

Stormy Passage: Lessons Learned From The Canadian Electronic Chart Experience

by
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Abstract

In 1996, the Canadian commercial carrier fleet was equipped with the most advanced vector-chart based Electronic Chart Systems (ECS) in the world. Additionally, the Canadian Federal Government had heavily invested in the basic infrastructure to make such systems operate to the best of their ability. A chain of Differential GPS stations interlinked with a similar chain in the US provided a state-of-the-art positioning system. Vector chart production, both inside and outside government, was well advanced and experiments were underway testing a prototype updating system. Ships equipped with ECS were working with government agencies suggesting improvements in these services in a cooperative and team-oriented style. Groups of experts were busy developing the international standards for data production, maintenance and display. The tools were all in place to realize the great vision - to create the world's most effective and efficient marine navigation system and to make Canada a showcase for world class, type-approved systems and services.

Now, 5 years later, the great visions of the past have not come to fruition. At the close of 2000 only one type-approved system has been installed in Canada and even it, rarely used, as shipboard officers prefer their tried-and-true ECS. The cooperative spirit built up over many years of trials trailed off, complaints ring in about the standards and the updating service remains underutilized.

So, what happened? This is a story of missed opportunities, mismanaged expectations, competing priorities, conflicting goals, drifting standards and underinvestment. A stormy passage.

That's the bad news. The good news is that despite all the above, the marine navigation system is better than it ever has been and shows all the potential for a steady stream of improvements. The world does not always unfold as you think it should and, as Mick Jagger once famously said so long ago:

*You can't always get what you want
But if you try sometimes
You just might find
You get what you need¹.*

1) Introduction

In 1996, the Canadian commercial carrier fleet was equipped with the most advanced vector-chart based Electronic Chart Systems (ECS) in the world². Additionally, the Canadian Federal Government had heavily invested in the basic infrastructure to make such systems operate to the best of their ability. A chain of Differential GPS stations interlinked with a similar chain in the US provided a state-of-the-art positioning system. Vector chart production, both inside and outside government, was well advanced and experiments were underway testing a prototype updating system. Ships equipped with ECS were working with government agencies suggesting improvements in these services in a cooperative and team-oriented style. Groups of experts were busy developing the international standards for data production, maintenance and display. The tools were all in place to realize the great vision - to create the world's most effective and efficient marine navigation system and to make Canada a showcase for world class, type-approved systems and services³.

Now, 5 years later, the great visions of the past have not come to fruition. At the close of 2000 only a handful of type approved system have been installed in Canada and even those are rarely used, as shipboard officers prefer their tried-and-true ECS. The cooperative spirit built up over many years of trials trailed off, complaints ring in about the display and format standards and the updating service remains underutilized.

2) What Happened ?

First we present

2.1) The Collection of Problems:

ENC Production Issues
The final data standard deviated unexpectedly from its precursor (S-57 Ver.2) causing a long delay in getting production software de-bugged and up and running.
The ENCs are far more complex to make and maintain than planned for. The line between Production level software and Development level software was blurred and ENC producers never felt in control of their software tools, which seemed to undergo continuous change.
Our production estimates were woefully naïve; early on we typically underestimated production timelines by a factor of 5 or more. This is even when we took Hofstadler's Law into account ⁴
Training on the new software was developed just in advance of the release of Version 1.0 and hence was inadequate in some areas.
Training sessions had been planned well in advance of the software's release and in some cases training was given far too early necessitating some re-training.
The cut-and-try approach, which works so well in developing new ideas, does not work

well in production environments which demand consistency.
The adoption of electronic navigation systems by Industry paved the way for a large decrease in the number of floating aids. This in turn lead to a huge increase in the number of Notices To Mariners that had to be produced and implemented by the same staff charged with making the ENC's.
The CHS underwent massive (40%) resource declines at the same time we were gearing up new production lines.

