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Use of Portable Piloting Units by Maritime Pilots

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The use of electronic navigation equipment onboard maritime vessels continues to increase, worldwide. The results of a recent Canadian study provide clear evidence that maritime pilots know what types of equipment to use -- and how to use them.

A Portable Pilot Unit (PPU) can be generally described as a portable, computer-based system that a pilot brings onboard a vessel to use as a decision-support tool for navigating in confined waters. Interfaced to a positioning sensor such as GPS/DGPS and using some form of electronic chart display, it shows the vessel's position/movement in real-time. In addition, PPUs provide information about the location/movement of other vessels via an AIS interface. Increasingly, PPUs are being used to display other types of navigation-related information such as soundings/depth contours from recent hydro surveys, dynamic water levels, current flow, ice coverage, and security zones. There is also some interest in using PPUs to access port/waterway information via the Internet.

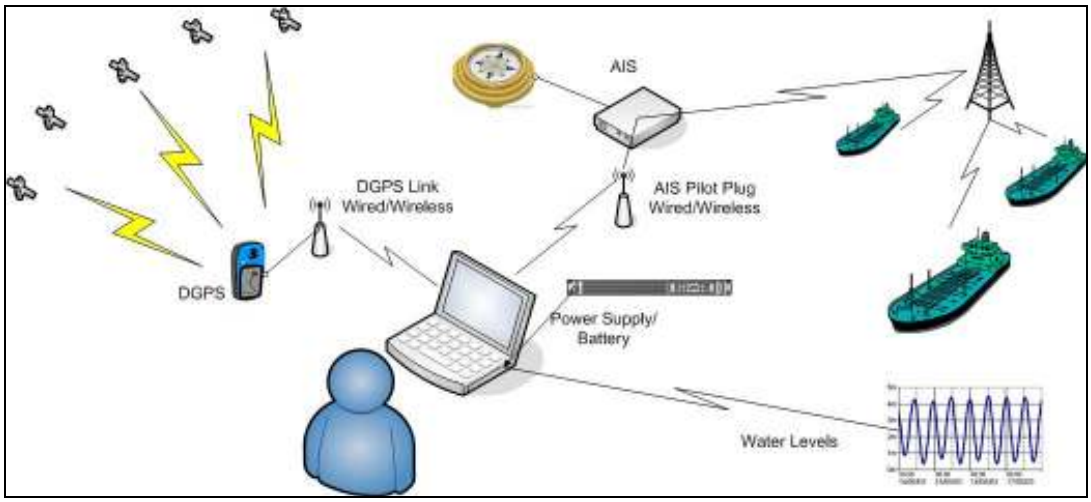

Figure 1 - General purpose diagram of a "typical" PPU.

On the St. Lawrence River in Canada, there is a federal government initiative to improve vessel navigation safety through the use of onboard electronic chart-related equipment and services. In particular, it is planned that all maritime pilots be equipped with PPUs. In order to make informed decisions regarding the acquisition and use of PPUs in the St. Lawrence River pilotage system, the Laurentian Pilotage Authority and Port of Montreal commissioned a study to investigate operational/technical aspects related to the use of PPUs. The main focus of this study was to determine what other pilotage organizations, primarily in North America and Europe, use as PPUs for approach/harbor or confined waters phase of navigation such as a river transit. Twenty-five pilots were interviewed representing piloting associations on the Fraser River (British Columbia), Columbia River (Oregon), Mississippi River (New Orleans), and Scheldt

River (The Netherlands). Major ports included Antwerp, Halifax, Houston, Le Havre, Tampa Bay, Rotterdam, Napier (New Zealand), and Queensland (Australia). The study investigated what was being used for computer hardware (e.g., a notebook computer), ECS software, electronic chart data, internet access, and interfaces to other navigation-related sensors and systems (e.g., GPS/DGPS, AIS, radar, VTS centers, etc.). The results of the study were to enable the Laurentian Pilotage Authority to make informed decisions regarding the acquisition and use of PPUs. Tables 1-3 summarize the results of our survey.

