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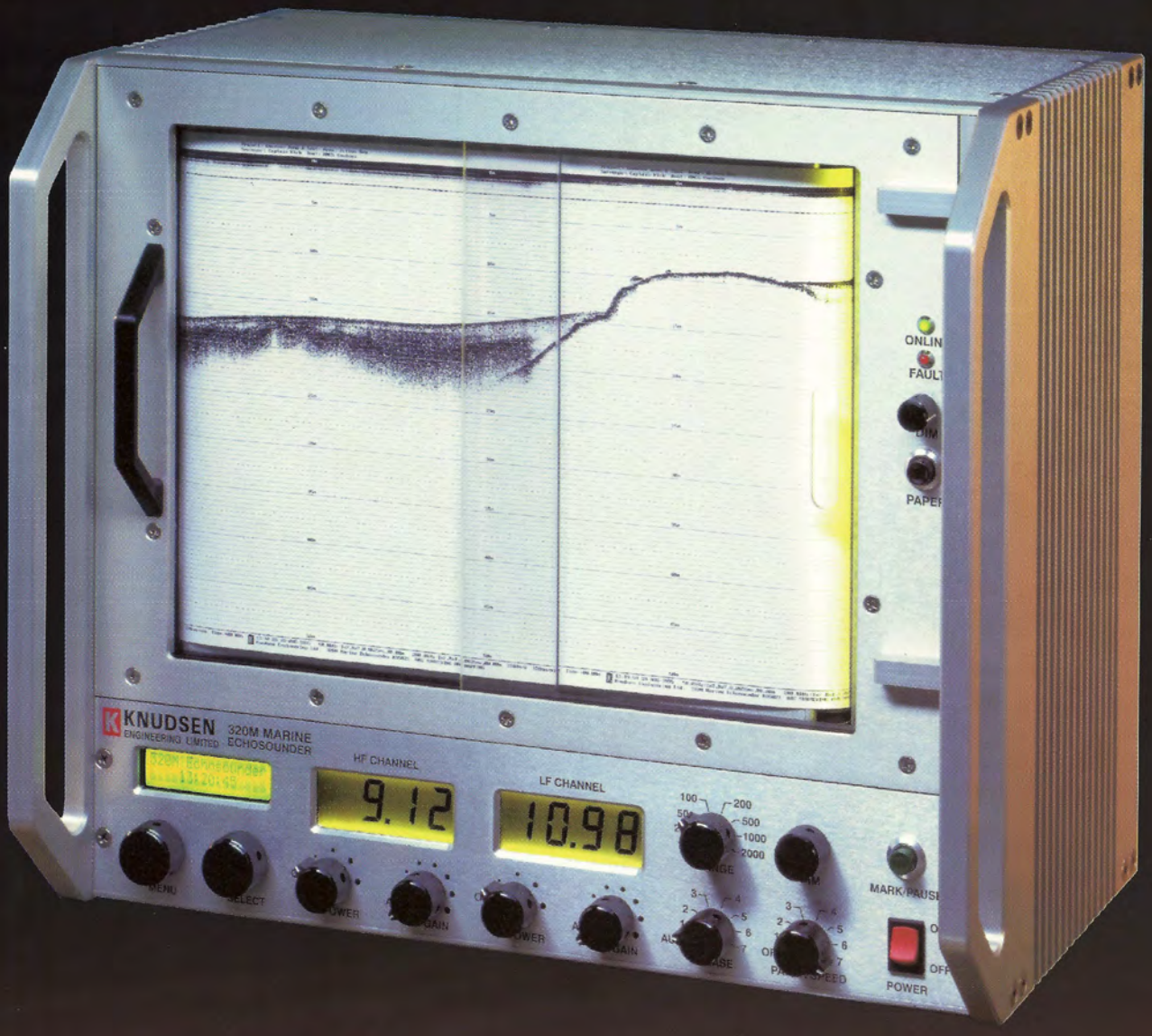

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Message from the National President
Mot du Président national

