Notes

A Note on Emerging Hydrographic Technology & Applications[1]

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The Objective of the IHO's Committee on Hydrographic Research in Information Systems (CHRIS) Technology Assessment Working Group (TAWG) is to assess the potential of present and developing information technology and applications. TAWG makes technology assessment reports to CHRIS every two years. This note summarizes the November, 2000 report.

The Assessment of Emerging Technology

In the most part technology advances incrementally with widely spaced intervals between significant breakthroughs. A good example of this incremental change phenomenon can be seen in semi-conductor technology and the advances made in integrated circuits. The step by step advance has been so repetitive and predictable that it has even been coined with a name – **Moore's Law**[3] which states that computer power will double every 18 months as it has for nearly two decades.

This kind of sequential advance has become so ingrained in our modern cultural mind set that most buyers of high technology devices today expect this kind of learning curve growth in power and rapidly declining pricing. In fact we now count on it. We have come to expect breakthrough technologies to be followed by a period of steady incremental advances.

Often the breakthrough technologies are so fundamental that they cause a shift in people's behavior or thinking. These are the paradigm shifts, described by Thomas Kuhn in ***The Structure of Scientific Revolutions*** in 1962[4]. Paradigm shifts are a concern for planning any distance into the future. This is one of the reasons for regularly reviewing emerging technologies, particularly those that lie outside one's normal sphere of contact. Paradigm shifts are frequently led from outside this sphere since those within have learned the rules through the existing shared paradigm.

1 *A full copy of the Report is available at http://www.openecdis.org/*
2 *M.J. Casey is the Chair of the Technology Assessment Working Group (TAWG) of the IHO's Committee on Hydrographic Research in Information Systems (CHRIS).*
3 *Semiconductor pioneer Gordon Moore predicted in 1965 that chip density would double every 18 months which it has with almost mathematical precision. See* ***Faster, The Acceleration of Just About Everything*** *by James Gleick, Pantheon, 1999*
4 *Kuhn, Thomas,* ***The Structure of Scientific Revolutions****, 1962*

Sometimes two or more emerging technologies can combine to have paradigm shifting effects. Typically this requires some form of technology that acts as an enabling infrastructure upon which other integrated technologies can be built. The marriage of Differential Global Positioning System (**DGPS**) and Geographic Information Systems (**GIS**) has re-created the charting world as we know it, ECDIS and ECS being two obvious examples. The **Internet** is the major paradigm shifter of our age and we are still at the beginning of that shift.

This is progress as seen from a technology viewpoint. There is another viewpoint, one more concerned with the unmet needs of a potential user. Technology by itself is of no value until it is married to an application, and a useful one at that. It takes two forces, one, the push of technology (solutions) and the other, the pull of applications (needs) to make the most significant advancements.

Given this, one might expect to see a programmatic approach to technology diffusion. If only that were true. Unfortunately history shows people have a hopeless record in predicting the impact of emerging technology. More typically we rationalize what has occurred after the fact. For some reason planning for changes in technology is chaotic. The removal of **Selective Availability (SA)** from GPS, while not unexpected, was a sudden event that we have to react to.

"The Tipping Point" by Malcolm Gladwell[5] gives an explanation for how trends, including technology trends, can catch hold of people's imagination and be taken up in huge numbers with little or no warning. New technologies can spread like a virus if they are pushed by a network of committed and influential people, if they have a stickiness that makes them attractive and if the world is ready for a new idea. Nevertheless predicting what will be accepted is still a chancy affair. The world is looking for a cheap, easy to use portable, global communications system. Clearly Iridium was not what the market was looking for, despite the ease of use and universal coverage it offered. It was too expensive and too slow to deliver the digital data stream clients want. We will have to wait for the Internet in the sky[6] that the market now wants.