Main Finding

It was expected there would be some general agreement among the various pilotage organizations with respect to the use of PPU hardware, software, chart data, and positioning sensors, etc. However, this was not the case. Instead, the consensus we found pertains more to the process of choosing or designing a system -- rather than the system itself. Usually, the process involved forming a committee of seasoned pilots including some with computer savvy. These pilots determine what are the crucial navigation-related pilotage issues facing their region. They then focus attention on the most important pilotage issue, and then build a system to solve that specific problem. The PPU "system" typically involves other partners outside of the pilotage organization who are capable of providing the right type of information at the right time. Based on the pilots we interviewed, Marine Pilots know what information is needed and available, as well as how to obtain and use it in a PPU. As stated by Capt. Julian Planton (Houston Pilots), "*The current state of PPU capability* [i.e., what the Houston Pilots use] *is greatest single advancement in pilot navigation safety since the advent of radar*."

Different Requirements: Different Systems

Each piloting organization we interviewed had different challenges and PPU requirements:

Some examples:

Fraser River, British Colombia - The main challenge is maneuvering in a channel which shifts regularly, but unpredictably. The Fraser River pilots have a system which uses sounding data acquired 12 to 24 hours after it is obtained by the Port Authority. Chart overlays of depth areas, precise positioning, and access to real-time water level information are key components.

Colombia River, Oregon – Knowing the location/movement of other vessels on this long river transit is crucial. Using AIS information, their PPU system continually computes a "meeting point" from ownship to passing/overtaking vessels. They also rely on recent channel survey information (40' contour line) obtained from US Army Corps of Engineers.

Halifax Harbour, Nova Scotia - Pilots are very concerned about the air draft under the two suspension bridges. As such, they devised a system involving continuous and precise 3-D positioning of the bridges together with a link to a network of tide/water level gauges.

Port of Rotterdam - Pilots are responsible for berthing VLCCs and LNGs after navigating along the River Maas. They use highly-precise docking aids (i.e., sub-meter positioning and rate-of-turn indicators) and large-scale docking charts integrated into their PPU displays.

Table 1 – PPU Hardware

	System Integrator	Notebook Rugged	Notebook Brand	Pointing Device	Screen size (inches)	Ship's Power?	Carry-on Weight (pounds)	DGPS Carry-on	DGPS Connect	Pilot Plug Used	PPlug Connect
Fraser River Dave Majoribanks and Mike Armstrong	self	Yes	Panasonic Toughbook	Touch Screen	12	No	8	yes	Wireless	Yes	Wireless
Columbia River Paul Amos and David Halmagyi	VOLPE	No	Varies	Varies	14	Yes	2 to 6	Varies	Varies	Yes	Varies
Tampa Bay Pilots Jorge Viso	ARINC	No	IBM X-40	Track Pad	12	No	20	Yes	Wireless	Yes	Wireless
Europort Serendipity Pilot Training Peter Kluytenaar	QPS	yes	Panasonic Toughbook	Mouse	12	No	20	Yes	Wireless	Yes	Wireless
Pilots' Association for the Bay and River Delaware Wayne Bailey	RAVEN	No	IBM/Lenovo X60	Pointer stick	12	Yes	10	Yes	cable	(being tested)	cable (under test)
Port of Rotterdam - *Lite* Wim van Buuren	QPS	No	IBM/Durabook	Track Pad/ touch screen	12	Yes	3	No	-	Yes	Wireless
Port of Rotterdam -*Ful)* Wim van Buuren	QPS	Yes	Panasonic Toughbook	Touch Screen	10	Yes	35	Yes	Wireless	Yes	Wireless
Schldt River -*Lites* Rein Midavaine	QPS	No	IBM	Track Pad	12	Yes	3	No	-	Yes	Wireless
Schldt River -*Full* Rein Midavaine	QPS	Yes	Panasonic Toughbook	Touch Screen	12	Yes	35	Yes	Wireless	Yes	Wireless
Port of le Havre Lionel Davy	Marimatech	Yes	Xplore	pen	10	Yes	20	Yes	Wireless	No	N/A
Atlantic Pilotage Authority Andrew Rae	ICAN	Yes	Durabook	Mouse	15	Yes	5	Yes	Wireless	Yes	cable
Gt. Lakes Pilotage Auth. Andrew St-Germain	NavCruiser Pro	No	Dell	Mouse	15	Yes	5	Yes for Ice Nav	Wireless	Yes	Wireless
Queensland Pilotage Authority - *Lite* Chris Thompson	Marimatech	Yes	Talon semi-rugged	Track Pad Touch Scrn	14	Yes	8	Yes	Wireless	No	N/A
Queensland Pilotage Authority - *Full* Chris Thompson	Marimatech	Yes	Roughrider	Track Pad Touch Scrn	12	Yes	20	Yes	Wireless	No	N/A
Crescent River Pilots Douglas Grubbs	RAVEN	Yes	Panasonic Toughbook	Track Pad Touch Scrn	12	Yes	8	Yes	Wireless	Yes	Wireless
Houston Pilots Julian Planton	RAVEN	Yes	Panasonic T5	Touch Scrn	12	yes	18	Yes	Yes	Yes	Wireless