Welcome to our 2002 Canadian Hydrographic Conference edition. Much has gone on since our last edition and it's been a process of learning for me having recently taken over the helm from Ken McMillan. As you will see below, our Board of Directors has changed considerably but we've a good crew. As professional associations go we're small but active. By now, mailings will have been sent to participating Canadian academic institutions notifying them of our annual CHA National student award. Central Branch members have been very active in assisting with the planning and preparation for the 2002 Coastal Multibeam Sonar Training Course as well as the Canadian Hydrographic Conference. Tom McCulloch, on behalf of CHA, is preparing a proposal to be submitted to the Canadian International Development Agency (CIDA) to seek assistance for CHA to provide cartographic training to the Universiti Teknologi Malaysia. Closer to home, CHA is also investigating the feasibility of bringing an IHO/FIG-accredited hydrographic program back to Canada. After many years of helping developing countries develop their hydrographic capabilities, it would be good to help one of our own colleges or universities achieve Category A or Category B accreditation.

To those readers who are referring to *LIGHTHOUSE* for their Conference program, welcome to Toronto and I hope you will find the articles and other features of our journal to be of interest. Hope to see you at CHC2002!

Andrew Leyzack

directors directeurs

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Editors' Note / Note des rédacteurs

We are very pleased that the 2002 Canadian Hydrographic Conference organizing committee has chosen *LIGHTHOUSE* as the means of communicating the conference program and other important information to its participants. We welcome such opportunities to introduce our journal to the hydrographic community. For those of you who are not attending, we hope it gives you a brief overview of what transpired and perhaps you can join us at the 2004 conference. We hope that all of you read the journal from cover to cover and find the contents of interest and value.

As editors, we remain committed to producing a quality journal – a journal that will be of interest and benefit to the hydrographic, marine science, navigation and the many other related communities. We will strive to ensure our publication will continue to be easy to read and cover contemporary topics of interest to a wide range of readers. We believe that, in addition to reflecting hydrography in Canada, *LIGHTHOUSE* has an important role in keeping readers abreast of what's happening in the entire industry.

We invite your input and comments at any time. During the conference we will make a special effort to solicit comments and suggestions from all of you. At this time one of our main areas of focus will be with advertisers and sustaining members and what improvements we can make that will be of greatest mutual benefit. It is our intent to make incremental improvements with each edition of the journal.

Our plan to increase the list of sustaining members is ambitious. We hope to improve our sustaining membership benefit package so we can help many more of our collegues in industry. Let's discuss possible actions for improvement.

You will be pleased to know that approximately 900 copies of LIGHTHOUSE, edition 60, were circulated to members, subscribers, advertisers and potential advertisers and subscribers in over 100 countries. We continue to be pleased with our rate of growth and sincerely thank you for your support.

Earl Brown and Paola Travaglini

Cover

Photo courtesy of R.C. Walker, CCG

CHANTRY ISLAND LIGHTHOUSE
Ontario

Jan Hawley, Goderich Marine Heritage Committee

To encourage settlement and the further development of northern parts of Ontario, the Canadian government initiated a program in the 1800's to construct lighthouses along the eastern shores of Lake Huron and into Georgian Bay. With the construction of these beacons came a greater assurance that ships carrying cargo and settlers would have a great chance of reaching their destination, as opposed to falling to their fateful demise on the rocky shoals that perpetually plagued these waters. The Chantry Island Lighthouse was one such lighthouse, situated about a mile southwest from the mouth of the Saugeen River at Southhampton, Ontario. One of six 'imperial towers' built by Contractor John Brown at a near cost of $37,000.00, this majestic and stately beacon was first lit on April 1st, 1859.