Client Uptake Issues
The clients were stunned about the ENC pricing and balked at paying what they felt were unjustified amounts.
The systems in use in Canada were not S-57 compliant leaving users happy with a working system but the HO with a product no-one wanted – yet.
The buying logic for ECDIS does not translate directly to the buying logic for S-57; the buyers are different and they think differently.
Manufacturers have a lukewarm interest in standards; they must meet compliance but first they must attract buyers.
ECDIS is not a mature technology; it is a technology in its infancy; the same with ENC's; the general buyer wants a fully tested and mature system at commodity prices.
Data suppliers operate on a small margin and don't have the resources to educate the market.
Competing visions for an electronic highway paradigm for the marine world don't provide for a stable basis to build applications upon; it isn't clear where we are all going with electronic marine navigation systems and how they will all integrate.
The clients, used to a display format they had helped to create, balked at changing to a display they felt was foreign, overly complex and slow to change.

This collection of problems led to an environment where progress and communication between the user, the producer and the supplier communities stalled. There are several specific causes, one of the most obvious being the dispute over pricing. A second issue is the adoption of the S52 Colours & Symbols. A third issue is the perceived marginal value of replacing existing near-ECDIS units. Finally, there are the issues of availability and reliability of data.

2.2) ENC Pricing – Ho Boy ...

The first sign of trouble occurred when shipowners discovered that **ECDIS was mostly a software system, not hardware**, despite the fact that so much energy had been placed on getting good reliable hardware up and running. Focussing on software meant that ultimately systems would be seen as PC-based and hence that, at least in the domestic, largely retrofit market, pricing would be the critical issue, not functionality of the system. Focussing on price meant that all components of the system would similarly have to be priced accordingly. And, as it turns out, price continues to be a critical issue.

Having missed this crucial point, the problem initially exploded when we priced the first S57 files. This we got completely wrong. Although we had conducted some market research we came up with a "buy then service" price plan which was too high. To compound the error we made a public announcement without sounding out key industry clients, which caught them off-guard. We still have yet to recover from that. This tended to discolour any future pricing schemes we came up with. Since the original announcement we have experimented with 4 different pricing approaches but it is only most recently that we have achieved some degree of commitment to buy.

2.3) The Display – Ho Boy II

In the early days of the Electronic Chart Pilot Project there was a spirit of "cut and try" in many aspects of the emerging technology. "Let's try it and see what happens" was the credo of the times. And, indeed many clever things were tried. Among them was a gradual convergence on a colour & symbol set that pleased most mariners. The emerging set was a bottom-up development that although lacking a clear thematic design premise behind it, nevertheless did work. Users became used to it and it was becoming the de facto standard.

Independent of this development, but on a parallel track, was the development of the "official" IHO colour and symbol set. This set, by contrast, did have an underlying integrated design theme and the colours were chosen through a careful scientific process based on well established colour rules for high performance Cathode Ray Tubes (CRTs). The human element was considered not by what looked good, but based on clinical trials of which colour sets were best able to get the intended message across.

Needless to say, the two colour schemes were, and remain, considerably different. Further, and as one would expect from any new approach, the new set needed to be de-bugged and sorted out through sea trials. Many mariners, by now accustomed to one presentation style, were understandably less keen on now debugging another, foreign style. After all, given all the problem areas in electronic navigation systems, the presentation display was not seen by the industry as a problem area until we created it.

2.4) ECS, ECDIS and Marginal Values

Since shipowners had already invested heavily into sophisticated (but not type-approved) systems they were no longer in a buying mood. From a purely practical point of view, shipowners did not see the additional functionality offered by a fully type-approved system to be worth the substantial re-investment costs.