Table 2 - Software and Charts

	System Integrator	Software	Vendor	Site	Operational Chart Data	HO or Gov't-approved	Background ENC/RNC	Precise Depths	Super scale Docking Charts	Software Complexity
Fraser River Dave Majoribanks and Mike Armstrong	self	Coastal Explorer	Rose Port Navigation	rosepointnav.com	Channel Survey	Yes	ENC	Yes	Yes	Lite
Columbia River Paul Amos and David Halmagyi	VOLPE	TransView	Transas	www.volpe.dot.gov	Channel Survey	Yes	RNC	Yes	Yes	Rich
Tampa Bay Pilots Jorge Viso	ARINC	Pilot Mate	ARINC	www.arinc.com	Channel Centre Line	Yes	ENC	No	Yes	Rich
Europort Serendipity Pilot Trng Peter Kluytenaar	QPS	Qastor	QPS	www.qps.nl	Channel Survey	Yes	ENC	Yes	Yes	Rich
Pilots' Association for the Bay and River Delaware Wayne Bailey	RAVEN	Wheel House 1	RAVEN	www.ravenprecision.com	Channel Centre Line	Yes	custom vector chart	No	No	Lite
Port of Rotterdam - *Lite* Wim van Buuren	QPS	Qastor	QPS	www.qps.nl	ENC/Channel survey	Yes	ENC	Yes	Yes	Rich
Port of Rotterdam - *Full* Wim van Buuren	QPS	Qastor	QPS	www.qps.nl	Channel Survey	Yes	ENC	Yes	Yes	Rich
Schldt River - *Lite* Rein Midavaine	QPS	Qastor	QPS	www.qps.nl	ENC	Yes	ENC	No	No	Rich
Schldt River - *Full* Rein Midavaine	QPS	Qastor	QPS	www.qps.nl	Channel Survey	Yes	ENC	Yes	Yes	Rich
Port of le Havre Lionel Davy	Marimatech	ORCA	7C's	www.sevencs.com	Channel Survey	Yes	ENC	Yes	Yes	Rich
Atlantic Pilotage Authority Andrew Rae	ICANN	Aldebaran	ICAN	www.icanmarine.com	ENC	Yes	ENC	No	No	Rich
Great Lakes Pilotage Authority Andrew St-Germain	NavSim Pro	NavSim Pro	?	www.navsim.com	ENC	Yes	ENC	No	Yes	Rich
Queensland Pilotage Authority - *Lite* Chris Thompson	Marimatech	ORCA M	7C's	www.sevencs.com	Specialty ENC	Yes	ENC	Yes	Yes	Rich
Queensland Pilotage Authority - *Full* Chris Thompson	Marimatech	ORCA M	7C's	www.sevencs.com	Specialty ENC	Yes	ENC	Yes	Yes	Rich
Crescent River Pilots Douglas Grubbs	RAVEN	Wheel House 2	RAVEN	www.ravenprecision.com	Channel Centre Line	Yes	ENC	No	Yes	Rich
Houston Pilots Julian Planton	RAVEN	customized Raven	RAVEN	www.ravenprecision.com	Channel Survey	Yes	ENC	No	No	Rich