Rising to a height of 80 feet from the base to the centre of its light, this circular shaped tower is constructed of 'dolomite limestone casting a brilliance and grandeur characteristic of these beautiful beacons. Although some say the stone was mined locally, there are stories of it being imported in the ballast of sailing ships traveling from as far away as Europe. This fact is still debated today. Either way, this tower as well as the many that dot the Bruce Peninsula in Northern Ontario continues to be a proud reminder of our rich marine heritage. To view Chantry Island Lighthouse and many more from this area visit ***www.naturalretreat.com.***

Improving a Multi-Reference GPS Station Network Method for OTF Positioning in the St. Lawrence Seaway

By: L.P. Fortes, M.E. Cannon, S. Skone, G. Lachapelle, Department of Geomatics Engineering, University of Calgary

Introduction

Real-time kinematic GPS positioning is able to provide cm-level positioning accuracies, as long as the carrier phase ambiguities are resolved on-the-fly (OTF) to integer values. Classical methods are based on differential positioning using a single fixed reference station located in the vicinity of the user. The maximum distance allowed between the reference station and a user is generally limited to 20-30 km due to the effects of the atmosphere and orbit. A novel and unique method developed at the University of Calgary uses all available reference stations to optimally generate regional code and carrier phase corrections, which can be transmitted to users in order to resolve integer ambiguities OTF over the region. A major advantage of this method is to increase the coverage under which successful OTF ambiguity resolution is possible, thereby decreasing the number of reference stations that would be needed using the standard single reference station approach and, consequently, maximising cost effectiveness.

The St. Lawrence Seaway is a constricted, shallow navigable waterway where three-dimensional positioning at the cm-accuracy level would be desirable for maintenance tasks such as hydrographic mapping after spring ice break-up and in 3D navigation to increase capacity. During August 1999, several marine radiobeacons equipped with high quality dual-frequency receivers collected code and carrier-phase data in order to support testing this method. The results obtained using the approach developed at the University of Calgary are shown in Fortes et al. [2000a]. Some of the network stations were treated as user receivers, after being alternately removed from the network, in order to have a reference for comparison. Therefore the tests using this data set simulate real-time kinematic positioning. In the present paper, optimization of the method is attempted based on separate modelling of the correlated errors, namely due to the ionosphere, troposphere and satellite orbits. In particular, ionospheric errors vary with local time, geographic location, season and solar cycle. Independent modelling of the ionospheric errors should allow for statistical characterisation of such variations. This is a significant issue for the current period of solar maximum, and for the St. Lawrence region, where enhanced ionospheric activity will be associated with geomagnetic storms for the next few years.

Multi-Reference Station Approach

The multi-reference station approach (referred to as Multi-Ref herein) was proposed by Raquet [1998], in order to model errors that affect GPS differential code and carrier-phase kinematic positioning applications [Raquet and Lachapelle, 2000]. The principle of the method is that as long as the carrier-phase observable errors are corrected (or minimised), it is possible to resolve integer ambiguities over longer distances, which increases the achievable accuracy for the user.

The equations used to compute the corrections to the carrier-phase observables are as follows:

$$\delta\hat{l}_r = C_{\delta l_r,\delta l} B^T (B C_{\delta l} B^T)^{-1} (B\overline{\Phi} - \lambda\Delta\nabla N) \qquad (1)$$

$$\delta\hat{l} = C_{\delta l} B^T (B C_{\delta l} B^T)^{-1} (B\overline{\Phi} - \lambda\Delta\nabla N) \qquad (2)$$

where,

- $\delta\hat{l}_r$ are the corrections to carrier-phase observables collected at the user receivers, in metres;
- $\delta\hat{l}$ are the corrections to carrier-phase observables collected at the reference stations, in metres;
- $\overline{\Phi}$ are the measurement-minus-range carrier-phase observables ($\overline{\Phi} = \Phi - \rho$), in metres, assuming that the reference station coordinates are known in order to compute the geometric range ρ;
- $\Delta\nabla N$ are the double difference integer ambiguities between the reference stations (assumed to be known),
- λ is the carrier-phase wavelength, in metres;
- B is the double difference matrix $B = \partial\Delta\nabla\overline{\Phi} / \partial\overline{\Phi}$ (made up of the values +1, -1 and 0);
- $C_{\delta l}$ is the covariance matrix of the carrier-phase observables collected at the reference stations and
- $C_{\delta l_r,\delta l}$ is the cross-covariance matrix between the carrier-phase observables collected at the user receivers and at the reference stations.