One of the major new needs to have emerged is in the area now referred to as **e-Commerce**. The shipping industry is quickly comprehending the enormous advantages the Internet can bring to the table[7]. After all the cost cutting is done, it is the creative use of new technology that will differentiate competitors. The use of **Interbox**[8] to manage empty containers is changing the nature of the container business. Companies like **OneSea.com** are making inroads into marine procurement as shippers continue to look for ideas that help create a transportation system that operates with pipeline simplicity and efficiency. Companies like **Inmarsat** and **Teledesic** are investing millions to provide the satellite based infrastructure for electronic marine highways to run on. **Logistics** remain a rich area for improvement and companies like **Descartes**[9] help to improve capacity utilization through improved networking of shippers and carriers. HOs and their agents will have to fit into this new networked world.

A second initiative is the field now popularly known by the term **Wireless**[10]. Although this term also applies to wireless LANs and alphanumeric pagers, the real new thrust is in the area of the wireless Internet or, more appropriately, mobile Internet. **IDC**[11], the world's largest Information Technology (IT) consultancy, forecasts that mobile Internet users will exceed web-based Internet users within 2 years. The applications expected are in mobile commerce and financial transaction capabilities, navigation and location specific applications, instant messaging and infotainment (e.g., news, sports, weather). Rather than

5 *Gladwell, Malcolm, The Tipping Point, 2000*
6 *http://www.teledesic.com/*
7 *Compuship Maritime E-Business Supplement June 2000*
8 *http://www.interasset.com/services/exchange.html*
9 *http://www.descartes.com/*
10 *http://www.wapforum.org/*
11 *http://www.idc.com/itforecaster/*

"surf the web" mobile users want information quickly with transparent access to the network. **Handheld Devices** such as Palm Pilot and their Windows CE-based kin are starting to take advantage of wireless networking for custom applications. The Blackberry[12] brings instant email to a pager-sized device clipped onto your belt.

A third initiative is in the field of **open standards. Linux**[13] is just one manifestation of this new trend towards open source software. However, it is in the field of data standards that more will be gained. Consider the case of **EDI**[14] (electronic data interchange) – a data interchange system that has been in place for decades but underutilized because of its expense. However **XML**, a language like HTML that can be read on any computer over the Internet can get suppliers and users together. This will help spur more vertical portals (or **vortals**) to provide tools for improving shipping efficiency and reduce costs.

Emerging Needs and Emerging Technologies

Table 1 gives a listing of emerging needs as expressed either by HOs, associated stakeholders or HO clients[15]. This list is not meant to be exhaustive but it does contain many of the major concerns expressed today. These represent ***Problems Looking For Solutions***.

Increased Navigation Efficiency
Pilot Carry-on ECDIS
Electronic Docking Aids
Forecasting real-time under-keel clearance
Vessel Traffic Systems (VTS) and Automated Identification System (AIS)
3D- ENC data.
Real-time data (water level, ice, weather, ...)
Short term forecasting of water levels
Modeling currents
Back-up Navigation Systems
Real-time chart functions
Increased HO Efficiencies
Real Time Kinematic positioning
Computer Assisted Compilation
Print on Demand (POD)
Improving Chart Accuracy
Technology for fast/cheap surveys
Ocean Mapping tools
Digital Sailing Directions
GPS vertical control
Archival Compression
Improved Product Distribution
Encryption Standards
Virtual RENC
e-Commerce
Authenticating Electronic Data

Table 1: *Emerging Needs*

[12] *http://www.blackberry-rim-pda-handheld-computers.com/*
[13] *http://www.linux.org/*
[14] *http://www.xmledi.com/*
[15] *Emerging needs are collected through a network of interested participants connected through TAWG and the Open ECDIS Forum (www.openecdisforum.com)*

In order to add some quantitative measure to each of these Emerging Needs a weighting is determined for each according to its level of importance and urgency in meeting the needs of HOs and their clients.