Table 3 – Operations

	Transit Duration (Hours)	Setup Time (Minutes)	Use Ship's Gyro ?	Integrated with Radar/ARPA	Integrated with VTS	In transit Internet	System use to support Docking?	Specialized Docking Technology
Fraser River Dave Majoribanks and Mike Armstrong	2 - 3	2 - 3	Yes	No	No	No	Yes	No
Columbia River Paul Amos and David Halmagyi	5 - 11	1 - 3	Yes	No	No	No	Yes	No
Tampa Bay Pilots Jorge Viso	3 - 5	5	Yes	No	No	Yes	Yes	No
Europort Serendipity Pilot Training Peter Kluytenaar	3	15	No	No	No	Yes	Yes	Yes
Pilots' Association for the Bay and River Delaware Wayne Bailey	1 - 12	5	No	No	No	No	No	No
Port of Rotterdam - *Lite* Wim van Buuren	3	1	Yes	No	No	Yes	No	No
Port of Rotterdam - *Full* Wim van Buuren	7	7	No	No	No	Yes	Yes	Yes
Schldt River - *Lite* Rein Midavaine	10	1	Yes	No	Yes (as of Aug07)	Yes	No	No
Schldt River - *Full* Rein Midavaine	10	7	No	No	No	Yes	Yes	Yes
Port of le Havre Lionel Davy	3	17	No	No	No	No	Yes	Yes
Atlantic Pilotage Authority Andrew Rae	1.5	3	Yes	No	No	No	Yes	No
Great Lakes Pilotage Authority Andrew St-Germain	9	3	Yes	No	No	No	Yes	No
Queensland Pilotage Authority - *Lite* Chris Thompson	4	2	No	No	No	No	No	No
Queensland Pilotage Authority - *Full* Chris Thompson	2	5	No	No	No	No	Yes	Yes
Crescent River Pilots Douglas Grubbs	7	5	Yes	No	No	Yes	Yes	No
Houston Pilots Julian Planton	.75 – 8 hrs (ave: 5.5 hrs)	2-3	Yes	No	No	Yes	Yes	No

Hardware – Of the 500 PPU units surveyed, over one-half are ruggedized notebook computers. Many pilotage authorities allow each pilot to choose their own notebook computer hardware. Screen size varies from 10" to 15" with 12" screens being the most popular. All run Windows XP, most with 1 Gbyte of RAM. Most use ship's power but also carry batteries to cover a 3-hour power loss. Weight is not a major consideration. Some pilots prefer soft packs while others use hard-molded cases.

Software - There is no consensus on what to use with widely differing views. In general, most North American pilots seem to prefer simplicity in their operational displays. But, some choose from a system with a rich selection of options while others prefer less-complicated systems with a minimum display (i.e., "*Keep it simple*!").

Electronic Chart Data - Most pilots use S-57 ENCs provided by a hydrographic office. But, this type of electronic chart is primarily used as a background. Instead, many rely on larger scale and more recent data provided by other government agencies (e.g., port authorities, US Army Corps of Engineers) for accurate channel depths or to assist in docking/close-quarters maneuvering.

