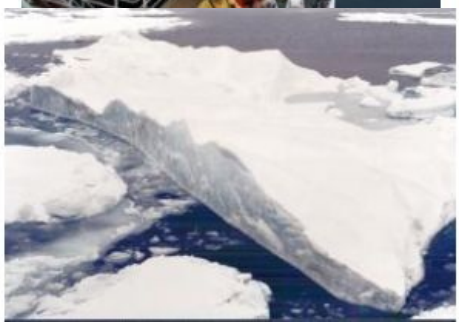
STILL NO PERFECT ELECTRONIC SOLUTION TO THE CHALLENGES OF ICE NAVIGATION

Ice Navigation and the Â-Electronic Age



Ice navigation is more of an art than a science, and like most arts, does not fit neatly into any scheme for enhancement by electronic means. It is an art learned in theory at navigation school, and perfected by many years of practical experience in forcing ships though ice. The successful ice-navigator is living proof that the human brain processes data faster, and with more accurate results for correct decision-making, than any computer currently in service. Thus, it becomes clear that electronic assistance to the process will consist mainly of the provision of tools, which will not only make the planning process for a voyage through ice more accurate, but can also quickly incorporate changes to the ice conditions while en route, and the consequent modifications to the base plan for that route.

The successful ice-navigator can be described as one who succeeds in bringing a vessel from departure point to destination in a reasonable amount of time, without the vessel suffering significant damage, or serious delay caused by any ice which has been met along the route. The basic premise that ice navigation will involve some risk of damage, some delay in arrival, and much extra effort on behalf of the crew, will never be negated by the provision of any electronic assistance. Ship-owners and charterers must accept that adding electronic gadgetry is not going to be a panacea for all the problems posed when their vessels are committed to routes through ice-covered waters, and no artificial intelligence will ever be able to substitute for human experience, navigating in an infinite variety of ice conditions.

Ice avoidance - the formulation of a Strategic Plan

For those who have never - or seldom - navigated in ice, perhaps it would be valuable to present a brief description of the process. Once the decision has been made to send a vessel between ports where sea-ice may be encountered, a Strategic Plan is formulated. A ‘Base Plan’ of the route is selected, founded upon safe open water navigation principles. A map of the current ice conditions is overlaid on the ‘Base Plan’ chart, and modifications to the selected courses are made, so as to avoid the ice completely if possible, or to minimise the time in serious ice conditions if not. This is the ‘Strategic Route’. The basic principle in ice navigation is, of course, to avoid ice if you can. Even if staying in the open water extends the distance between ports by a substantial amount, the time difference can usually be made up by increased speed possible in open water.

Tactical Plan Needed in the Light of Daily Changing Ice Conditions

While the vessel is steaming towards the destination, the ice conditions are changing daily - sometimes hourly - so the ‘Tactical Plan’ comes into play, as the original strategic courses are modified even more to reflect the movement of the ice. The final fine-tuning is done in the ice-navigator’s brain as the ice is observed by eye from the wheelhouse. Minute-by-minute decisions for manoeuvring are based on the interpretation of what the ice-navigator sees through the wheelhouse windows ahead, to the sides and all around. It is this final process which no electronic system has thus far been able to emulate, because the experienced ice-navigator is unconsciously processing in his

mind all of the clues presented by the observed ice conditions. These clues indicate the different types of ice - of which there are seventeen officially recognised ; the selection of dangerous floes from others which do not threaten damage; the onset or release of pressure; the thickness and age of the individual floes; the advance or retreat of the melting processes on the ice-field; the snow-cover concealing dangerous ice features; the effects of wind and tide, and a host of other small details which remain undetected by any electronic sensing systems.

Electronics Can be of Assistance to the Ice-navigator, But are too Expensive for Most Vessels

All of the above does not deny that electronics can be of assistance to the ice-navigator, especially where electronic navigation charts are in use. For vessels such as Government icebreakers, which spend their entire lives engaged in ice navigation, there are already some very sophisticated systems which will overlay satellite ice-imagery in real time on radar displays, but these systems are very expensive and out of reach for the vessel which makes occasional forays into ice. Much of the ice-information broadcast by Government Agencies is available in electronic form, sometimes downloaded directly from the Internet, or by subscription to specialised services. The author is personally not aware of any interface where these easily attained ice-maps can be overlaid directly on electronic navigation charts, but sees no reason why it is not technically possible. It has been the author's observation aboard vessels transiting Arctic and Antarctic waters that the electronic charts for Polar Regions leave a lot to be desired in accuracy of information, as well as the lack of navigational detail. These problems would need to be addressed before ice-chart overlays become standard practice. A more practical idea might be to project the image of an ice-chart directly on to a paper chart, with means to adjust the scale of the projection to match the scale of the chart beneath.

The electronic navigation charts already provide a very rapid means for revision of ship-tracks already programmed (the 'Base Plan'), so that a 'tactical' modification could be easily generated with an ice-map overlaid on the navigational data. Government ice maps are generated from data collected from various sources (satellite surveillance; aerial reconnaissance; visual observations; ship reports etc.) so they are almost always reporting on ice conditions which existed some hours - or even days - in the past. The accuracy of forecasts varies enormously, so that tactical ice navigation takes precedence over strategic planning once the vessel has entered the ice. It is therefore very useful to have a rapid means available to make frequent changes to the route, not only to make better progress through the ice, but also to understand the eventual outcome and navigational consequences of frequent modifications.