Emerging Needs	Importance	HO Urgency	Client Urgency
Encryption Standards	9	6	4
Electronic Docking Aids	7		6
Pilot Carry-on ECDIS	7		6
Tools for faster/cheaper surveys	7	4	
Print on Demand (POD)	8	10	
Forecasting real-time under-keel clearance	5		6
Real-time chart functions	5	4	6
Authenticating Electronic Data	9	6	4
Computer Assisted Compilation	7	10	
Real-time data (water level, ice, weather	7		4
Vessel Traffic Systems (VTS) and AIS	7		10
Back-up Navigation Systems	5		10
Improving Chart Accuracy	7	6	10
Short term forecasting of water levels	5		10
Real Time Kinematic positioning	5		4
Modelling currents etc	5	6	1
e-Commerce	7	6	6
Virtual RENC Tools	5	6	
Ocean Mapping Tools	5	6	
Digital Sailing Directions	7	10	6
GPS vertical control	5	5	3
Archival Compression	3	3	
3D- ENC data.	3		1

Table 2: *Emerging Needs and Level of Importance*

Urgency	Rating
Immediate	10
Next 2 years	6
Next 5 years	4
Long term	1

Emerging Technologies

Table 3 includes the major technologies now in ascendance. Some of these technologies are developing in an environment focused on a problem area. Some, however, are simply **Technologies Looking For Problems To Solve**. It is not so much that any one technology will bring about a revolution but more the confluence of several technologies that fuse together. GPS, high resolution remote sensing, cheap storage, wireless, Internet, telecomm LEOS and open standards all collaborate to help create what former US VP Al Gore calls a "Digital World". **Pervasive GPS chip integration** might help push this vision to fruition.

Acoustics
Side-scan sonars
Acoustic Seafloor Classification
Synthetic aperture sonar
Multibeam echosounder
Precise 3D Positioning
GPS Attitude & squat
On-The-Fly DGPS
Motion sensors
INS integration with GPS
GPS/Glonass integration
Pervasive GPS chip integration
Remote Sensing
Satellite radar imagery
Laser hydrography
High resolution satellite imagery
SPOT bathymetry & bottom type
Data Communications
Internet
High Band Width data links to ships
LEOS Communication
Wireless
Ultrawideband pulse
Displays
Flat screen
Low cost Image engines
Low cost large scale plotters
Wearable heads-up displays
Visualisation
Handheld devices
Informatics
Low cost GHz CPUs
64 bit OS
Data warehousing
Spatial Data Base
Encryption
High Density Storage
Machine Voice recognition
Open Standards

Table 3: *Emerging Technologies*

Technology Readiness

A significant element in estimating the impact of emerging technologies is the state-of-readiness of the technology. A great idea ahead of its time remains that, ahead of its time. Each technology was evaluated according to its state-of-readiness. A weight of 10 was given to well-developed technology available commercially to a wide market whereas a weight of 1 signifies a technology at the proof-of-concept stage.

Emerging Technologies	Tech. Readiness
Acoustics	
Side-scan sonars	10
Acoustic Seafloor Classification	6
Synthetic aperture sonar	1
Multibeam echosounder	10
Precise 3D Positioning	
GPS Attitude & squat	6
On-The-Fly DGPS	6
Motion sensors	10
INS integration with GPS	4
GPS/Glonass integration	2
Pervasive GPS chip integration	6
Remote Sensing	
Satellite radar imagery	6
Laser hydrography	10
High resolution satellite imagery	6
SPOT bathymetry & bottom type	1
Data Communications	
Internet	10
High Band Width data links to ships	4
LEOS Communication	4
Wireless	4
Ultrawideband pulse	3
Displays	
Flat screen	6
Low cost Image engines	6
Low cost large scale plotters	10
Wearable heads-up displays	1
Visualisation	6
Handheld devices	6
Informatics	
Low cost GHz CPUs	10
64 bit OS	10
Data warehousing	6
Spatial Data Base	6
Encryption	10
High Density Storage	6
Machine Voice recognition	1
Open Standards	4

Table 4: *Emerging Technologies & State of Readiness*

Summary Matrix

The Emerging Technologies, and Emerging Needs were combined into a matrix. A score was applied as to the goodness-of-fit between each row/column pair in the matrix. This is the Technology-to-Need correlation. Scores of zero were given for pairings with no obvious direct connection. Weighted scores were then computed according to the state-of-readiness, level-of-importance, Client Urgency, HO Urgency and strategic importance. Finally, the matrix was ranked by score to find the most important emerging technology trends to follow.

