones, it could be useful to take some inspiration from mosquitoes to make our machines safer when operating close to buildings or other infrastructure."

Reference:

Nakata, T., Phillips, N., Simões, P., Russell, I. J., Cheney, J. A., Walker, S. M. and Bomphrey, R. J. 2020. Aerodynamic imaging by mosquitoes inspires a surface detector for autonomous flying vehicles. Science. 368, 634-637

Autonomously Navigated Vessels Help Scientists Estimate Fish Abundance While Protecting Human Health and Safety

National Oceanic and Atmospheric Administration (NOAA) Fisheries plans to use autonomous surface vehicles to help fill in the gap resulting from the cancellation of FY20 ship-based surveys due to the COVID-19 pandemic to collect some critically needed data to support management of the nation's largest commercial fishery for Alaska pollock.

NOAA has a broader strategy, released in February, to expand the use of emerging science and technologies that includes unmanned systems.

Three saildrones, which are unmanned wind-powered surface vehicles, are (at time of writing) on a six-week journey sailing autonomously from California to the eastern Bering Sea, expected to reach Alaska in early July. The saildrones will then begin a 60-day survey during which they will cover roughly the same area normally covered by standard research vessels to estimate the abundance of pollock using echosounders. Echosounders are low-power sonar instruments that send sound pulses into the water and measure how much energy echoes back from the fish.

The saildrones are also equipped with solar-powered instruments to measure oceanographic and meteorological conditions to take wind, solar radiation, surface temperature, and salinity measurements along the way. Summaries of this environmental data, as well as echosounder data and photos, will be transmitted to shore via the saildrone's satellite modem four times per hour throughout the survey. The satellite link will also allow the scientists to adjust the course of the saildrone if necessary. Apart from this possibility of course intervention, the vehicles are understood to navigate autonomously. This project is an example of unmanned vessel surveys helping scientists provide some key scientific data at a time when it is difficult to collect such data through traditional means.

Details from fisheries.noaa.gov

Credit: Saildrone

Ground Rocket Test In Scotland

The UK's first complete ground rocket test since the Black Arrow Programme, 50 years ago, has taken place in Scotland.

A team from Skyrora, a European private launch vehicle company headquartered in Edinburgh, has successfully built a mobile launch complex and completed a full static fire test with the Skylark-L rocket.

A report from Space Newsfeed (spacenewsfeed.com) states that the Skylark-L rocket could be ready for launch form a British spaceport from as early as spring 2021.

The ground test took place at the mobile launch complex at Kildemorie Estate in North Scotland in early May. During the test the Skylark-L performed all actions of a launch, but was restrained to the ground and prevented from taking off.

Skylark-L is a sub-orbital flight vehicle with the potential to reach a height of 100km (62 miles) and carry a payload of up to 60kg.

The Skyrora team managed the mobile launch complex build in only five days.

Leading the operations of Skylark-L's static fire testing, Dr Jack-James Marlow said: "It is very hard to oversell what we have achieved here with this test; the whole team has pulled through again to deliver another UK first. We have successfully static tested a fully integrated, sub-orbital Skylark L launch vehicle in flight configuration. This means we performed all actions of a launch but did not release the vehicle. The rocket engine successfully burned, with all vehicle systems showing nominal operation.

"The test did not only validate the vehicle, it also tested our mobile launch complex's ground equipment and performed many cold flow and fuel/defuel tests. In all, there were over one hundred unique operations and the team has gained vital experience. This collection of tests, combined with the 25 other engine tests this year, allow us to take another step along our technology roadmap to orbital launch.

"This is the first time a launch vehicle of this magnitude has been tested in the UK for many years and I am very proud of my team for achieving this. The vehicle is now ready for flight and we are one step closer to putting the UK back into space."

Skyrora's chief executive officer, Volodymyr Levykin said: "With the expertise in place and all the necessary hardware at the ready, we are poised to take the next steps in making the UK a serious leader in the Space business once again"

THE JOURNAL OF NAVIGATION – SELECTED ABSTRACTS

Design of a Low Earth Orbit Satellite Constellation Network for Air Traffic Surveillance

Jianming Guo[1], Lei Yang[1], Quan Chen[1], Sunquan Yu[1], Xiaoqian Chen[1] and Yong Zhao[1]

[1] (College of Aerospace Science and Engineering, National University of Defense Technology, Changsha, Hunan, P.R. China)

The satellite constellation with automatic dependent surveillance-broadcast on-board is of great importance for air traffic surveillance due to its multiple advantages compared with traditional methods. Although some research has been conducted on satellite constellation design based on coverage performance, the findings cannot entirely satisfy all the requirements of air traffic surveillance owing to the lack of analysis on inter-satellite links and network transmission. This paper presents a novel design of a low earth orbit satellite constellation network to solve this problem. Based on the requirements of space-based surveillance, an evaluation model of constellation performance is proposed concerning coverage, link and transmission. The simulation results show that the evaluation model can reflect the performance of a satellite constellation network designed for a space-based surveillance system, and a 55-satellite constellation design scheme with fairly good performance can fulfil the function of global real-time air traffic surveillance.

To read the article in full, please visit: https://rin.org.uk/page/JournalofNavigation.
Doi: 10.1017/S0373463320000260

Bridge Resource Management: Training for the Minimisation of Human Error in the Military Naval Context

Sandra Campaniço Cavaleiro[1,2], Catarina Gomes[3,4] and Miguel Pereira Lopes[2,5]

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2 (Universidade de Lisboa Instituto Superior de Ciencias Sociais e Politicas, Lisbon, Portugal)

3 (CIPES, Centro de Investigação em Política, Economia e Sociedade, Universidade Lusófona de Humanidades e Tecnologias, Lisbon, Portugal)

4 (CICPSI, Universidade de Lisboa Centro de Investigacao em Ciencia Psicologica, Lisbon, Portugal)

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Naval maritime operations entail a permanent concern for safety, ensuring that all crew members receive the necessary information on time. This implies the existence of specific training for improving non-technical skills (NTS). This paper proposes that bridge resource management (BRM) may be determinant for the success of naval maritime operations. Through a literature review on NTS, maritime team training and BRM, the paper presents insights about the way the level of NTS, inherent to BRM, may be determinant for naval officers to operate in safety. We propose that human error may be minimised and safety maximised in military teams operating in the maritime environment through the implementation of an NTS training programme. The paper offers an insight into the importance of safety during maritime operations, focusing on recent international orientations about training requirements, proposing that implementing BRM will be pivotal for the future of the military navy context.

To read the article in full, please visit: https://rin.org.uk/page/JournalofNavigation.
Doi: 10.1017/S0373463320000235

China Completes BeiDou Constellation

The last 3rd-generation BDS-3 satellite required to complete full worldwide cover was launched on 23 June.

Launch took place from the Xichang Satellite Launch Centre at 0943 local time (0243 UTC), having been delayed from 16 June due to problems with the Long March-3B launch rocket.

This 55th BDS satellite will use its own propulsion to obtain a geosynchronous equatorial orbit (GEO) at ~22,000 miles (~36,000 km).

The final constellation comprises 27 medium earth orbit (MEO), 5 GEO and 3 inclined geosynchronous orbit (IGSO) satellites. The system provides global navigation services similar to GPS, GLONASS and Galileo.

The worldwide BDS-3 uses, amongst other transmissions, a frequency of 1575.42 MHz - the same as GPS L1 and Galileo E1 civil signals; and it uses multiplexed binary offset carrier (MBOC) modulation, similar to the GPS L1C and Galileo's E1. Satellite-based augmentation (SBAS) and SAR facilities are included.

Details from beidou.gov.cn

Insects Inspire Swarms Of Autonomous Robots For Space Exploration

A researcher at California State University, Northridge (CSUN) has received a sizeable grant from the US Department of Defense to fund a project that involves developing swarms of fully autonomous robots capable of planetary exploration.

The grant was awarded to Nhut Ho, a mechanical engineering professor at CSUN and founding director of the NASA Autonomy Research Center for STEAHM (ARCS). The project will explore how to build a swarm of robots that are designed to mimic the behaviour of swarming insects like ants, such that they can be placed in new environments and learn how to navigate the unfamiliar surroundings to complete tasks. The project also has potential terrestrial applications like search and rescue.

"We were inspired by the behaviours that we see in swarms of ants and bees that self-organize, create clever solutions for different tasks, work in groups of different sizes and have the ability to complete the tasks even when members fail," Ho said. "The next thing is figuring out how humans can use the insights gained to design complex robotic systems for really challenging missions."

Historic Launch Followed By Rocket Return

In a historic first, NASA astronauts have launched from American soil in a commercially built and operated American crew spacecraft on its way to the International Space Station (ISS).

On 30 May 2020 the SpaceX Falcon 9 rocket carried the Crew Dragon spacecraft with astronauts Doug Hurley and Bob Behnken into orbit for a rendezvous with the ISS in the Demo-2 mission. The test flight acts as an end-to-end demonstration of SpaceX's crew transportation system.

About 9 minutes after the launch, the Falcon 9 first stage successfully achieved a pinpoint landing on "Of Course I Still Love You," the SpaceX drone ship that was stationed a few hundred miles off the Florida coast. The return, refurbishment and reuse of Falcon 9 first stages is a key priority of SpaceX founder and CEO Elon Musk, who wants to drastically reduce the cost of spaceflight.