Sensors Could be Valuable in the Prevention of Serious Ice-damage

So far we have been looking at how electronics can assist the ice-navigator in making progress through the ice, but this is not the only contribution that electronics can make to the safe transit of a vessel. For vessels which can expect to spend more time navigating in ice than in open water (i.e: icebreakers and specialised vessels designed for polar work in the oil industry, or bulk carriers exploiting mineral resources in polar regions) it might be worth investing in sensors throughout the ship to indicate to the ice-navigator the punishment inflicted by the ice. This is particularly necessary in very large vessels, where the wheelhouse may be a long way from the bow, and the force of impacts on the hull will not be physically appreciated on the Bridge. There are many cases of serious ice-damage to the hulls of vessels which have gone completely unnoticed at the moment of impact, only becoming apparent when flooding occurs or an oil-slick appears in the water alongside.

"Navigating by the Soles of the Feet" not Enough on Larger Vessels

The installation of stress gauges in the fore-part of the hull above, at and below the ice-belt, also along the sides around the waterline, and on the rudder, propellers and shafting, with read-outs and alarms available to the ice-navigator, will go a long way in curbing excessive speed, as the readings delivered by ice-impacts will trigger visual and audible warnings. On smaller vessels the ice-navigator can - as the saying goes - "navigate by the soles of the feet", being aware of every impact, acceleration and sudden deceleration caused by the ice, which will attract the attention of the Captain if things become violent enough to cause damage. Such is not the case, however, on larger vessels, which must provide feed-back to the ice-navigator for physical sensations which do not penetrate to the command position.

The Pros and Cons of Electronic Remote-sensing and Ship-borne Sensing

There has been a lot of research for many years in electronic remote-sensing to determine the different characteristics of ice. So far, the greatest success has been with satellite-borne synthetic aperture radar equipment, and infra-red sensing to observe ice-surface temperature differences, thereby inferring the varying thickness of floes in an ice-field. Laser beams directed downwards from satellites can measure the roughness of the ice, and aircraft fitted with Side Looking Airborne Radar (SLAR) cameras can record the concentration of ice in great detail, even to the extent of identifying floes down to 10 metres in diameter. All of this is wonderful for reporting ice conditions to the mariner for strategic planning, but it is mostly very small scale, requiring special expertise in interpretation of the visual data, thus with limited use in tactical planning for the average seafarer. Research in ship-borne sensing has not been so successful. The sensor has such a close horizon due to its restricted height above the waterline, dictated by the height of the installation point on the mast or fo'c'sle, that the ice-navigator cannot plan more than the next move ahead, when subsequent moves through the ice must also be considered, just like in a game of chess. The human eye can do a better job for ice this close to the vessel, and the human brain can interpret the situation more quickly.

Marine Radar - the Advantages and Disadvantages

Marine radar has been used as a warning system for ice ever since it became commonplace on board ship for navigational purposes. While it gives a good warning that ice is present, it is not a great help in most attempts at finding a safe route through drift ice, because it cannot discriminate between different types of ice. The interpretation of the presentation is complicated by too many radar returns from ice which is not at all dangerous. Radar is thus not a good tool for finding a route through an ice-field. It is, however, very good at showing the limits of ice when approaching from open water. There is a tendency to rely too much on radar to warn of the approach of ice, particularly the most dangerous type of all, which is glacial ice (icebergs) or fragments of them (bergy bits and growlers). Small bergy bits and growlers

often disappear from both radar and visual view in a swell or rough seas, which makes them particularly dangerous. The development of the Automated Radar Plotting Aid (ARPA) and the computerised daylight-view radar screen assist the ice-navigator in ways that the older radars never could. The ability to maintain automatic plots of large numbers of stationary objects (icebergs), azimuth-stabilisation and true motion "north-up" displays give a realistic picture of the physical environment around the vessel, so that the ice-navigator can concentrate on finding a way through the ice by visual observation - still the best approach.

Sonar not a Solution

Forward-looking sonar is often advocated for warning of icebergs and their accompanying growlers, but there are very few merchant ships fitted with this, and the chance of locating by sonar small - but dangerous - ice fragments, with sufficient time to avoid collision is quite slim. Large icebergs are generally easily visible to the eye and to radar in darkness or thick weather, so sonar would be a duplication of effort. The only ice of interest to a vessel is at less than 10 metres depth, so a sonar system would have to be set very close to the surface, more likely to be inefficient, especially in rough weather. It would also be very vulnerable to ice damage and the shocks from ice-impact on the stem, probably not worth the cost of installation for the small benefit it might provide.

Conclusion: "Keep Looking out of the Wheelhouse Windows"

In conclusion, the art of ice navigation can be aided and enhanced by the use of electronic aids, many more of which are still in development, but the ice-navigator should never rely too much on equipment which can never show the full picture in anything like the detail provided by a good pair of eyes - with binoculars for the distant stuff. Remember the mantra, "keep looking out of the wheelhouse windows" and you should not come to too much harm.

---

https://www.hydro-international.com/content/article/ice-navigation-and-the-electronic-age