The above equations can be derived using the principle of Least-Squares Prediction (Collocation), as shown by Fortes [1998].

Role of the Covariance Function

Through Equations (1) and (2), it can be seen that, besides the double difference integer ambiguities between the reference stations and the precise coordinates for the reference stations, the covariance matrices $C_{\delta l}$ and $C_{\delta l_r,\delta l}$ are also required to apply the method (this is actually a requirement of Least-Squares Prediction). Each element of these matrices can be calculated based on the knowledge of the mathematical functions that map how the correlated errors (atmospheric delays and satellite position

errors) behave over the region covered by the network, and their dependency on the satellite elevation. In addition, it is necessary to know the variance of the uncorrelated errors (multipath effects and receiver noise) for each station in the network. Thus, elements of the covariance matrices can be properly estimated by combining the correlated and uncorrelated variances through a covariance function, according to the procedure described in detail in Raquet [1998] and Raquet et al. [2001].

Raquet [1998] states that the effectiveness of the Multi-Ref approach depends on the accuracy of the covariance matrix. Therefore, two questions arise with respect to the covariance functions utilised in the generation of the results given previously by Fortes et al. [2000a] with the same data set used in this paper:

i) Considering that the previous results were obtained based on covariance functions computed using data collected in the same region but 10 months earlier (in November, 1998), would the use of an improved covariance function, using the same functional model as before, but using data collected during the August, 1999, campaign, enhance the improvement brought by the method?
ii) Considering that the original approach models the total correlated errors that affect positioning, and knowing that the spatial decorrelation of each error is different, would an approach that separately models the ionospheric signals, and the tropospheric and orbit errors, improve the quality of the results?

In order to answer these questions, three tests were performed:

i) Recomputing the covariance functions using data collected during the August, 1999, campaign and using them in the Multi-Ref approach;
ii) Applying Equations (1) and (2) to observables that directly measure the ionospheric effects on L1, and the tropospheric plus satellite orbit errors, instead of L1 and WL. This approach requires that new covariance functions be computed for the specific observables;
iii) Refining the ionospheric covariance function mentioned in (ii), using directional components (NS-EW), considering the possibility of different ionospheric gradients in these two directions.

The results of these three tests are shown in subsequent sections, in the observation domain, and compared with those published previously by Fortes et al. [2000a].

Description of the August, 1999, Data Set

From August 2 to 7 four temporary NovAtel MiLLennium™ GPS receivers were used in Grand-Mère, Deschaillons, Thetford Mines and Sorel, in addition to the Canadian Coast Guard Ashtech Z-XII receivers located in Lauzon, Trois-Rivières and St-Jean-sur-Richelieu (Figure 1). Code and carrier phase data were collected at 1 Hz. There were two days for which all seven stations simultaneously tracked GPS satellites (August 4 and 5), which were then selected for processing and analysis in terms of testing the method, whereas data collected on August 4 was used for all covariance function computations, for being representative of the error conditions during the campaign.

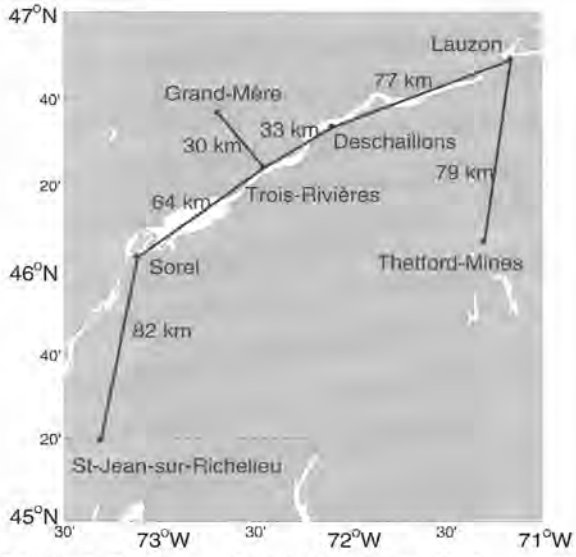

Figure 1: *Reference Network or August 1999.*

The approach used to compute precise coordinates for the reference stations and to resolve integer ambiguities between the reference stations is described in Fortes et al. [2000a].