The SpaceX Crew Dragon successfully docked with the ISS on 31 May. Behnken and Hurley join the three other crew mates already on board the ISS and are set for a stay that may last up to four months.

Autonomous Vehicle Trial Route in UK

Work has begun on a 300km (186 miles) autonomous vehicle trial route in the UK, spanning from Coventry to Birmingham along the Midlands Future Mobility route.

The test environment will see autonomous vehicles trialled on urban, rural, suburban and highway roads. The aim of the work is to fully assess vehicle performance across a wide variety of real world locations and situations. It is expected that later this year the route will be extended to 350km (217 miles).

Initially, the vehicles to be trialled will be operated by a driver and will be connected vehicles that can interact with each other and provide traffic and hazard warnings to the connected vehicles.

Infrastructure including smart CCTV, highly accurate GPS, weather stations and communications units are included along the route.

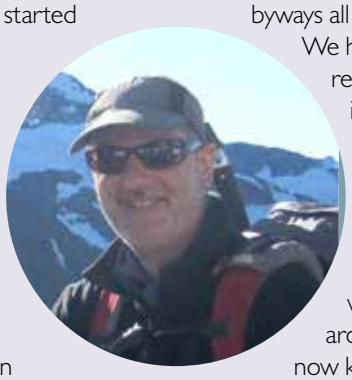
Future plans will see autonomous vehicles trialled on the route while closely monitored by safety operators. The build-up to autonomous vehicles will be gradual, with the testing of increasingly advanced 'driver assistance' systems like lane centering.

The project is led by a group of companies that includes Transport for West Midlands (TfWM), Coventry University, Highways England as part of the Midlands Future Mobility consortium, WMG, AVL, MIRA, Costain, Wireless Infrastructure Group and Amey.

Mayor of the West Midlands Andy Street, who leads TfWM, said: "Connected and autonomous vehicle technology has the potential to radically change our lives, and I am pleased the West Midlands is leading the way in this sector with research facilities and production plants already in place."

THE PRESIDENTIAL COLUMN

When I sat down to write my previous column, for the May/June issue of Navigation News, I don't think I even started to imagine that I would still be sat here at home, working on the same dining room table, writing this column for the July/August issue. The last few months have been a great strain on all our working and social lives, with so much having changed, and with so many tragic losses around the country. At times like these it is difficult to focus on matters such as transport and navigation, but there is no doubt that there are and will continue to be significant changes to our personal mobility for years to come. I think we can all see that there is likely to be much more of a focus on walking and cycling rather than other forms of transportation, and so perhaps we should be paying these disciplines more attention from our navigational perspective.



The early weeks of the lock down meant that we could only exercise from home, but what a voyage of rediscovery that offered. We are fortunate to live in the Derbyshire Dales, and we took every opportunity to explore the rarely used paths and byways all around us. And what discoveries we have made! We have sought out historical railway lines (the oldest recorded railway tunnel in the World, from 1793, is in our own village), and wonderful disused canals (including the sunken and abandoned hull of a barge slowly being absorbed into the landscape). And all around the abundant wildlife has been relishing the transport free countryside. But one of the crucial keys to this new age of rediscovery were the maps and their careful use to navigate around and find such wonderful hidden treasures. We now know of some lovely hills right here on our very doorstep that we had never climbed before, quiet tracks that we had never trodden or cycled. And it was all there, waiting, just outside the door. So, I will finish on that positive note, yes times have been hard, but it has allowed many of us to rediscover the places we actually live and safely navigate around them.

Prof. Terry Moore

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By Michelle Brown

Get to know John Cairns in this month's Q&A

What is your name and where are you from?

My name is John Cairns, I originate from the West Coast of Scotland but now live in a village North of Portsmouth.

What is your favourite piece of technology?

The internal combustion engine. I have always been fascinated by engines of all types and I have stripped and rebuilt many marine diesels and car engines.

How long have you been involved with RIN, and what was your first impression?

I have been a member for 15 years, I bumped into the late Bob Cherry at the London Boat Show and he convinced me to join! I was not disappointed. I served as a Navigator for most of my time in the Service flying on Shackletons, Vulcans and Nimrod. Even on Vulcans most of my flying was over the sea so traditional navigation techniques were the norm. On joining my knowledge of the subject increased rapidly beyond air navigation and I remain challenged by the subject to the present day.

What is your favourite boat or ship?

Difficult to give an answer, I love them all! My closest connection is with HMS Illustrious on which I served when attached to the Royal Navy. I do however feel very close to the paddle steamer Waverley; we grew up together on the River Clyde. But I must not forget my yacht Lucy Ashton (named after a paddle steamer) on which I spent many years sailing in UK Waters and the Med.

Do you drive with Maps, GPS, or memory?

Memory, Maps and GPS in that order. If I have to divert at short notice GPS comes to the fore.

What is your favourite RIN memory?

Witnessing the Spirit of Goole members receiving their Top Nav trophies from HRH The Duke of Edinburgh.

If you were stranded on a desert island, what are your three must haves?

My sextant
A thesaurus
A comprehensive oil painting set.

What three people – living or dead – would you like to have dinner with?

Dame Vera Lynn
Sir Barnes Wallace
Nicholas Monserrat

What do you like to do in your spare time?

As I have been retired for some time, I have plenty of spare time! I skipper sailing yachts for 2 disabled sailing charities, one on the Solent and the other on the Clyde. I am a reasonably active member of GANG. I have established a project on the Isle of Wight, presently on hold due to the virus, with the task of gathering 40 youngsters and, together, we will build and fly a light aircraft. I was inspired by Jack Milne and the Spirit of Goole. I am in the process of rebuilding an MGB – a long project! I am a GA pilot although presently out of currency. When the world returns to normal, I will get up to speed and possibly enter Sebastian Pooley's "Dawn to Dusk" competition with a Coastal Command based route. People will see me frequently entering the local Hospital and naturally assume I am a brain surgeon; however, I push the library trolley around the wards. That will do for now.

If you were a rapper, what would your name be?

Happy Chappy!

What is the best advice you have ever received or given?

Many years ago, when serving as a Police Officer in the Met, I was advised by my sergeant to follow my dreams and join the RAF. I did and served for 38 fantastic years.

What is something you have had to learn the 'hard' way?

I initially applied for a flying scholarship with the RAF. I was unsuccessful as I was declared medically unfit due to suffering from headaches. I ended up joining the Met Police. I decided to join as a ground tradesman, Navigation Instrument mechanic, and worked on getting the decision reversed. I applied to train as an Air Electronics Operator and was successful. On my second tour on Shackletons I applied for training as a pilot and was successful. By not completing the paperwork correctly I lost 4 years however not too bad as one tour was in Singapore!

What did you want to be when you grew up when you were a child?

A pilot in the RAF. I was eventually selected for Pilot Training and I must have been exceptionally good because my instructor said he could not teach me anything and sent me off to train as a Navigator!

Q&A
John Cairns
Chair of the General Aviation Navigation Group (GANG)

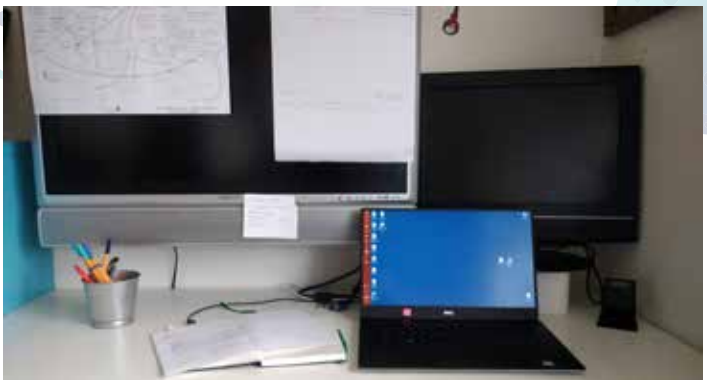
The PhD Life in Lockdown

Joseph Walters, Chair of the Younger Members' Group shares how things have changed for him since March…

The lockdown, amongst other things, has (some might say dramatically) changed my PhD. Major trials at the Millbrook 5G test track that could have provided all the results I needed to complete my project were cancelled and research equipment was no longer accessible as the university was closed.

However, I like to think that the lockdown has provided me with some space and time to think about my PhD, its direction, and the future. As such, the lockdown became an opportunity for me to become more independent and follow a direction of research more suited to my current interests, but also aid my future prospects and potentially open up more career paths.

It took me a few weeks to get into the swing of working from home. Eventually, I took some time to reorganise my office space which helped me to settle on an effective daily plan. I am most productive in the mornings and usually now work from the early morning until lunchtime when I watch Star Trek Voyager (very relevant to navigation) and then spend the afternoon doing



'fun' things like making graphs and maps for my research. It works for me.

Other than the change of PhD topic, my everyday personal life hasn't changed much. As a PhD student, I sit at a computer 90% of the time and can often get away with working from home anyway, lockdown or not. I've also found supervisions easy enough (if not easier) to do online. My wife and I have still been able to get out walking everyday once we've finished work, and the increased deliveries have provided cardboard boxes that I've been using to build things for the cats!

I think I've managed to turn lockdown into a positive experience, even if it did take a few weeks to get there.

Caption Competition!