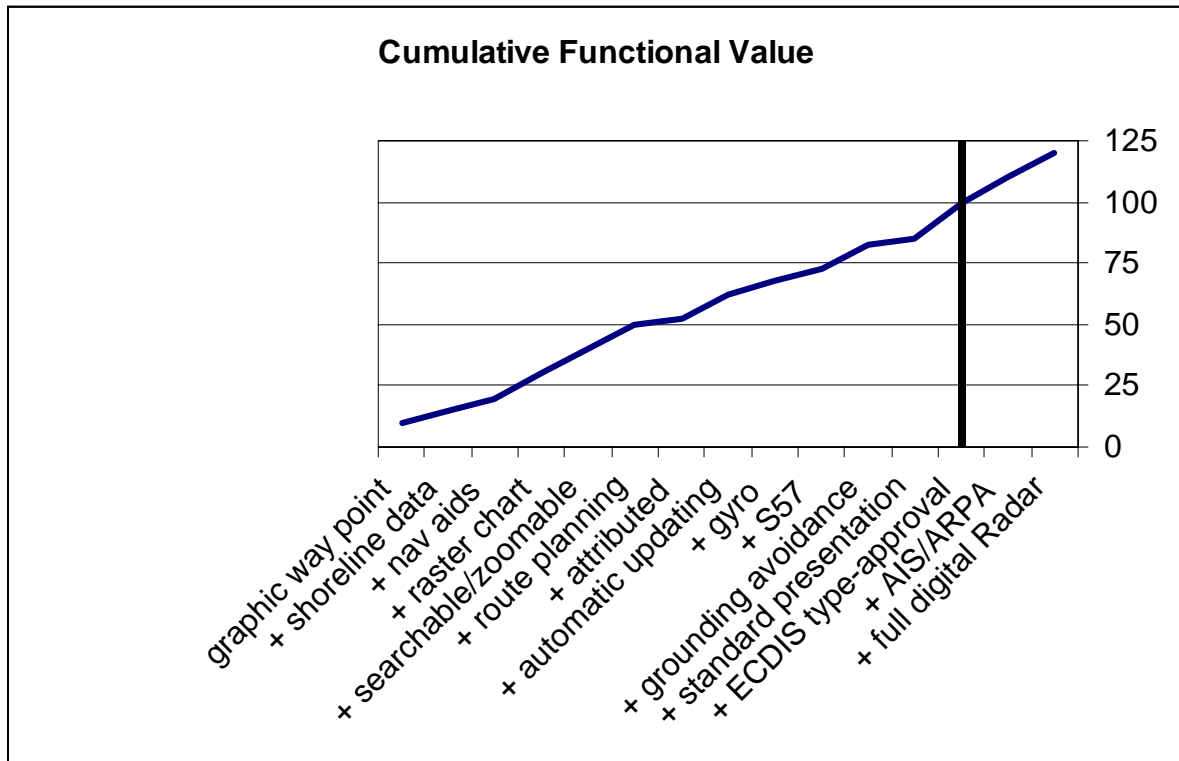
Table 1 is a list of the major functions of an ECDIS + system in cumulative order.

Table 1 Electronic Navigation System Cumulative Functionality

- continuous positioning with graphic display way point navigation
- shoreline data
- navigation aids
- raster chart
- searchable/zoomable chart data
- route planning
- attributed data
- automatic updating
- gyro integration
- S57 compatible
- grounding avoidance
- standard presentation set
- ECDIS type-approval
- AIS/ARPA integration
- full digital Radar integration