To assess the impact of using different covariance functions in the Multi-Ref method, two network configurations were analysed. In the first one (Figure 2a), Trois-Rivières was treated as the user receiver and all the remaining stations acted as reference stations to generate network corrections using the various covariance functions. Since Grand-Mère is the closest station to Trois-Rivières, the 30 km baseline defined by these two stations was processed using raw and corrected observations (actually the selection of the closest reference station is necessary only in terms of the single-reference OTF processing using raw data, since using any reference station with corrected observations gives the same results using Multi-Ref). The second configuration (Figure 2b), implemented in order to test the impact of the method on a longer baseline, consisted of choosing Deschaillons as the user and all the remaining stations but Trois-Rivières were used to compute network corrections. Grand-Mère was again the closest station to Deschaillons and then the 46 km baseline formed by them was processed using raw and corrected observations.

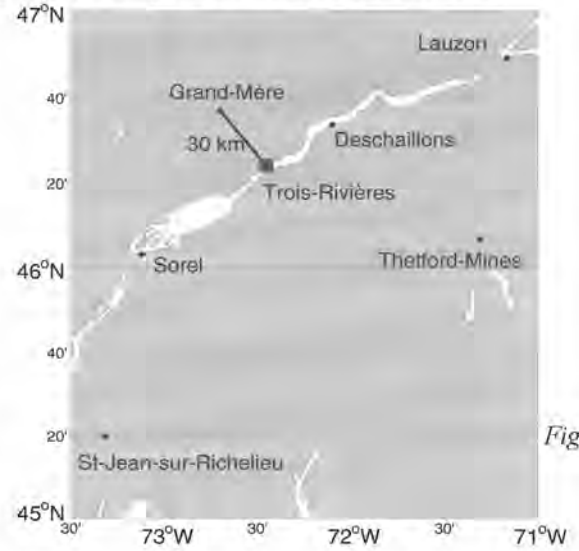

Figure: 2a

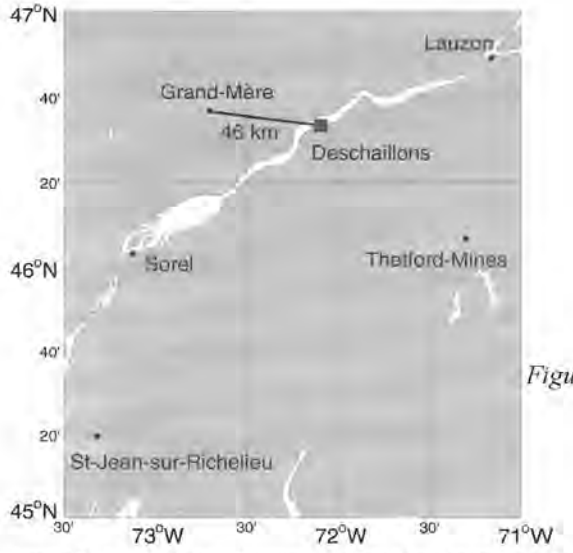

Figure: 2b

Figure 2: *Network configurations used to determine the impact of using different covariance functions in the Multi-Ref method. The user station is represented as a square, and the line connects it to the closest reference network station.*

All the results presented herein are shown in the observation domain. Hence, the L1 and WL raw double difference misclosures were compared with those generated after applying the corrections. It is expected that the misclosures will be small with corrections, since effects are better modelled – this should also lead to improved performance in the position domain. The known integer ambiguities between stations were used to compute the misclosures. RMS of the raw and corrected double differences misclosures for the two baselines shown in Figure 2, as well as the percentage improvement, are computed in each test.