Please enter your caption submission to us on
Twitter at @at_RIN - captions must has some link to navigation... no matter how tenuous

Navigating Submarines
The Original Stealth Fighters

A young James Taylor on HMS Spartan

By James Taylor
OBE FRIN

In the Beginning…

Submarines fascinate; they always have. Since their inception at the start of the 20th century, over time and warfare they have made the transition from small submersible craft of limited range to today's nuclear powered attack or strategic missile-firing submarines. In the beginning, the Royal Navy saw submarines as no fit place for an Officer and a Gentleman, such that for decades afterwards, the Submarine Service was "The Trade." But the First World War saw them come into their own, in the U-boat campaign against British and Allied shipping, and by British submarines in epic campaigns in the Baltic, in the Sea of Marmara and elsewhere. The submarine had truly arrived.

The Second World War saw something very similar – for the submarines on each side were essentially very much the same as in 1914-18 – small, torpedo-firing submarines, fitted with a deck gun for smaller targets, now with slightly increased speed, better torpedoes, greater endurance and diving depth. But essentially the same – diesel-powered submersibles which would spend the bulk of any patrol on the surface, and switching to massive batteries for underwater propulsion. There were very heavy shipping losses – from the U-boat campaign in the Battle of the Atlantic, by British submarines in the Mediterranean, and the most successful submarine campaign of them all, in the Pacific, where the United States Submarine Force effectively wiped out the Japanese merchant fleet. There were heavy submarine losses, too, Germany losing 80% of all its submarines in the course of the war.

How do they…

A major part of the fascination with submarines is their ability to move in 3 dimensions, unseen. These are the original Stealth Fighters. So how do they navigate? In the case of the earliest submarines, the answer was "with difficulty." Charts, a simple mechanical log, a magnetic compass, a clock and a sextant comprised the total navigational fit. On the surface, visual bearings and astro-navigation were used. Dived navigation was conducted by Dead Reckoning (DR) and Estimated Position (EP). Until the arrival of a serviceable echo-sounder, submarines might simply "bottom" on to the seabed and note the depth. Let's look at the generation of Royal Navy Submarines which saw service from the 1950s through to 1991 and the Gulf War, the Porpoise (8 submarines) and Oberon (13 submarines) or "P&O" classes. Essentially a development of the German Type 21 diesel-electric submarine of 1944-45, with a crew of 67, a large torpedo load and carrying sufficient diesel fuel for their 2 generators to take them from the UK to the far side of the Indian Ocean, these were excellent and remarkably quiet submarines. Maximum speed surfaced was 13 knots, dived 17 knots, but that required massive discharge rates from the main batteries. At lower speeds, say 4 knots, dived endurance on batteries was literally days. The schnorkel or "snort" gave them the ability to charge the main batteries at periscope depth, running the 2 supercharged V16 diesel generators via an induction system. But the successful design

The control room of the HMS Ocelot, with the ARL table and chart table combined shown on the left of the picture

The same control room of the HMS Ocelot, looking forward

HMS Orpheus Credit: Carlo Martinelli, shipspotting.com

was sold to the Canadian, Australian and Chilean Navies, so that in any RN submarine in the 60s and 70s up to 30% of the Officer strength would be Australian, or Canadian, or more rarely, Chilean.

Some basics: submarines move and navigate within a fixed or moving space of water, allocated by a central Naval authority; this might be a geographic exercise area for a specific period of time, and/or a moving haven, which allows submarines the freedom to exercise with other units, or to conduct training drills surfaced or dived, while trying to avoid or where necessary, to promote mutual interference. It is essentially a form of underwater air traffic control. Each submarine, until it was fully worked up and had gained some operational experience would report at regular intervals to that central authority that all was well. Failure to do so would initiate the submarine search and rescue procedures. But whether obliged to make reports or not, it would always be assumed that a submarine was within its allocated area or moving haven. The majority of peacetime passages from A to B were made on the surface, at a transit speed of around 11 knots, with perhaps a daily dive to check the "trim".

The Conventional Submarine

The navigational equipment in the earlier P&O class conventional submarines was fairly basic: Admiralty gyro compass, a magnetic compass and a portable boat's compass, known as "Faithful Fred" to be fitted on the bridge when all else was lost - including necessarily the ability to submerge. DR and EP were maintained on an Admiralty Research Laboratories (ARL) table in the Control Room, doubling up as the chart table, and during attacks as local operations plot, with log, compass and clockwork inputs driving a "splod" of light upwards through a glass surface there were visual fixes taken from the periscope. Hand-held sextants, for use on the surface, were complemented by a sextant fitted within one of the periscopes. There was a Type 765 echo sounder and a basic Chernikeef log which had to be retracted into the hull and secured behind a hull valve at anything much deeper than a couple of hundred feet; after which the stop watch, of which more later, and the revolutions per knot table, were in charge. For radio aids there was Decca, with all the joys of lane-slip and night effect; CONSOL; and LORAN-A. Many radio aids to navigation in submarines then stemmed from those introduced for RAF Bomber Command in the 1940s, and some were designed to employ a 500 ft. training wire aerial at altitude rather than the miniscule stub aerial at periscope depth they enjoyed in submarines, with unsurprising loss of coverage and accuracy. There was radar, for use surfaced or at periscope depth, but its use was positively discouraged, except for entering and leaving harbour in much reduced visibility. Stealth fighters don't transmit on radar.

The Navigating Officer of these conventional submarines was not a navigation specialist. Very many were, like me, Supplementary List Officers, initially on short service commissions, with rather minimal training, filling the Submarine Officer Corps as it expanded rapidly to meet the manning requirements of the fast-approaching nuclear Service. At that time – 1967 - what an Officer did in the lower levels of Wardroom life – Torpedo Officer, Navigator, Sonar Officer – was very much in the gift of the Captain. It was also a time of instant sackings, with Officers found wanting left on jetties in some remote location and told effectively to find their jolly

HMS Spartan

old way back to the surface Navy. My second submarine was HMS Walrus, still as a Sub-Lieutenant, and initially as Torpedo Officer. The Navigator of Walrus departed; possibly linked to his booking us all into a temperance hotel during a visit to Belfast, possibly not. In any case he went. And lo,

"You are now the Navigating Officer"

"Yes, Sir."

"But be in no doubt; I navigate this submarine, not you."

"Yes, Sir."

The Captain was Colin Grant, a large, red-haired, bearded man, now in his second command. He was an excellent tutor who over the next 18months, including a 4- month deployment to the Caribbean, taught me a very great deal, not merely about navigating a submarine, but about the role of every Commanding Officer in training and endlessly educating his team. He had a robust sense of humour, essential in any submariner, and a remarkably short fuse.

Where are we?

When surfaced and visual fixing was available, from the bridge, a one metre square gap at the forward end of the fin, usually shared with the lookout, and in which the occupants were secured by harnesses in foul weather, the Officer of the Watch would take visual bearings, peering through the wind, sleet and rain. These bearings would be relayed, hopefully uncorrupted via a hand-held and not always waterproof microphone, or the voice pipe to the Control Room, where the Petty Officer of the Watch, staying nicely warm and dry, would plot the fix on the chart table and report the results – again, hopefully uncorrupted. In very many places it was easier to mark various fixing points on the chart as Lighthouse A, or Monument B rather than attempt to master the intricacies of Gaelic or Norwegian or Spanish or whatever via the voice pipe. Much could be lost in translation. The prudent Navigating Officer, and every Captain, would from time to time check the chartwork and take a fix using one of the periscopes. On occasion, a helpful helmsman would whisper up the voice pipe, "Captain's on the after periscope." This allowed young Officers of the Watch to steel themselves for the somehow inevitable blast at some minor oversight or lapse in drill. Operating in and out of the Clyde, one gained a knowledge of and familiarity with the topography, the lights, buoys and beacons so that in time a glance would confirm that the submarine was not standing into navigational danger. From the very beginnings of watch-keeping, every Officer of the Watch would learn to treat every visual contact as a "target" – assessing the range visually, assessing inclination, the angle-on-the target's bow (ATB), and mentally calculate – and report to the Captain - distance off track (range x Sin ATB) and closest point of approach. This became second nature, and fostered mental agility, and would be vital later in making periscope observations and conducting torpedo attacks, calculating when to turn and at what range to gain the ideal torpedo firing position.

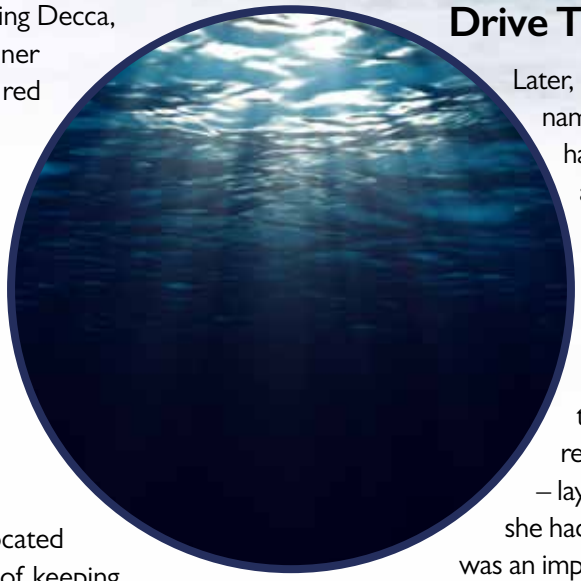
For ocean navigation, astro was King. While LORAN-A and in extremes Consol might provide one position line, DR and EP, confirmed by a sounding line were the basis of most navigation. Taking star sights from the rolling, heaving, soaking fin of a surfaced submarine in bad weather is at best tricky, and not conducive to accurate navigation. But every little helped, even if it was a sonar bearing of the January storms breaking on distant Rockall.

