Port management – back to basics:

knowing what vessels are really doing in your space

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Technological progress

Compared with the current state of human machine interface science and technology, VTS systems lag years behind. This results in a significant limitation of VTS operators' efficiency and operational comfort, preventing VTS from fully performing its role in improving the safety of navigation in port waters. Luckily, there are solutions.

The last two decades have seen unprecedented technological progress in electronics, computers and software. With that progress an important trend, that marks the Twenty-First Century, becomes evident. As technology becomes ubiquitous it stops being perceived as something strange and different. Increasingly it becomes mainstream, blends with the environment, as an indispensable part of our lives.

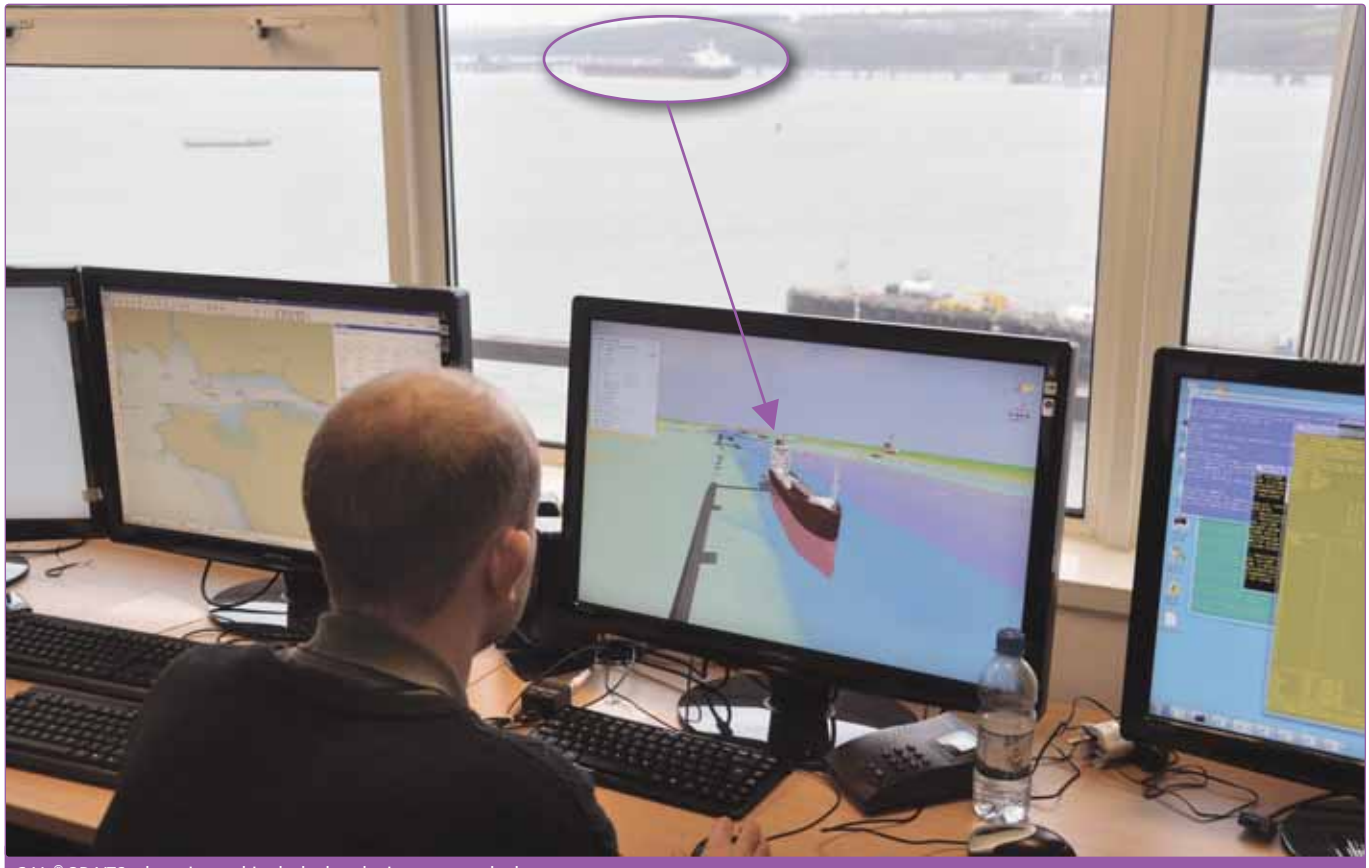
This is partially due to the technical capabilities of smaller and more powerful chips and displays, but also – in a large part – due to advances in human machine interfaces. It was realised that technology should no longer be a closed domain of clunky user interfaces for experts and highly trained operators. Instead the human spirit should be brought to the world of machines, which ought to become more ergonomic, intuitive and usable. Mobile phones and tablet computers are typical examples of such a human-centric approach.

Upgrading to three dimensional charts

According to the new paradigm, it is not people who should have to learn how to operate complex technology, often using badly designed interfaces, and then have to constantly keep bending themselves to its peculiarities and limitations – it is the computer systems that should be optimized to better cater to our needs, enhance our natural capabilities and compensate for our limitations. This approach dramatically enhances efficiency and improves operational comfort of the technology users.