$S_j = P_j * In_j$
Where S_j is the Score of need j
P_j is the technology Potential
In_j is the Influence score

And where
$In_j = MAX(H_j * C_j) * I_j$
Where H_j is the Hydrographic urgency
C_j is the Client urgency
And I_j is the Importance

And where
$P_j = SUM(TN_{ij} * E_I)$ i =1, ..., n
$E_i = SUM(TN_{ij}) * R_i$ j = 1, ..., m
Where TN_{ij} is the correlation Matrix between Technology and Need
E_i is the technology Effectiveness
And R_j is the technology Readiness

Print On Demand (POD)
Pilot Carry-on ECDIS
Data Encryption/Authentication
Electronic Docking Aids
e-Commerce
Computer Assisted Compilation
Under-keel Clearance Prediction
Tools for Improving Chart Accuracy
Tools For Faster/Cheaper Surveys
Real-time Charts

Table 5: *Top Ten Emerging Technology Trends – Year 2000*

This table can be cross-referenced to the table from the 1998 TAWG Report

Top Ten Emerging Technology Trends – 1998
Encryption Standards
Electronic Docking Aids
Pilot Carry-On ECDIS
Technology For Fast/Cheap Surveys
Print On Demand
Forecasting Real-Time Under-Keel Clearance
Real-Time Chart Functions
Authenticating Electronic Data
Computer Assisted Compilation
Real-time data (water level, ice, weather, ...)

The most notable difference being the combination of Encryption and Data Authentication, the leap of POD from 5th to first and the addition of e-Commerce tools and Tools for Improving Chart Accuracy. This is explained by using a slightly more complex method for scoring which differentiates between Importance, HO Urgency and Client Urgency and by the addition of the three new technology theme areas: e-Commerce, Wireless and Open Standards.

Emerging Recommendations for CHRIS:

Top Ten Emerging Technology Trends	Recommendations
Print On Demand (POD)	HOs should co-operate through CHRIS on evolving best practices
Pilot Carry-on ECDIS	Monitor Feedback from existing Sea Trials
Data Encryption/Authentication	Monitor operational experience at PRIMAR and continue implementation trials elsewhere
Electronic Docking Aids	Monitor progress in technology and report on feedback from special purpose Electronic Docking Charts (EDCs) through CHRIS
e-Commerce	HOs should co-operate through CHRIS on evolving best practices
Computer Assisted Compilation	Market-driven: No action needed
Under-keel Clearance Prediction	Monitor operational experience
Tools for Improving Chart Accuracy	No additional action needed
Tools For Faster/Cheaper Surveys	Market-driven: No action needed
Real-time Charts	Monitor Feedback from Sea Trials

Contributions to Technology Assessment Reports

The TAWG invites anyone interested in contributing ideas on emerging technologies, applications or trends in the field of Hydrography to contact the Chairman via email (caseym@dfo-mpo.gc.ca). The next report will be compiled in the Fall of 2002 but contributions are invited at any time.

Biography

Michael J. Casey has worked for the CHS since 1971. In that time he has performed at a variety of positions from field hydrography to his current position acting as Director of Marine Cartography. For many years he worked in the field of R&D and in 1991 became the Project Leader for the Canadian Electronic Chart Pilot Project. This project spearheaded an aggressive ENC production programme within CHS that continues today. Mr. Casey is the Canadian representative on the IHO's Committee On Hydrographic Requirement For Information Systems (CHRIS) and the Chairman of the Technology Assessment Working Group and the Encryption Project Group under CHRIS.
He is married with two grown children. In the accompanying picture he is shown in one of his favorite places, the Annapurna region of central Nepal.