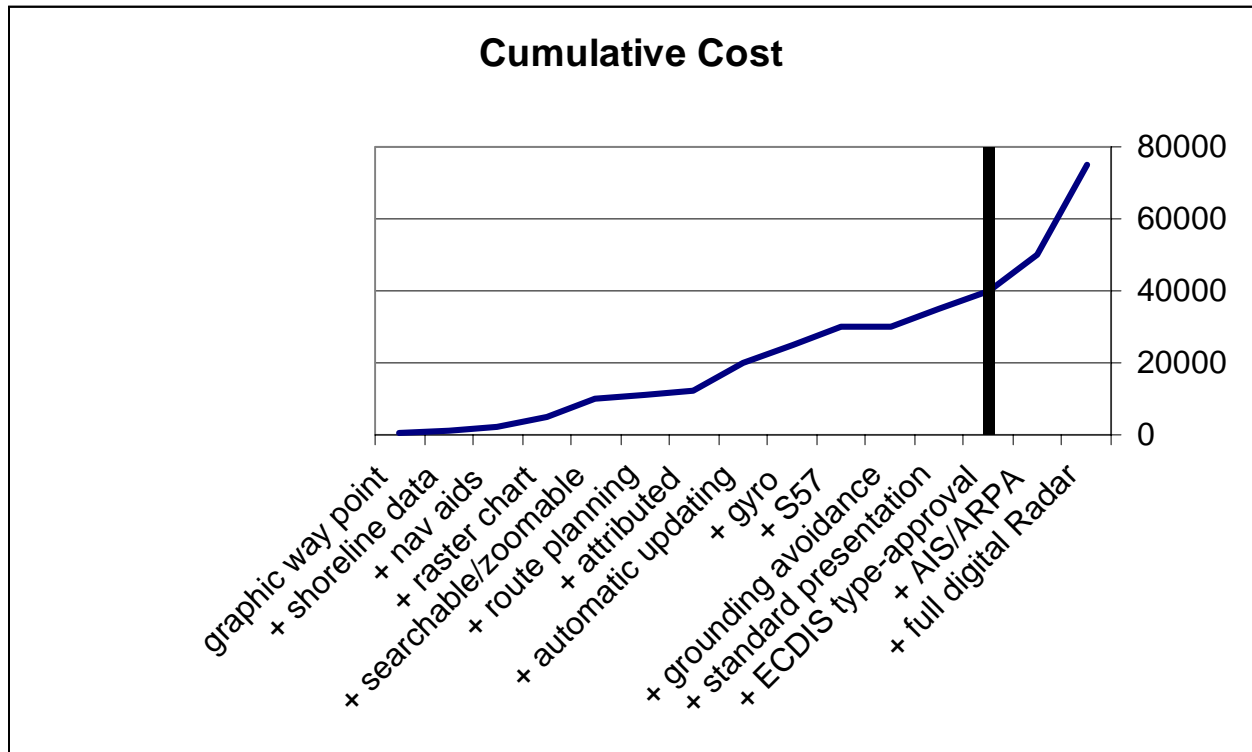
Figuratively it appears as a series of step-wise additions in functionality.

Figure 1



Cost-wise, each step in functionality can come at a rapidly accelerating cost.

Figure 2 Functionality and System Cost⁵



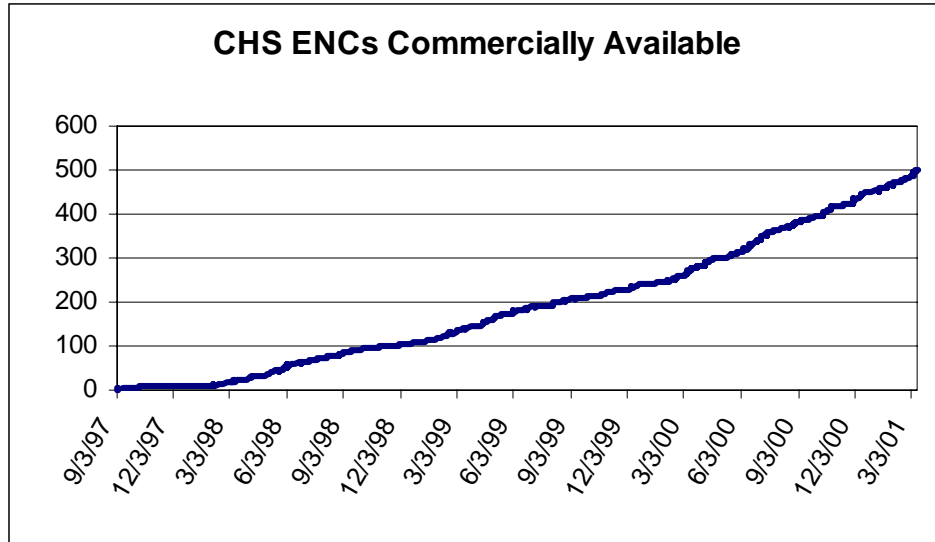
Shipowners who already owned packages that provided say, 85% of full ECDIS functionality are faced with a decision based on whether or not the increased functionality is worth the cost of replacing the existing systems. Typically the decision is to do a partial upgrade or to wait until the end of the lifecycle of the existing systems.