Common to both surface or dived navigation was the need always to generate a pool of errors, a circle or ovoid expanding at a rate determined by likely log and compass errors over time, and based on the last reliable fix, until such time as some new information – a visual bearing, a single sounding, a sun or star line reduced it. The periscope sextant was good enough to produce a position line within a mile or 2 at Mer.Alt to indicate latitude and so reduce the pool. At which point it would expand again until the next piece of information or fix. The pool of errors does not give your position; but is based on a great submarine navigational truth: It is almost inevitably more important to know with certainty where you are not, rather than precisely where you are.

Some tricks of "The Trade"

There were tricks of the trade, how to build and refine that pool of errors, perhaps by a single sounding, or visual bearing. How a visual bearing allied to a range obtained from the Almanac as a lighthouse or mountain peak of known height above sea level dipped below or rose above the horizon, and confirmed by a single sounding, gave a very useable fix. How radar was seldom used – and how in any case it would give away our position and identity to any warship in the vicinity and latterly to any surveillance satellite. How successful bottom contour navigation (before the days of multi-point dividers) required lengths of knotted thread or string. For this, a knot would be tied at distances covering, say x minutes' travel at a range of speeds – typically 4, 6 and 8 knots, according to the scale of the chart or an enlarged sketch copy of it. A single sounding every y minutes allowed one to see where the knots fitted on the course being steered. Another

fix. How at periscope depth when using Decca, and its lattice charts, the prudent mariner would draw in a dotted line on all the red lattices – essential in the confines of a submarine control room at night in dim red lighting. How to avoid the Wardroom using the back of the chart in use as a makeshift screen for film night. Finding from the chart and using local transits to ensure the submarine is in safe water. How to use the passing ferries, with their fixed routes, or other shipping as an indicator as to whether you might be straying towards the edge of your allocated water. All these were a useful means of keeping the Captain content and in his bunk, where he sat in a fog of cigarette smoke (everyone smoked in those days), reading paperbacks, but with a keen, almost prescient ear on any irregularity coming from the adjacent Control Room. Perhaps most of all it was developing "periscope eye," the ability during an all-round look (a 360-degree visual sweep on the periscope lasting no more than 25 seconds) to recognise that this headland was clear of that one, that such and such a bay was open, that the change in bearing of a headmark, perhaps a lighthouse, might indicate that the tidal set was stronger than anticipated. As much as anything it was understanding what was expected to be seen, compared instantly with what was seen. Knowing that in this position, with that headland clear, there was sufficient depth of water to allow the submarine to go deep to avoid collision with a surfaced vessel, or to accelerate towards a potential target. All this from a height of eye of 1 foot, perhaps less. It also demanded a facility with mental geometry, as the distance off track of any landmark, just as with an approaching ship, can be worked out by using the sine of its current relative bearing – know your sine tables – multiplied by range. There was a pride in the ability to work out range on a known height (of a landmark or ship's masts) from the angle subtended by with the periscope's spilt image range-finder without using tables or resorting to the slide rule. A submariner, surfaced, at periscope depth or deep, must always think mathematically and in 3 dimensions.



Always, the stop watch was brought into play. When (depending on speed and visibility) the next all round look was due; when, at this speed, the point of danger of which you have just calculated the range, will be past and clear. When your expanding pool of errors will "hit" some limiting line or danger. Calculating, on altering course, that there are x minutes to run on the next course, at this speed, so start your stop watch, so that if positional information is lost for any reason, you will still alter accurately. Surfaced or dived, the stopwatch and the pool of errors were constant companions.

Drive Time

Later, in 1974, after "Perisher," the aptly named submarine Command course, I had my first Command, HMS Grampus, almost exactly the same as Walrus, with the same navigational set-up, and the need to train my own young Officers. Within a year I had another Command, HMS Orpheus, one of the modernised Oberon class, and this was a step improvement. With a revised internal – and more comfortable – layout, a much higher capacity battery, she had greater range and endurance. There was an improved navigational fit – more modern Decca, Loran C, and highly accurate EM logs – which functioned at all depths - to measure speed and distance run. There was a slightly improved radar, seldom brought into play, and a more accurate periscope sextant, much improved echo-sounders to make best use of the increasing range of accurate bottom-contour charts, and the ARL table, designed in 1946, still ticking away in the Control Room. But the principles of submarine navigation remained, of using every clue, every trick of the trade to determine whether the submarine was standing into danger without giving one's position away, to be absolutely certain of where the submarines is not. Because very accurate navigation, metric or sub-metric was only required for specific events, say berthing. During attacks, whether on a surface or submarine target, geographical position remained unimportant as long as the submarine was safe; the entire attack problem was, and is, a relative one. Orpheus was also fitted with a specialist exit and re-entry chamber to allow Special Forces "frogmen" to leave and enter the submarine while dived, which meant there was much call for close inshore navigation, necessarily at night. Training in the deep and narrow Norwegian fjords at night, with very few visual clues, a discreet sonar "ping" either from the main sonar or the beam-mounted underwater telephone (essentially a sonar carrier wave) plus a chronoscope – a stopwatch with time marks converted into range using the speed of sound in water - would give an accurate distance off the steep fjord side.

Appointed in 1980 to command HMS Spartan, a Swiftsure-class nuclear-powered attack submarine which had only entered service the previous year, I described it at the time, making the move from conventional to nuclear submarines as "rather like getting out of a Ford Sierra and into a Formula 1 car." That was probably wrong; it was more like getting out of a LandRover – basic, rugged, based on wartime service, frequent faults but easy to maintain, not comfortable but will always get the job cheerfully done. In Spartan, speed, endurance and quietness were absolutely outstanding. She and the other submarines of the Swiftsure class were on the very front line of the submarine Cold War. Dived, she

handled just like an aircraft, banking steeply into the turn on altering course, and able to change depth at astonishing angles. Handling her at speed was exhilarating, although for pre-planned manoeuvres it was always best to warn off the galley before their workspace and the liquids in it assumed a sudden 30+ degree angle. This was a submarine that could do just about anything, anywhere in the world there was sufficient water to dive, and with the sonar equipment to match. The navigational equipment fit was excellent; with an improved suite of echo-sounders (including upward looking for under-ice patrols) Loran-C, Decca, OMEGA, a seldom-used radar, and from 1981, the first satellite navigation equipment fitted in Royal Navy Submarines – this used NAVSTAR, allied to a Magnavox 1105 receiver, fitted in the submarine by a young Colin Beattie! The most important equipment was Submarine Inertial Navigation System 1, or SINS-1, reliable, accurate (if properly maintained and supported) and with a slight tendency to go a bit wibbly-wobbly North of about 83N. The extensive data handling systems for target motion analysis also acted as an additional means of generating DR and EP, to complement manual pencil- and-paper calculations. But the principles of submarine navigation, using and assessing every clue, always with a strong element of mistrust, weighing and weighting the navigational evidence, to determine where you were – or were not - stopwatch at the ready, remain unchanged.

Who?

Submariners, from the beginning saw themselves as different, and in time, as an elite. Others saw them as an elite, albeit a scruffy elite - there was always that hint of "The Trade" - with more than a hint of arrogance. Uniform was seldom worn at sea, and one wore whatever was comfortable, be it shorts and flip-flops in the Far East, or layers of clothing topped by a rugby jersey and a submarine sweater in an Atlantic winter. Contrary to popular opinion, not all submariners are volunteers; many are drafted in. But of those who were so drafted for an initial 5 years submarine service, over 98% opted to remain when offered the chance to return to the surface Navy. Which suggests that we were doing something right. Submariners themselves require that robust sense of humour I mentioned earlier, an unrivalled ability to get on with your fellow human-being in adverse circumstances, sheer professionalism, a tireless work ethic and an understanding family. These are qualities I found in abundance all around me throughout my submarine career, and the qualities needed when you go in harm's way. As we did.

Submarines are a mass of piping, of extremely high-powered electrics, of electronics, and of compressed air and hydraulic systems which are the life-blood of any submarine. They are entirely safe until you forget that they can be very dangerous. They are highly technical and demanding whatever the propulsion system. Uniform and the wearing of badges of rank became mandatory in 1971 – at which time the submarine badge, the "dolphins," the proudly-worn mark of a qualified submariner came into being. All this reflected the role of the Submarine Service now in operating nuclear attack submarines, and the national strategic deterrent. The advent of the nuclear submarine made the Royal Navy as a whole up its game. The equipment, training and techniques which enabled that will be covered by David Pollitt in the following issue.