Sensor Interfaces

GPS/DGPS/RTK: Most pilots use the ship's GPS/DGPS position as provided through the AIS Pilot Plug. However, many carry their own DGPS units and choose whether to deploy it depending upon the current situation or task-at-hand. For instance, European pilots involved in docking use Real-Time Kinematic GPS or purpose-built, precision docking aids.

Heading: Nearly all pilots obtain ship's heading information via the Pilot Plug. Depending upon the task, some pilots bring aboard special dual-antenna DGPS for heading. Some docking pilots in Europe also use rate-of-turn sensors.

AIS: All pilots access AIS via the Pilot Plug. However, the Pilot Plug itself has been a difficult issue for most due to wiring problems, wrong baud rates, and a poor mechanical plug design. This problem is slowly improving.

VTS: No pilots felt an urgent need to integrate VTS (or radar) into their PPU.

Internet Access: Few pilots feel a need to access the Internet while underway. While some view future enhancements as potentially beneficial, the current attitude is "wait-and-see."

Wireless or Hardwired: There are widely differing views as to what is suitable or desirable. Even among the wireless supporters there are two different camps (e.g., *Bluetooth* and *WiFi*).

Operational

Once aboard the vessel, pilots usually have their PPUs up and running within 2-3 minutes. If they deploy their own DGPS this can add an additional five minutes. Docking systems take longer to deploy but often there are assistants or pilots-in-training who help.

- Updating and route planning is done prior to boarding.

- Ownship parameters (e.g., length, beam, draft, etc.) are usually entered prior to boarding.

- Some pilotage organizations take PPU training very seriously while others less so.

- Maintenance is carried out yearly or as needed. Where there are more than 30 PPUs deployed often a technician is assigned full-time to perform maintenance.

Concerns about Using PPUs

In the March 2007 issue of *Digital Ship* an article by Dr. Andy Norris expressed some concerns regarding the use of PPUs. The following table lists the five "concerns" as described in his article. In turn, we provide a "comment" that is based on the results of our study findings.

Table 4 – Comments regarding published concerns on the use of PPUs

Concern (From an article by Dr. Andy Norris in *Digital Ship*, March 2007, p. 30.)	**Comment** (based on results of the "Use of PPU by Maritime Pilots" study)
1. *If the ship can only be safely navigated with the special data available to the pilot, what happens if this single unit malfunctions?*	Pilots treat PPUs as just another tool in their toolbox. If any tool fails there are always alternatives. Pilotage has been carried out for decades without the use of PPUs. Pilots can always fall back onto other tried-and-true methods.
2. *The ship's master and officers are alienated from the data that the pilot is using, yet the master continues to accept responsibility for the command of the vessel.*	Pilots and Masters share their procedures during the initial meeting onboard. Good "Bridge Resource Management" (BRM) means that the Master is always aware of what information the Pilot has available and how it is being used. Pilotage, by definition, is about using the local knowledge of professional Pilots – in depth local knowledge that most Masters acknowledge they will never possess.
3. *If there are discrepancies between the PPU and the ship's navigation system, which system should take precedence?*	The PPUs that have their own DGPS usually have a higher degree of accuracy than the shipboard unit. All Pilots compare their own system position to the ship's upon boot-up - any discrepancies can be identified at that time. Pilots also continually monitor all sources of positioning.
4. *There are no internationally agreed standards for such equipment to ensure data accuracy and reliability of the equipment, or that the equipment would meet IMO standards for ship's navigation equipment. What would be their status in the case of an accident?*	Liability always depends upon the court. All Pilots are obligated to use the best tools available to them. There is a growing consensus among pilots that PPUs of one form or another are a useful tool for improved pilotage. One could equally argue if a Pilot failed to use a proven and available technology, then he/she may be held liable.
5. *How is it ensured that there are no electromagnetic or compass compatibility issues between the ship's navigation equipment and the PPU?*	Most PPUs can interface to the ship's gyro via the AIS Pilot Plug. But, not all ship's gyros provide a digital output. As such, many pilots rely on COG from GPS instead of "true" heading that would be provided by a gyro compass.