This suggests that the advantages of getting into electronic navigation early can be compromised if the owner is forced to replace all of the equipment. It had been easy to demonstrate how cost-effective the near-ECDIS purchases had been. Demonstrating the cost effectiveness of complete replacement for the increased marginal functionality is not so obvious.

Data Production, Delivery and Reliability

S57 availability is a moving story changing daily. For up-to-the-minute coverage see the NDI site (www.ndi.nf.ca).

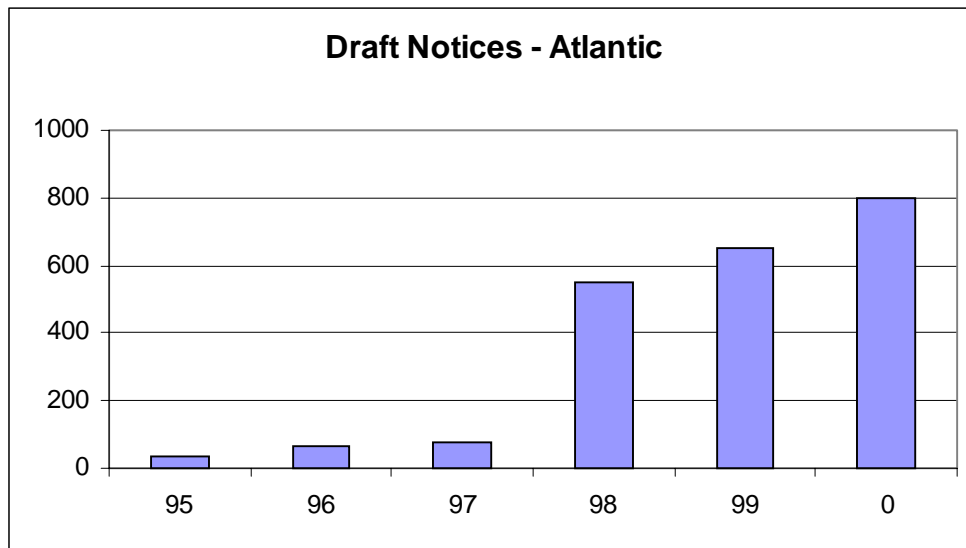
Figure 3



Production Workload: Death by Success

The adoption of electronic navigation systems allowed the industry to call for a reduction in the overhead costs of maintaining the waterway (aids, icebreaking, dredging). This paved the way for a large decrease in the number of floating aids and subsequently there was a huge increase in the number of Notices To Mariners that had to be produced and implemented by the same staff charged with making the ENC's.