Further recommended reading:

"One of our Submarines" by Edward Young

"We come unseen" by Jim Ring

"The Silent Deep" by Peter Hennessy and James Jinks

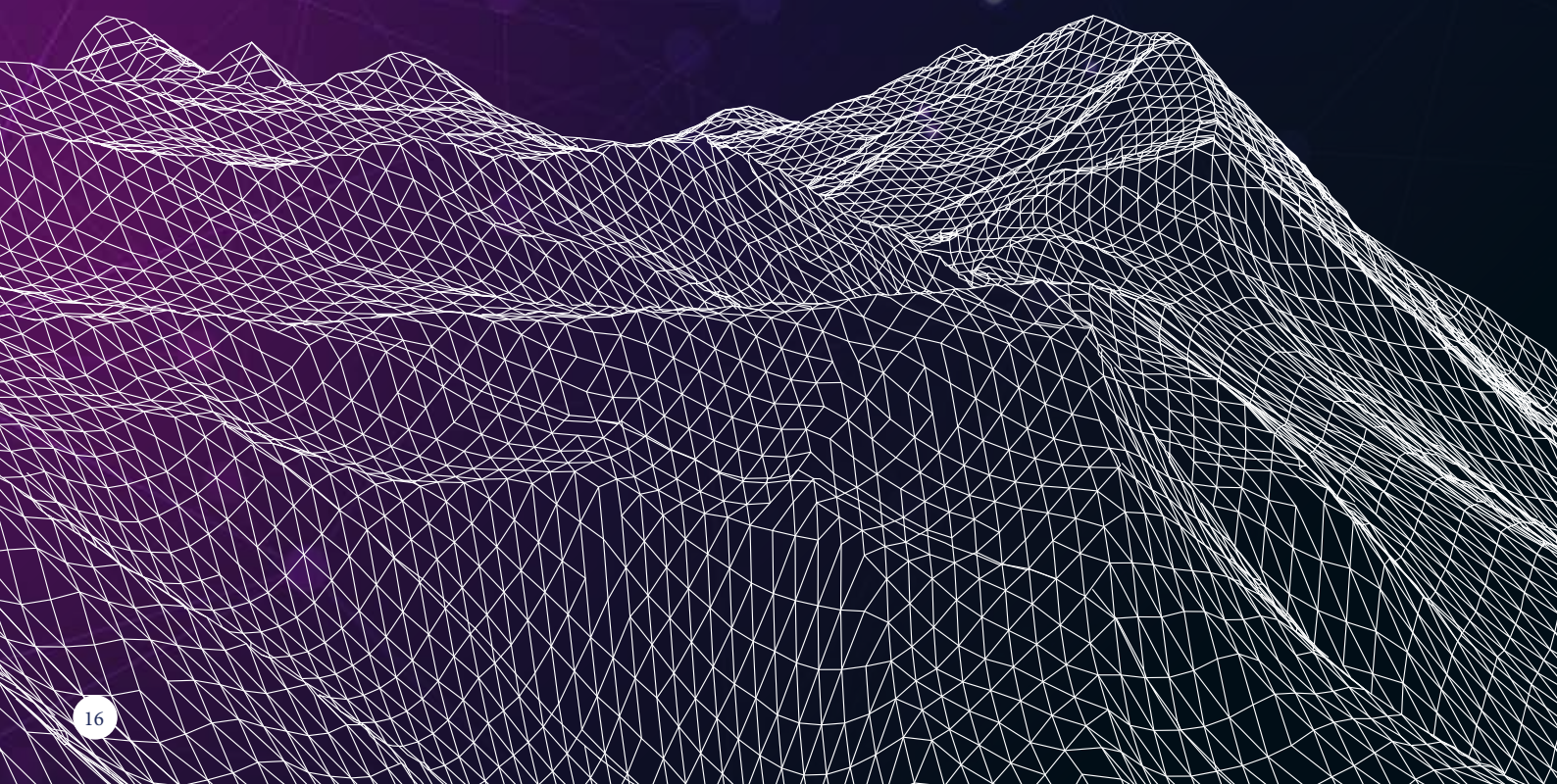
More about the author:

James's childhood ambition always was to be a submariner. He commanded the conventional submarines HMS Grampus and HMS Orpheus, the nuclear powered submarine HMS Spartan and the frigate HMS London. He is an alumnus of the Royal College of Defence Studies and a Younger Brother of Trinity House. He was awarded his Foreign going Master's Certificate in 1980. On leaving the Royal Navy he became CEO of the Northern Lighthouse Board, and subsequently Chair of the Scottish Public Pensions Agency and a Non-executive Director of Scottish Ballet. He served as President of the Institute from 2015 to 2018, and currently represents the International Association of Institutes of Navigation (IAIN) at IMO.

The author in HMS Spartan for her last day dived, having also been there for her first.

Can AI become a salty seadog?

Ville Lehtola, assistant professor at the University of Twente, Netherlands, and Jakub Montewka, associate professor at the Gdynia Maritime University, Poland, explain how less experienced ice-going navigators could benefit significantly from e-navigation technology that accommodates the best knowledge of seasoned mariners.



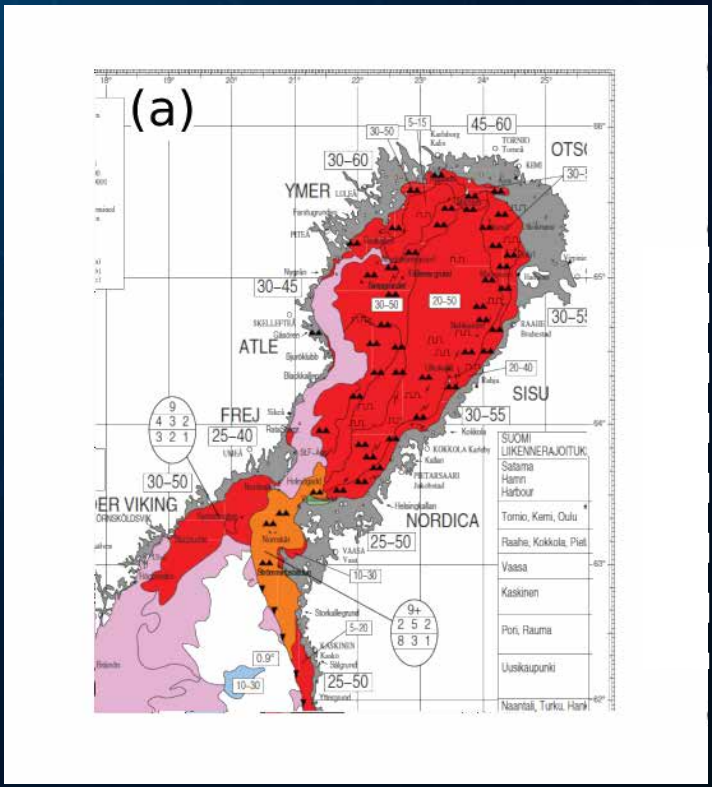


Figure 1: (a) Traditional ice map from the Baltic Sea

Artificial intelligence (AI) and autonomous functions are gaining ground in landlubber news. In e-navigation, one prominent suggestion is to use a computer to plan ship routes in ice-covered waters. The idea is to reduce travel time and increase safety of ships in a similar manner to how it is done for open sea navigation. Some ships are more ice-capable than others. However, the major concern lies in the proper translation of the anticipated ice conditions along the route of the ship. Conventionally, the crews of ice-going ships read the ice conditions from the synopsis maps (see figure 1a) and gather on-board observations, while the knowledge of the ship's performance in ice-covered waters is based on the crew's experience.

The computerized method is to combine the data and then calculate the safest possible ice-going route for a given ship. The ice and weather data may consist of forecasts that cover the whole journey timewise with a one-hour resolution, and spatially with a resolution of one nautical mile. The data on a ship's performance in different ice conditions may be digitized from empirical observations, mathematical models, or both. The computer fuses these data into a map where the ship's performance is often reduced into two estimates: attainable speed and the probability of getting stuck in ice. The safest route is calculated using this map.

The major limitation of humans lies in the ability to process large datasets with spatial and temporal variations. This is similar to trying to make sense of hundreds of maps at the same time. Nevertheless, humans possess something that the computer does not have: good seamanship and experience.

Therefore, we wanted to see ice-going captains' reactions on the cutting edge of this e-navigation technology and get their feedback on the computer-calculated routes. To this end, we held a workshop where we tasked eight seafarers to plan steaming routes that we would then compare to the ones we computed using our recently developed e-navigation tool. The participants were divided into two groups: the test group and the control group. The test group was given additional information in the form of speed maps produced using our recently developed e-navigation tool (see figure 1b).

The influence of the experience showed clearly on some occasions. Particularly, in one case when the ship route ended in the city of Kemi, located in Northern Finland, the most experienced captains in the control group could see (without the help of the speed map) where their given ship could easily travel through the ice field. This was exactly the route calculated by the computer. Other members of the control group tried to avoid the ice field - unnecessarily. Also, well-seasoned captains sometimes questioned the rigour of the computer-generated speed maps, i.e. they would not trust it if they could not verify what they saw against another independent information source, while less

experienced captains were more lenient in accepting and utilizing the information. We would say that a healthy distrust is reasonable in order to prevent disasters in case if there is a systematic fault.

The element of trust is something the up-to-date ice routing tools are trying to develop, however, often without a holistic approach to the subject. Mainly, there are three questions to be answered: whether the ice and weather forecast data is accurate enough, whether the model calculating ship speed in ice - Ship Performance Model (SPM) - is valid, and whether the overarching framework for ice path finding - Ice Routing Tool (IRT) is valid. Specifically, the SPM describes the extent that the model can correctly predict a ship's speed in given local circumstances, and IRT indicates the appropriateness of the method in given operational settings and maritime traffic system requirements.