Computation of the Original Covariance Functions Using August, 1999, Data

In the case of the original Multi-Ref approach, two mathematical functions for each kind of carrier-phase observable (L1 carrier-phase – L1; and Widelane, WL) are used. The first one maps the zenith variance of the differential correlated errors over the region, given by the following equation:

$$\sigma^2_{c_z}(p_m, p_n) = k_1 d + k_2 d^2 \qquad (3)$$

where $\sigma^2_{c_z}(p_m, p_n)$ is the zenith variance of the differential correlated errors between two points $\mathbf{p}_m$ and $\mathbf{p}_n$ (in m² for L1 code and in cycles² for L1 and WL carrier-phases), **d** is the distance between them (in km) and $\mathbf{k}_1$ and $\mathbf{k}_2$ are coefficients (see units in Table 1).

Table 1: k_1, k_2 *and* k_μ *coefficients and variances of the uncorrelated errors at the zenith (*$\sigma^2_{u_z}$*) for L1 and WL using data collected on August4, 1999.*

Coefficient	L1	WL
k_1 [a]	1.71331e-04	3.98211e-06
k_2 [b]	1.37359e-05	2.96245e-07
k_μ [c]	12.277	13.493
$\sigma^2_{u_z}$ [d]	4.4273e-05	3.0794e-05

a: cycles²/km; b: cycles²/km²; c: unitless; d: cycles²

The second function maps the zenith correlated and uncorrelated errors to a specific satellite elevation, given by the equation:

$$\mu(\varepsilon) = \frac{1}{\sin\varepsilon} + k_\mu \left(0.53 - \frac{\varepsilon}{180^o} \right)^3 \qquad (4)$$

where $\mu(\varepsilon)$ is a scale factor (unitless) which is multiplied by the zenith errors in order to get the error at a specific satellite elevation ε in degrees). $\mathbf{k}_\mu$ is a coefficient (unitless). This equation represents the linear combination of the simplified tropospheric mapping function $\mathbf{1/sin}\ \varepsilon$ and that based on the ionospheric model given by Klobuchar [1996].

The coefficients $\mathbf{k}_1$, $\mathbf{k}_2$ and $\mathbf{k}_\mu$ and the variances of the uncorrelated errors at the zenith ($\sigma^2_{u_z}$) for each station can be computed using field data, according to the procedure described by Raquet [1998]. Basically, double difference misclosures, given by the term $(B\bar{\Phi} - \lambda\Delta\nabla N)$ in Equations (1) and (2), for 18 baselines in the network, covering a range of 30 to 235 km, were computed. In order to evaluate the $\mathbf{k}_\mu$ coefficient, the misclosures were grouped into 3-degree elevation bins and the function given in Equation (4) was fit to the variance of each bin. More details about this procedure can be found in Raquet [1998]. For computing coefficients $\mathbf{k}_1$ and $\mathbf{k}_2$, each double difference misclosure for each baseline was reduced to the zenith according to the following equation:

$$(B\bar{\Phi} - \lambda\Delta\nabla N)_z = (B\bar{\Phi} - \lambda\Delta\nabla N) \left(\frac{\mu(\varepsilon^x) + \mu(\varepsilon^y)}{2} \right)^{-1} \qquad (5)$$

where $(B\bar{\Phi} - \lambda\Delta\nabla N)_z$ is the misclosure reduced to the zenith and $\mu(\varepsilon^{\mathbf{x}})$ and $\mu(\varepsilon^{\mathbf{y}})$ are the mapping function average values obtained by applying Equation (4) for each station to the elevation of the base and remote satellite respectively (using the $\mathbf{k}_\mu$ coefficient computed previously). Hence, for all 18 baselines, each misclosure was computed every 15 seconds for 24 hours and reduced to the zenith using Equation (5). The variance of the misclosures for each baseline was also calculated. These variances comprise the observations used to evaluate the coefficients $\mathbf{k}_1$ and $\mathbf{k}_2$, in a Least-Squares adjustment using the following mathematical model:

$$\sigma^2_{(B\bar{\Phi} - \lambda\Delta\nabla N)_z} = 2(k_1 d + k_2 d^2) + 2\sigma^2_{u_z}(a) + 2\sigma^2_{u_z}(b) \qquad (6)$$

where $\sigma^2_{(B\bar{\Phi} - \lambda\Delta\nabla N)_z}$ is the variance of the double difference misclosures reduced to the zenith for each baseline; **d** is the baseline length; and $\sigma^2_{u_z}$ **(a)** and $\sigma^2_{u_z}$ **(b)** are the variances of the uncorrelated errors for stations **a** and **b**, which define the specific baseline. For these two terms to be reliably evaluated, very short baselines (few metres) should be used, as the correlated errors dominate the carrier-phase positioning. As there was no such short baseline in the data set, their values were not calculated. The ones used in the November, 1998, covariance function computation were re-used here.