In the marine world, as a result of that thinking, the idea of the three dimensional chart emerged. At first it was not completely clear whether, and how exactly, it would be better than its two dimensional counterparts. However, it seemed sensible to assume that removing the extra workload and concentration required to interpret two dimensional charts, and instead use the natural three dimensional cognitive capabilities of the human brain, should have some merits.

Indeed, formal research proved the benefits of three dimensional charts over two dimensional representations. In experiments, conducted for example by Dr Thomas Porathe at the Malardalen University in Sweden, it has been shown that the use of three dimensional charts leads to a significant reduction in human error and a similar increase in the navigator's



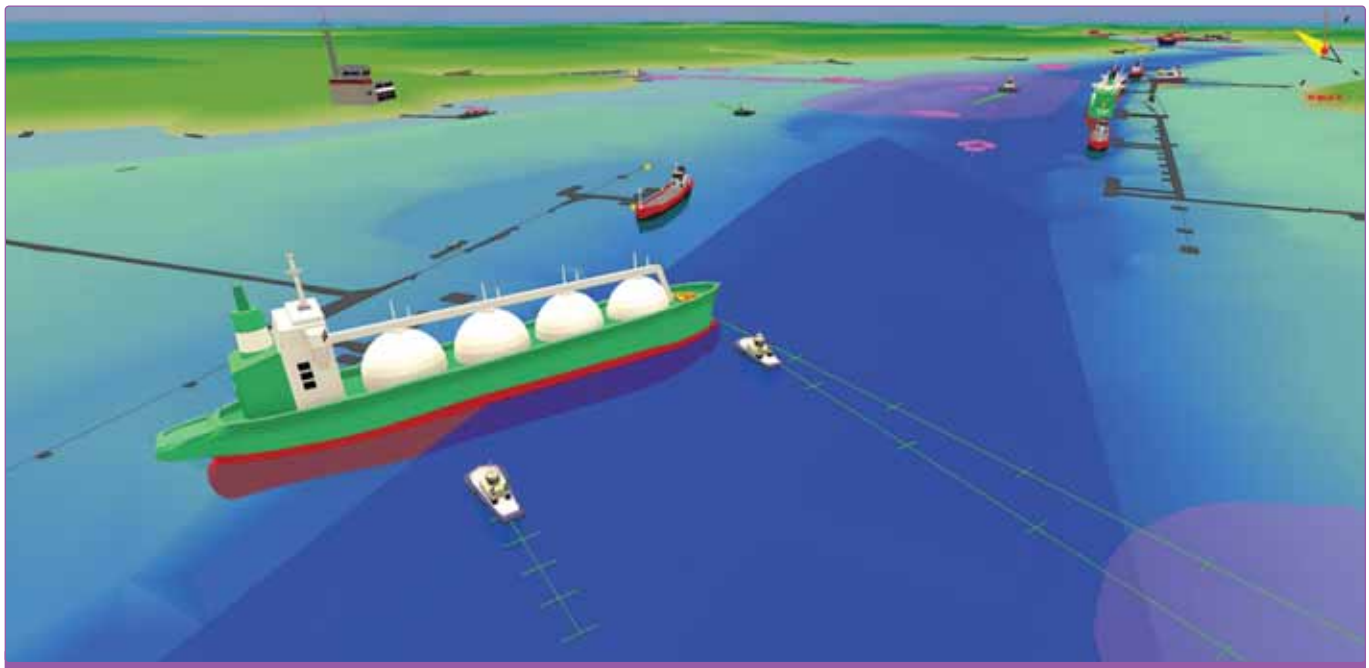
C-Vu® 3D VTS: observing a ship docked at the jetty across the bay.

efficiency. In the experiment, a large group of participants, with different levels of nautical expertise, were asked to complete a simulated navigational exercise using two dimensional and three dimensional charts. Not only was the average time required to complete the exercise about 50 percent shorter using three dimensional charts, but the participants made on average 80 percent fewer errors and selected the three dimensional chart as by far the most ergonomic. What is more important, the results were similar in all experience groups, from novice to expert.

The challenges

Despite such exceptionally encouraging results three dimensional charting is not easily achieved and currently is hardly ever seen in professional shipping and VTS. This is due to several

Milford Haven: escorting gas tanker into the port.



Milford Haven: gas tanker docking manoeuvre.

Milford Haven: Q-Max LNG tanker turned around on the way out, with depth safety markers on.

factors. Although it may be tempting to blame the natural (and undeniably healthy) conservatism of the marine industry towards new technologies, the far more important reason seems to be the difficulty of producing a three dimensional chart display which would be 'right', meaning as good for the purpose as the two dimensional charts are.

The traditional charts have a number of advantages: they have been around, and the art of cartography has been perfected, for hundreds of years. They are also much simpler with the removal of the third dimension. This allowed for a relatively easy transition from paper charts to electronic chart plotters. As interactive three dimensional environments are more complicated, and there is no similar body of cartographic knowledge and practice to tap into, the task of producing a truly usable three dimensional chart display becomes much more challenging. The third dimension brings new requirements in terms of data processing and presentation, visual optimization and symbolism, as well as design of user interfaces to allow efficient use.