In all fairness to Dr. Norris, the concerns he cited about PPUs are similar to what others have expressed. However, the results of our study provide some further insight about the pilots use of PPUs. In particular, maritime pilots are confident in their ability -- and in the tools that they use.

Pilot's Confidence

We expected there would be a number of concerns expressed by pilots about the "pitfalls" of using PPUs. Further, we expected to hear some anecdotal descriptions or "horror stories" about circumstances or situations when a PPU caused a problem. However, this was not the case for the pilots we interviewed. If anything, almost all pilots expressed confidence that they knew both the capabilities and limitations of their PPUs. Further, they indicated that they always had a means of backup or a contingency plan. While a few admitted that they felt somewhat "uncomfortable" if they did not have a PPU to use while piloting, none said that it was critical in the performance of their professional duties. As commented by Capt. Wayne Bailey (Delaware River Pilots), "A guiding principle in our use of the PPUs is: "*Never do something with one of these systems that you would not do without it."*

Implications for Hydrographic Data and Services

There are several implications on the use of PPUs that are relevant to a HO. Most obvious is the use digital nautical chart data.

Most pilots have ENCs available but usually rely on specialized chart data tailored specifically for them. The special post-survey sounding charts prepared for the Fraser River is one example. Most pilots involved in docking or tight port maneuvers employ very accurate port charts ("super-scale") with piers and jetties mapped to a high degree of accuracy (+/- 1 metre) to allow for docking in all visibility conditions. In Queensland**,** pilots who use such charts with their docking systems speak of "instrument pilotage" as the way forward. In some cases a raster chart is actually preferred as the background chart in addition to (or instead of) the vector-based ENC (e.g., Columbia River).

Some specific implications related to the use of electronic chart data:

- The timeliness of the data is often more important that its accuracy or level of content. This is particularly true for dynamic rivers where the river bottom is constantly changing.
- Overlays of decimeter contour lines or depth areas are relied on more than the information contained in ENCs. This is crucial in terms of determining under-keel clearance.
- ENCs are the background upon which other more recent information is added (as an overlay).
  - channel center line
  - recent channel survey
  - depth areas/depth contours
- Specialty ENCs are widely used
  - very large scale (1:5-10K)
  - produced by commercial company or Port Authority
  - Super-scale docking charts (.>1:1000)

More general implications include:

- Pilots use hydrographic data in unconventional ways to solve real-world problems. HOs provide a valuable service when they make themselves open to this approach through a partnership with the pilots.
- Pilots can be a constant source of new information about the quality of the chart data as they are often the first mariners to use it. The closer the partnership, the more the information flows both ways.
- Hydrographers are by now well aware that others use HO data for unintended and sometimes unimaginable purposes such as flood zone mapping, coastal interdiction, wetlands management and adapting to the implications of climate change. This open, "use-it-how-you-will" approach should also apply to professional mariners (e.g., maritime pilots).
- If professional mariners choose to display or use chart data in non-traditional ways it is their business. HOs should be judgmental. Pilots are cutting edge in terms of how used and displayed.
- Provide the best data, but then leave it up to the professional mariner to decide how to use it. Standards are useful, not if they inhibit innovation.

- Qualifying the data in terms of accuracy and currency is now perhaps a HO's most important role in promoting the use of electronic charts for safety-of-navigation.
- The traditional navigation chart (as we know it) may survive for another 10 or 20 years. But, sooner or later, it will be replaced by another entity. The evolution of that product → service is now underway, and being led by mariners who are largely unconstrained by tradition and a sense of historical importance to icons such as paper charts. HOs would be well served to support that evolution.

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Biographies

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Michael J. Casey is a Senior Executive with IIC Technologies Inc. His major focus is on new business development in the hydrographic and marine navigation communities. He is also closely involved in the use of Lidar technology in both the marine and topographic environment, specifically investigating evolving applications for a wide variety of users.