Our study was made in the Baltic sea, where the forecast systems are well developed, but this is not the case everywhere. The validity of the SPM is often ensured to a certain degree but is still limited by the difficulties in gathering data. The IRT is based on mathematics and works well as a pre-planning tool, but currently does not make use of observations from aboard the ship during the journey. This is likely to change in the future.

Superhero-level eyes and ears can be given to ships by installing sensors on them. These include thermal and laser sight, sounds not audible to human ears, sonar, and vibrations of the ship's hull. These data come on top of the traditional RADAR, Automatic Identification Systems (AIS), and Global Navigation Satellite System (GNSS) observations. AI acts as a brain, fusing these multi-sensor data inputs and forming a situational awareness about the status of the ship's system and its environment. This is what the ongoing research aims for: pushing the AI towards a situational awareness that is similar or better to what a human can achieve (see figure 2). Decisions on how to react to different situations, however, come from the captain. This includes making sure that all the global and local

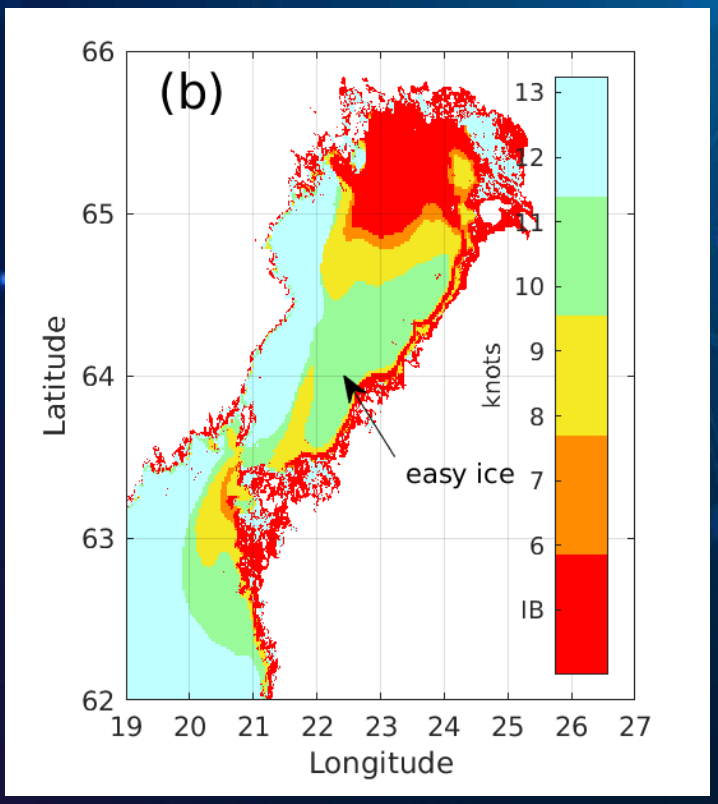


Figure 1: (b) Computer calculated speed map given the properties of a specific ice-going ship.

requirements of a transportation system, where a ship is operating, are met.

Any attempt to digitize good seamanship that seasoned captains possess is expected to be a long and stormy sail. On the other hand, smooth seas never made a skilled sailor!

Footnotes:

**The authors are also associated with the Finnish Geospatial Research Institute (FGI)*

**This article is based on the original publication in The Journal of Navigation:*

Lehtola, V. V., Montewka, J. and Salokannel, J. (2020) Sea Captains' Views on Automated Ship Route Optimization in Ice-covered Waters. The Journal of Navigation, 73(2), 364-383.

Figure 2. Ongoing AI project on Tallink Megastar, http://maritimeai.org. Image copyright Tallink Grupp, reproduced with permission.

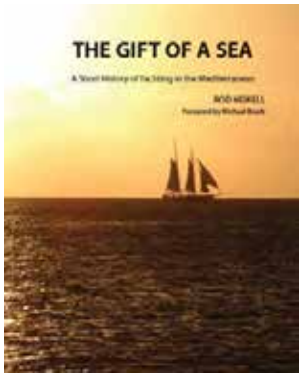
Royal Institute of Navigation

RIN SPECIAL INTEREST GROUP

A joint meeting of
The Royal Institute of Navigation
Small Craft Group and
The Royal Thames Yacht Club

Venue: The Royal Thames Yacht Club, 60, Knightsbridge, London
Date: **Thursday 19 November 2020 – 1800 hrs for 1845 hrs**

Rod Heikell – From the Periplus of Skylax to the Digital Age



The topic for Rod Heikell's talk is based on the last chapter of his latest book '***The Gift of a Sea: A short history of yachting in the Mediterranean.*** The talk starts with the Periplus of Skylax, arguably the first sailing guide to the Mediterranean and continues on through early contributions from the Greeks to the first Portulans. Sailing guides for the yachtsman started in the 19th century but it wasn't until the 1960's that yachting pilots really came into their own with the likes of Henry Denham and Phillip Bristow and later the RCC Pilotage Foundation. Today electronic navigation has made our navigation so much easier, but there are caveats to navigation in the digital age. In this book he has painstakingly put together the history of sailing for pleasure in the Mediterranean from the ancient Egyptians up to the present.

About the speaker:

Rod Heikell was born in New Zealand in 1949 and sailed hesitantly around bits of its coast in a variety of yachts. In England he abandoned academic life and for no good reason other than curiosity, he bought a 1950's plywood JOG yacht nearly 20ft long, and sailed it down to the Mediterranean. He worked on charter here and delivered yachts until, in ignorance of the scale of the task, he set off to write a yachtsman's guide to Greece. This was followed by guides for other countries in the Mediterranean. Subsequent sailing voyages included to SE Asia and back for the research for Indian Ocean Cruising Guide. Apart from sailing the 'wrong' way and back again the 'right' way across the Indian Ocean, he has done four transatlantics. However, he always returns to the Mediterranean, his favourite cruising grounds, where with his wife Lu he updates his guides on the area.

Housekeeping: *There is no charge for attendance at the talk.* ***However, prior booking with the RTYC is required.*** *To book your place contact Sonia Rafi at the RTYC on 0207 201 6267 or email membersadmin@royalthames.com* ***Dress code for the Talk is Smart Casual (no jeans or trainers allowed). The talk starts promptly at 1845hrs.***

We hope this event can take place at RTYC and will review in September.

Sound the alarm! How many alerts are too many on a ship's bridge?

Lovro Maglić from the Faculty of Maritime Studies in the University of Rijeka takes us through his recent paper from The Journal of Navigation (Maglić and Zec, 2020).

What is an alert?

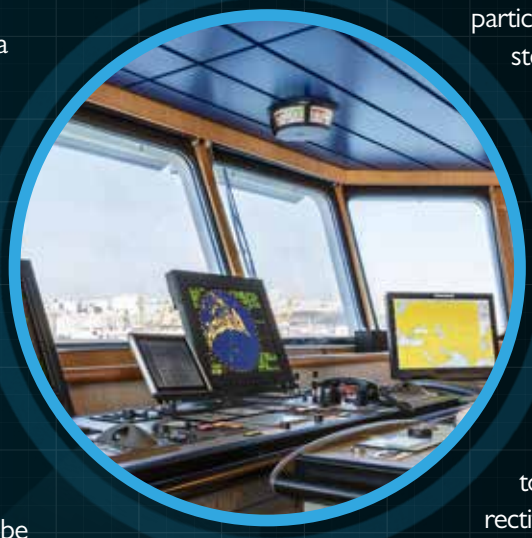
The International Maritime Organization (IMO) defines an alert as information indicating a circumstance or condition on a ship that requires the attention and possibly a specific task carried out by the Officer of the Watch (OOW). The alerts are classified as emergency alarms, alarms, warnings, and cautions. Emergency alarms indicate an immediate danger to human lives, the ship, or machinery, requiring immediate actions from the crew. Alarms indicate conditions, on or around the ship, requiring immediate attention and action from an OOW. Warnings indicate potentially hazardous conditions requiring attention and, possibly, actions, while cautions indicate low-priority non-ordinary conditions, requiring only the attention of an OOW.

Depending on the ship's bridge design and integration, alerts can be generated on devices and systems installed on a bridge (a so-called decentralized or "old" approach) or through the Central Alert Management Human-Machine Interface (CAM-HMI) as a part of the Bridge Alert Management (BAM) System (a "new" approach on integrated bridge systems). BAM is designed to improve alert management by listing alerts sorted by their priority, by grouping alerts triggered by the same cause and by providing a systematic record. One of BAM's main disadvantages is the fact that many alerts are duplicated, i.e. sounded on the CAM-HMI unit and the source system or device.

Generally, in integrated bridge systems, engine and cargo related alerts are displayed and sounded almost identically as in the engine and cargo control room. Nevertheless, the OOW's actions are very limited, often restricted to acknowledging and verifying the information. Further actions are the responsibility of the duty engineer or cargo officer.

How many alerts may be sounded on a bridge?

According to IMO altogether there are 69 mandatory navigation-related alerts and other essential ship systems' alerts defined for a bridge for all ships in international trade. However, on a modern bridge the total number of alerts exceeds this number significantly. An attempt to count all of a ship's alerts for research purposes took place on the Faculty of Maritime Study in Rijeka, Croatia. There the Transas Marine Navi-Trainer Professional 5000 bridge simulator has 202 different navigational equipment alerts. Additionally, the Kongsberg MC 90-IV engine simulator (MAN B&W MC 90 slow motion diesel engine) generates 482 different alerts. Finally, 164 alerts can be generated by the cargo simulator CHT 2000-VLCC-II for a Very Large Crude Carrier with 16 cargo tanks and four discharging pumps. It can be estimated that on some ships that have engine and cargo systems integrated on a bridge with unrestricted access through computer systems, approximately 850 different alerts may be sounded on a bridge.