A common misconception is the use of excessive photorealism, where a virtual reality representation is created, instead of a cartographic presentation. While this works very well in training simulators, where all real life perceptive limitations should be reconstructed for the purpose of realistic training, this is not the right approach to charting. In the same way as an aerial photo is much less efficient for navigation than a nautical chart created with cartographic skill for specific purpose, a photorealistic three dimensional visualization is not a three dimensional chart. What is needed is a truly cartographic approach where the visualization is optimised for fast comprehension of the important information.

Research in this particular direction has been conducted since 2001 at the Hong Kong Polytechnic University, French Naval Academy, University of Glamorgan and GeoVS Limited. The project has been conducted by a team consisting of sea going captains and computer experts, and involved studies in human cognition, user interface design, GIS and three dimensional cartography.

C-Vu® 3D VTS – Real Space Enhancement Engine

For the past twelve years my colleagues and I have been grappling with the complex realities of enhancing situational awareness for maritime safety. It's only now that we can integrate data from many sensors around a port to produce a real time three dimensional traffic management visualization tool. The tool is all about what the operator sees and interprets, and relies on an advanced software engine – RealSEE™ (Real Space Enhancement Engine) – operating with modern port computers and sensors. The real challenge has been to apply RealSEE™ without affecting the operational integrity of existing VTS. We can confidently state that we have achieved this.

The research resulted in the world's first three dimensional ECDIS prototype being demonstrated at SeaTechWeek in Brest in 2007. The three dimensional ECDIS and RealSEE™ technologies were subsequently commercialized and applied to C-Vu® 3D VTS, which was presented at the UK Harbour Masters Association and European Harbour Masters Committee seminar in April 2011, and officially released later that year. The system works on its own or as a bolt-on to existing systems, and employs the cartographic three dimensional technology to an ecosystem of port and navigational products, which also includes three dimensional chart displays for pilots and port boats, creating an integrated safety management system (ISMS). In this ISMS, different elements work together to efficiently distribute navigational safety related data and provide the most complete situational awareness picture allowed with modern technology.

The users work with efficient and ergonomic three dimensional interfaces which allow them to quickly comprehend static and dynamic data and respond quickly to developing situations. The static elements include official ENC S-57 charts, custom bathymetric surveys, and any custom objects (port infrastructure or buildings). Chart updates are automatically incorporated, and bathymetric surveys can be updated as often as needed. The dynamic data come from sensors such as AIS, radar, tide gauges, current profilers, meteorological buoys and others, but also from existing port systems (PMIS, VTS) or manual VTSOs' entries (marking of diving areas, adding custom objects or refining ship attributes.)

Ships are represented with their correct (symbolic) types and dimensions (including draught). System users can freely select any viewpoint and efficiently navigate within the chart area. They can also select a view from any ship's bridge, and observe vessels from any perspective. This supports a closer and more confident cooperation of VTS operators with pilots. To simplify the system's operation the user interface is highly automated.

All data are constantly recorded into safe database storage for over ten continuous years, and may be easily retrieved for replay or analysis at any time. This offers excellent incident analysis, training and evaluation capabilities. The traffic data stored in the database is also highly useful in port planning and risk assessment activities. C-Vu® is also a useful tool for presentations to non-experts, for example in litigation or to improve public engagement.

C-Vu® 3D VTS facilitates enhanced situational awareness, but also improves the efficiency and operational comfort of its users. Feedback from VTS operators from the Port of Milford Haven, which supported system development in its latest stages, confirms the benefits. VTS operators agree that C-Vu® is more ergonomic than the traditional VTS, and allows them to analyze local situations in much more depth. The claims vary from 'In a few years, all VTS systems will have to look like this' to 'it is difficult to switch back to using the traditional VTS system after C-Vu.' Even initial sceptics admit that 'this is definitely the move into the right direction' and emphasize the systems value to less experienced colleagues – which is an important benefit in its own right, given the current situation of diminishing sea-going experience in the port industry.

C-Vu® 3D VTS is a very new system, and the transition to three dimensional data in VTS is just starting, with eight out of ten top UK ports in various stages of the process of adopting the technology. That transition is inevitable, and exemplifies the process of technology becoming more user-centric, amplifying natural capabilities, and neutralizing the limitations of its human operators. The Twenty-First Century may already be a decade old, but for the VTS systems the best part of it is just beginning.

ABOUT THE AUTHOR

Dr Rafal Goralski, GeoVS' technical director, was the lead designer of the world's first three dimensional ECIDS prototype, and currently heads the development of C-Vu® 3D VTS. He is an expert in three dimensional cartography, with 15 years of experience researching human cognition, design of ergonomic interfaces, interactive three dimensional maps and GIS.

ABOUT THE COMPANY

GeoVS is the producer of C-Vu® 3D VTS and other three dimensional cartographic products that offer unmatched ergonomics and efficiency, improve operational comfort and situational awareness of VTSOs, port managers and navigators. The company specializes in bridging the gap between technology and people in port safety, management, planning, training and navigation.

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