Figure 4

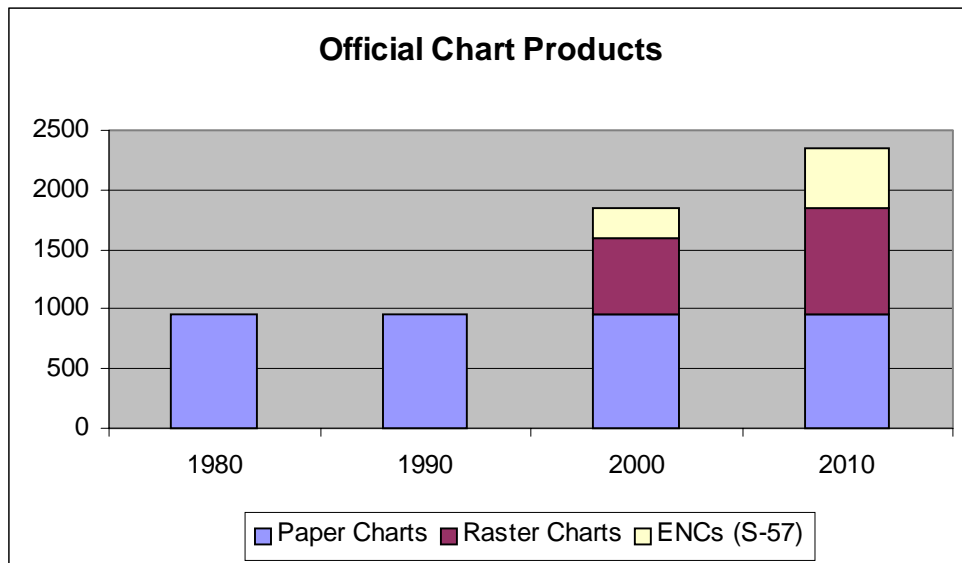


The Paper, Vector, Raster Product Mix – Is it Sustainable ?

The range of official chart products produced and maintained by CHS took a quantum step a few years ago. Figure 4 shows this growth and also the expected continuation for the next decade.⁶ This forecast is unsustainable with

the current approach as the production of paper products and their ENC derivatives will continue to diverge.

Figure 5



Given such a situation, one must ask the question: how important is implementing the S57 standard more fully to the production of all chart products? ENC's have been designed to fill a crucially important, yet relatively small market segment. And, until regulations change, this market continues to demand a high focus on our paper chart products as well.

3) Now What ?

Reviewing the major problem areas:

- pricing
- S52 Colours & Symbols
- marginal value of ECS replacement
- availability of data
- reliability of data
- lack of integrated vision for marine navigation systems

There are a number of things we can do.

3.1) Pricing

The current pricing regime is being re-examined in an effort to make the product more palatable to the North American market. A new packaging scheme includes a complete and contiguous ENC product coverage for various geographic zones.

Raster navigational charts (RNCs) are provided in places where there are gaps in the ENC coverage. This product is now being test marketed.

3.2) S52 Colours & Symbols

A number of projects are underway to facilitate input from users on the use of the Presentation Library (PL). Some changes have been made and a project is now underway for a systematic and thorough review of the PL and its various implementations. Convergence on an acceptable set of colours and symbols appears likely within the next 1 to 2 years.

3.3) Data Issues

The sustainability of the ENC product line is the crux of the matter. Can we use the S57 standard to help make paper products or will ENCs continue to be a marginal activity ?

The construction and maintenance of paper charts from the S57 data set is crucial for efficient operations over the next 5 years. The dream of making products directly from source data will remain in the development mode for some time to come. Therefore, prudence dictates that a major effort be made now to prototype new paper chart products from S57.

There is little or no experience in doing this. Therefore new techniques have to be developed and undoubtedly, new standards will have to be derived for paper charts to make the process work efficiently. The paper chart must become the child to S57, not the reverse.

3.4) Towards a National Vision of Electronic Marine Navigation Systems

Client consultation has made one issue crystal clear. Nationally Canada must develop a coherent and collaborative vision for marine navigation systems. ECDIS, DGPS, AIS MIOs etc. etc. must find a place in an integrated vision of how the transportation system will evolve. John Pace & Associates was recently hired to perform a study to investigate this area and to meet with national stakeholders to develop that vision and the steps required to achieve such a vision⁷.

The overall objectives of this study were:

(a) to develop a “vision” statement for ECDIS including recommendations on the steps required to achieve the vision appropriate for incorporation into a strategic action plan for ECDIS in Canada.

(b) to investigate the national perspective of commercial shipping stakeholders concerning Government rulemaking related to ECDIS in Canada;

(c) to investigate the strategic requirements necessary to develop ECDIS and associated technologies into an integrated system which could serve as the foundation for a marine “electronic” information infrastructure capable of supporting enhanced marine safety and commercial performance in Canada.

The study concluded with a large number of recommendations and the following Vision statement.