Alerts in reality

According to recent research and based on the questionnaire survey with 104 participants considering different ship types during coastal navigation, on average 4 alerts are sounded per hour (Maglić and Zec, 2020). This frequency of alerts is significantly higher on faster, more complex, and modern ships (mainly container ships, different oil tankers and liquid gas carriers), counting even up to 10 alerts per hour or one every 5 to 6 minutes. Considering the breakdown of different alert types, alarms occur in approximately 27% of the cases, warnings in 38% and cautions in 35%. Engine-related alerts are sounded on a bridge in 90% of the ships, whereas cargo-related alerts (of any kind) in 56% of the ships. What is very interesting, according to the judgement of the participants, is that 45% of all alarm level alerts are over-prioritised and actually act as distractions in the moment of notification.

How an alert influences an OOW

As part of the same research (Maglić and Zec, 2020) an extensive experiment on OOW workload conducted on a navigational bridge simulator was carried out. The goal of the experiment was to observe the behaviour of the OOW during a navigational watch in high traffic coastal waters. One of the specific, and very interesting, aims was to analyse each action in the officer's procedure triggered by an alert. The results of the analysis, which included 220 alert procedures, showed that the reactions of the OOW vary between one and nine distinctive actions (or four actions on average) per alert. In most cases, low priority alerts (warnings and cautions) trigger only a visual observation and alert acknowledgement. On the other hand, uncommon and high priority alarms trigger more responsive and numerous actions. For example, almost all participants acted similarly in the case of a steering gear pump failure simulation: acknowledgement, turning off the autopilot, starting the second pump, rectifying heading, turning on the autopilot, setting the autopilot, calling the master, instructing the helmsman, calling the duty engineer.

A single action can last from less than 0.1 minutes (just a few seconds, usually for the first action including a visual check with acknowledgement) to more than 1 minute (for example, rectifying the ship's heading by manual steering). Considering all alert types and actions, the average time to conduct a single action is 0.35 minutes. According to the study it is estimated that after each alert an

OOW spends 1.4 minutes conducting four actions on average. The longest total time spent by the OOW recorded during an experiment, triggered by one alert, was 8.3 minutes. This included nine actions upon a gyro compass failure alarm.

Based on the study, it may be estimated that in one standard navigational watch of four hours, on average 16 different alerts are sounded, generating in total 64 actions that an OOW conducts in 22.4 minutes or 9.3% of the watch time.

There was one important observation. Nearly all the participants showed an idle time - time spent doing nothing between certain important actions, usually for a few seconds. The participants explained that these short periods were used for reflection and the planning of the next actions. Such reflection time is not included in the results. However, it is estimated that in many cases the reflection time can prolong the whole procedure time even up to 50%.

How many alerts are too many?

The following question arises: is it acceptable that approximately 10% of the OOW's time is spent on managing different alerts? If looking purely from a statistical point of view, the answer could be "yes". However, if superfluous and non-essential alerts dominate, and if they occur during a demanding navigational situation (such as collision avoidance, during waypoint course changes, distress or urgency message receipt, another high priority alert state, etc.) then the answer would be "no". Some of these demanding situations, like collision avoidance, can last for several minutes, and in such situations low priority alerts that require a few minutes of the OOW's attention may significantly reduce the situational awareness of the OOW. In other words, alerts do not "choose" a suitable moment for notification. Even the low priority alerts, not requiring "real actions", sometimes require walking, reading, acknowledgement, information collection from a source and related equipment, event record, forwarding information to other crew members, etc. When observing all the actions that an OOW conducts following each alert, it is not surprising that 45% of all the alerts are experienced as distracters, i.e. events that unnecessarily interrupt the processing of a previously started procedure.

There are several possible approaches to cope with the issue of the ever-growing number of alerts. One method would be a careful selection of permissible cargo and engine-related alerts, limiting the notifications only to alerts essential for the ship's safety or pollution prevention. The second approach could be developing an intelligent adaptive information system. Such a system could intercept low-priority alerts and postpone their notification for a short period during recognized demanding situations (Maglić et al., 2016). Finally, the third approach includes further development of automated systems and making them capable of carrying out remedial actions without the involvement of the OOW. In this case, the interaction with the officer should be limited to information about the situation after remedial actions.

So, how many alerts are too many? The answer lies in whether or not the alerts were worth distracting the OOW.

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Maglić, L., Zec, D. (2020). The Impact of Bridge Alerts on Navigating Officers. The Journal of Navigation, 73(2), 421-432.

Maglić, L., Zec, D. and Frančić, V. (2016). Model of the Adaptive Information System on a Navigational Bridge. The Journal of Navigation, 69(6), 1247-1260.

Example of a bridge alarm log

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Branch & SIG News

BRANCH NEWS – East Midlands

East Midlands Branch embrace webinars

McRae Crew 463Sqn 1945. Spot the Navigator. Credit: Bruce and Alan McRae

Anxious to retain Members' interest through the CV19 lockdown, East Midlands Branch has been experimenting with webinars. On Tuesday 12th May, the Branch's combined lecture at Newark Air Museum was replaced by a webinar titled 'An analysis of a Lancaster Navigator's Logs and Charts' from Dave Pike, East Midlands Branch's Hon Secretary and former RAF Navigator. The webinar was advertised locally and via the RIN Website where people wishing to watch were required to register. The results were very pleasing. 71 people registered to watch. 64 people from as far afield as Australia and the USA did watch on the night, and 60 watched all the way through. Three of the four who left early emailed to say how sorry they were they were unable to watch all the way through. Apparently, in marketing terms, such a result should be classed as exceptional engagement. Our thanks go to RIN HQ for providing the medium, and to Clare Stead for giving her time to set up and present the webinar on the night and for coaching Dave how to do webinars.

If you're sorry you missed it, don't worry. You can still see it on YouTube by selecting this link **https://www.youtube.com/watch?v=vAS6qEohbvc** or by finding us on YouTube – just search for The Royal Institute of Navigation.

Gift Aid

If you are a UK Tax Payer and have previously made a Gift Aid declaration and your circumstances or wishes have changed then please advise the Royal Institute of Navigation or login to update your profile on the RIN website.

If you are a UK Tax Payer and have not previously made a Gift Aid declaration, please consider doing so. The criteria you need to meet are that you are not employed in the navigation profession and are not claiming UK income tax relief on your subscription. If this is you and you would like to Gift Aid your subscription, please contact Mick Watt **membership@rin.org.uk**. Thank you.

SPECIAL INTEREST GROUP NEWS – General Aviation Navigation Group

What was going to be a busy and exciting year has slowed down somewhat with the arrival of Covid-19. Some of the programme has been cancelled but others are postponed in the hope that given a fair wind we can recover them at short notice. I suspect that the opportunity to take part in some social activity towards the end of the season will be acceptable to many members.

Top Nav is probably the least likely candidate for re-scheduling. When the green light is given to the GA Community there will be much re-evaluating and getting currency back up to scratch that a rapid recovery may prove too difficult, however, we will not give up unless we must. We could mount the competition in September or at the latest, early October. The original planning was coming together very well with new competitors from Aerobility (Blackbushe) and the North Country. As soon as the future is clear we will get together and produce a new plan. Rest assured if it can be done, we will do it.

Fly-Sail was also postponed and, like Top Nav, if it is possible to mount the event in the early Autumn, we will do our best. It is more of a casual weekend which requires much less planning than Top Nav, so anything is possible. In fact, a relaxing weekend with like-minded folk is just what will be needed when the emergency is over. We will again hold the event in the Solent using Hornet Services Sailing Club and probably Seaview Yacht Club on the Isle of Wight. Once again, given the opportunity, we are ready to re-plan and schedule the event.

The LAA are presently continuing with planning for the Annual Rally which will take place in early September. The event will be held at Sywell and we hope to be present for all 3 days. A slightly different version of "Spot the Waypoint" will entertain and test you. I will join the LAA members in praying for a solution to the Covid-19 emergency before September and look forward to joining them on the day. The Rally will be the only large-scale GA event this year and is a favourite with us as it is a down-to-earth event with good contacts with the GA Community.

The Spirit of Vectis got off to a good start in February. Mark Batin, Rod Angel and I opened the workshop to parents and youngsters with a view to recruit a team to build our aircraft. We thought it would be successful in our first effort to recruit around a dozen youngsters. On the day we recruited 27 youngsters, 4 Dads with an engineering background, and one Aeronautical engineer with no children. Within days that was overtaken with 6 pupils from a special needs school escorted by a teacher who will give up her own time to help as she is so excited about building an aeroplane. At the open day, a local Scout leader brought his aircraft across to let the youngsters sit in it and get a feel for the project. He has since added 5 scouts to the list!

This was good news for us, we knew this was a good project and we have now discovered that a large percentage of the locals agree with us. We were ready to start production on the 25th April when Covid-19 struck! We are now lying low waiting on the emergency to end and expect to be back online possibly in September but probably later.

SPECIAL INTEREST GROUP NEWS - Small Craft Group

My last report was on day 10 of the Covid-19 lockdown, today I am writing this on day 66! Fortunately, we are now allowed a bit more freedom so I hope those of you with boats have been able to get afloat again, if only for day trips.

You will not be surprised to hear that our plans for events are under constant review. The SCG AGM which was to be held on 19th March we have now changed to 19th November at the Royal Thames YC before the re-scheduled talk by Rod Heikell. We had considered holding a virtual SCG AGM on the same day as the virtual RIN AGM but think that would be too difficult to organise, so have opted for the next available talk. Obviously, we will keep both the SCG AGM and the talk under review and consider both with respect to government guidance some time before the event.

At present we are also continuing with planning the Weather & Sailing conference, scheduled to be held at the RNLI Poole on 7th November. That event will obviously require a "clear run" of several months if it is going to attract sufficient attendees so we will have to review the position with our partners, the Royal Met. Soc. in August. The same is probably true for the Weather & Sailing conference in Ireland planned for 3rd December in Dun Laoghaire, which is a joint event with the Irish Met. Soc.

Those of you who were booked in to the visit to the NLB depot in Oban should note that we are aiming to re-schedule the visit for early next year. For information on all currently scheduled events and booking arrangements, please see the RIN website.

Jane Russell has now circulated the second draft of the Electronic Navigation booklet to the main stakeholders for comments. This draft incorporates many of the suggestions and ideas from those who reviewed the first draft at the time of the conference in January at the Royal Lymington YC. We are very grateful to Trinity House for their financial support for the preparation of this booklet and hope to be in a position to launch it in the autumn, Covid-19 restrictions permitting.

I look forward to seeing many of you in November but for the next few weeks stay safe and I hope you can get as much exercise as possible, hopefully even out on the water!

Space Weather

Space weather and its impacts here on Earth are largely controlled by the solar cycle, an approximately 11-year cycle which describes the level of activity on the Sun. There are four phases of activity, starting with solar minimum when there are extended periods with very few (or no) sunspots visible on the Sun's surface, through the ascending phase when the number of sunspots increases. Then solar maximum when the number of sunspots peaks and we see a big increase in the number of solar flares and coronal mass ejections, before heading through the descending phase back to solar minimum.

An international panel chaired by NOAA and NASA has recently predicted that the solar minimum marking the end of solar cycle 24 would occur in April 2020. However, numerous small sunspots that appeared towards the end of the month have led to speculation that the Sun is already beginning its next solar cycle – cycle 25.

Despite being so close to the solar minimum, the largely quiet conditions of recent months have been interrupted by a few small bursts of activity. Notably a few streams of high-speed solar wind associated with coronal holes (cool regions in the solar corona which allow more particles to escape) caused some minor activity on 8th and 11th April, and a small coronal mass ejection (an explosive release of plasma and magnetic field from the corona) had an impact at the Earth on 20th April leading to some active geomagnetic conditions.

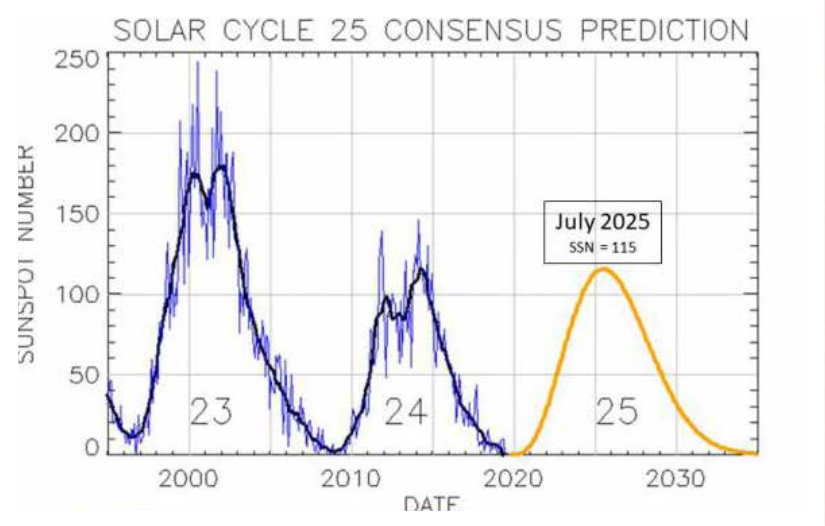
As we move out of solar minimum and head into solar cycle 25 (expected to peak between December 2024 and March 2026) it is likely that we will see an increase in the number and magnitude of space weather storms, including geomagnetic storms, radio blackouts and solar radiation storms. Whilst these storms do not pose a threat to life, we may see some impacts on the technology we now rely so heavily upon.

At the present time solar cycle 25 is expected to be similar to cycle 24, which has been relatively small compared to previous cycles, but it is important to keep in mind that predicting solar activity is incredibly difficult, and large storms can occur at any time, even during solar minimum.

Gemma Richardson
geomag.bgs.ac.uk
British Geological Survey
Picture from https://www.swpc.noaa.gov/news/solar-cycle-25-forecast-update

Solar Cycle 25 Forecast Update

- Released December 9th, 2019-



Solar Cycle 25 will have a peak SSN of 115 (± 10) in July 2025
Solar Cycle 24/25 minimum will occur in April, 2020 (± 6 months)

Weather & Sailing 2020

7 November 2020

RNLI Training College, Poole

RIN & RMetS Members: £36

Non-Members: £48

(Includes lunch and refreshments)

- Are you a keen sailor whether by power or sail?
- Are you a weather enthusiast or a professional from the sailing or meteorological communities?
- Want to learn more about Weather and Sailing's powerful relationship?
- Need extra knowledge to improve both safety and performance?

Then Weather & Sailing 2020 is an event you won't want to miss!

For registration and further information see:
rin.org.uk/event/WeatherandSailing2020

@at_RIN The Royal Institute of Navigation

Weather & Sailing

3 December 2020

Royal Irish Yacht Club Dun Laoghaire

- Are you a keen sailor whether by power or sail?
- Are you a weather enthusiast or a professional from the sailing or meteorological communities?
- Want to learn more about Weather and Sailing's powerful relationship?
- Need extra knowledge about how technology improves safety and performance?

Then Weather & Sailing is an event you won't want to miss!

0900 – 1700

Register early, places are limited and this event **will** sell out.

REGISTRATION WILL OPEN IN DUE COURSE: Through the Irish Met. Society website: www.irishmetsociety.org

COMPASS POINTS

Forthcoming Navigation Events

ALL INTERESTS

Thursday 8 October

Annual E.G.R. Taylor Lecture

Estimates and Instruments: The Case for Comparative Maritime History with Dr. Margaret Schotte.

This webinar is an event that the RIN, RGS and Hakluyt society collaborate to hold in the memory of E.G.R. Taylor. Further details and information about how to access this webinar will be provided in due course

15-18 November 2021

Navigation 2021

Navigation 2021 where the International Navigation Conference (INC), European Navigation Conference (ENC) and the International Association of the Institutes of Navigation (IAIN) World Congress meet in 2021 in Edinburgh, Scotland.

The website for Navigation 2021 is now live - visit rin.org.uk/Navigation2021 for further information.

SMALL CRAFT GROUP

Saturday 7 November, 0945

Weather & Sailing 2020

The joint Royal Institute of Navigation (RIN) and Royal Meteorological Society (RMetS) one-day seminar will take place at the RNLI Training College. Make sure to put the date in your diary. We hope to be able to confirm the event and open registrations later in the summer – we will then recommend registering early to secure your spot as this event is sure to sell-out!

Thursday 19 November, 1730

Small Craft Group AGM and Joint Talk

From The Periplus Of Skylax To The Digital Age with Rod Heikell

The RIN Joint RIN Small Craft Group/Royal Thames Yacht Club Joint Autumn Meeting will be held in the Queenborough and Paget rooms on the ground floor of the Royal Thames Yacht Club, following on from the RIN SCG AGM.

The topic for Rod Heikell's talk is based on the last chapter of his latest book 'The Gift of a Sea: A short history of yachting in the Mediterranean'.

To book your place for the AGM and/or talk please contact Sonia Rafi at the RTYC on 0207 201 6267 or **membersadmin@royalthames.com**

Thursday 3 December, 0900

Weather & Sailing Ireland

Weather and Sailing Ireland 2020, the joint Royal Institute of Navigation (RIN) and Irish Meteorological Society (IMS) one-day seminar will take place in Dún Laoghaire on 3rd December 2020. As with the inaugural Seminar, held in 2018, the event is sponsored by Dublin Port and hosted by the Royal Irish Yacht Club.

The Seminar will bring together sailors and meteorologists to share their experience and expertise in what promises to be an informative and enjoyable event.

The Seminar begins with registration at 0900 and finishes at 1700. Further information will be available in due course.

For the latest updates about RIN events please see rin.org.uk/events

More information about all these events can be found at www.rin.org.uk. If you have an event that should appear in Compass Points please contact the Editor: **comms@rin.org.uk**

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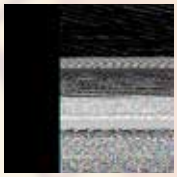

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How did you hear of the RIN?

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Please tick. NB - all fees are free of VAT

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- ☐ Junior Associate Member (Under 18) £11.00*
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- ☐ Affiliated College £191.00*
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- ☐ I wish to apply for Associate Fellowship (AFRIN)

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