The ECDIS Vision Statement

ECDIS will be proactively developed in Canada to:

- *optimize the use of smart data in an information enhanced “intelligent” marine transportation system to contribute to navigation safety, environmental protection and marine transportation efficiency*
- *create an effective communication and information management infrastructure capable of delivering accurate, up-to-date and real-time marine information to users.*
- *establish ECDIS technology as the heart and hub of an instrument based, people centered, navigation process supported by national regulations*
- *emphasize the use of Bridge Resource Management concepts and effective training to ensure mariners derive maximal operational benefit from ECDIS information*

ECDIS Vision Timeframe

ID	Task Name	Start Date	End Date	00	01	02	03	04	05	06	07
1	ENC Coverage and Support	6/1/00	1/1/02	█							
2	Core DGPS	6/1/00	1/1/01	█							
3	Confined Waters DGPS	9/1/01	6/1/04		█						
4	Core AIS	6/1/01	6/1/04		█						
5	Training AIS and ECDIS	6/1/02	1/1/05			█					
6	Portable ECDIS	9/1/00	6/1/02	█							
7	Rulemaking Process	6/1/01	6/1/04		█						
8	MIO sub-systems	6/1/02	6/1/07			█					
9	Ultra High Bandwidth IS to Ships	6/1/04	6/1/06					█			
10	Radar/Video S/S S/S	6/1/05	1/1/07							█	

The report led to the creation of the Electronic Navigation Technologies Working Group, reporting to the Standing Committee on Navigation & Operations of the Canadian Marine Advisory Committee (CMAC). This is the official forum for client consultation on marine safety and navigation to the Canadian Government.

Copies of the ECDIS Vision Report are available on line at the CMAC website⁸.

4) Summary of Lessons Learned:

- Avoid being at the front of any new product development unless you are prepared to bear the pain of pioneers; you really do bleed at the cutting edge
- Build financial robustness plans into your business model; things rarely go the way you think they will, in fact they usually go worse
- Stick with key clients and adapt to their needs; don't out-guess them and try and get ahead of the way the world is evolving; you won't endear yourself to anyone
- Take conservative steps in developing new products but be liberal in how you can improve servicing those products
- Never stop talking to key and influential clients; in most cases they want you to do well
- Despite what you might hear to the contrary, tell clients what you think the end price might be to sustain a new product line; the earlier you can tell them the better
- If price turns out to be the key determinant in the success of a new product, move quickly to do everything you can to reduce that price; don't expect the market to become "enlightened" to your view of fair pricing; clients rarely ratchet their concept of a fair price upwards
- Stay away from issues that no-one except you thinks are yours to solve; over-regulating will eventually and almost certainly come back to haunt and hurt you
- Clients have different mental models than you do; that leads to different expectations; clients usually expect you to do more than you can; they are unimpressed by what they view as "old wine in a new bottle"
- In setting standards, remember that things naturally evolve to more complexity, not more simplicity; only standardize what you have to and keep them simple; there never is a shortage of volunteers to make things more complex
- It can take years to educate the market to the benefits of a new product, particularly if the product offers more than the market is looking for

5) References and Notes

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- ¹ Copyright, Mick Jagger, Keith Richards, 1969; see <http://www.keno.org/Songlistnlyrics.htm#Y>
- ² Final Report: Canadian Electronic Chart Pilot Project, Offshore Systems Ltd., 1996
- ³ Casey, M.J. and Goodyear, J.; *Bleeding at the Cutting Edge*, Proceeding of HYDRO '94, Norfolk Virginia, April, 1994
- ⁴ Hofstadler's Law : "It always takes longer than you think it will take, even if you take into account Hofstadler's Law.", Douglas Hofstadler, *Metamagical Themas*, Basic Books, 1985
- ⁵ Canadian \$
- ⁶ Brent Beale: personal correspondence, February 2001
- ⁷ The Marine Electronic Highway: An ECDIS Vision For Canada, March 2000
- ⁸ available at <http://www.tc.gc.ca/CMAC/documents/documentindex.htm>