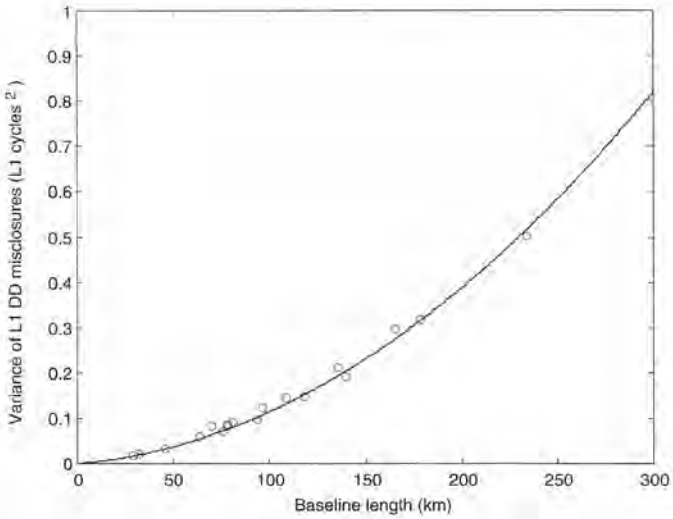

Figure 3: *Function fit after determining L1 $\mathbf{k}_1$ and $\mathbf{k}_2$ coefficients using August 4, 1999 data.*

Figures 3 and 4 show a plot of the function fit to determine the $\mathbf{k}_1$ and $\mathbf{k}_2$ coefficients for L1 and WL, respectively, using data collected on August 4, 1999. Each small circle represents the actual "observation" used in the fitting, formed by the variances of each baseline reduced to the zenith at the corresponding baseline length. It can be seen that the quality of the fit was very good. Table 1 shows the computed coefficients.

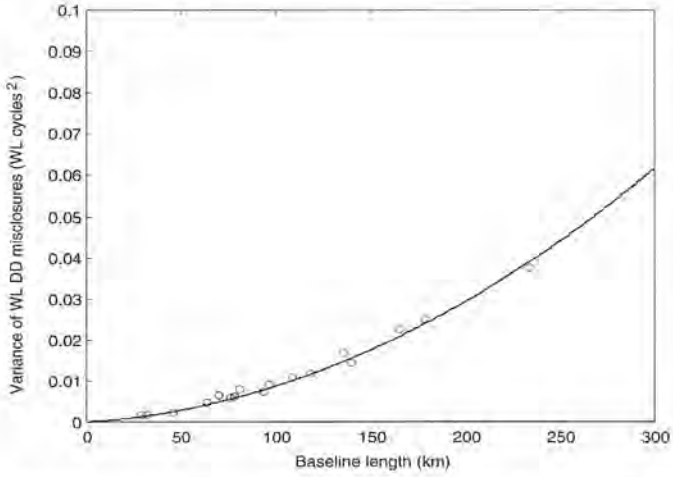

Figure 4: *Function fit after determining WL $\mathbf{k}_1$ and $\mathbf{k}_2$ coefficients using August 4, 1999 data.*

The corresponding mapping and covariance functions given by Equations (3) and (4), respectively, are given in Figure 5. For the sake of comparison, the functions obtained using data collected in September, 1997 (Norway), in November, 1998 (St. Lawrence region), and in August, 1999 (Brazil), are also shown in the figure.

From Figure 5, it can be seen that the correlated errors are much smaller for data collected in September, 1997, in Norway and they degrade slowly towards the horizon. This can be explained by the fact that the ionosphere was quieter during that campaign, as it occurred well before the current solar maximum, which

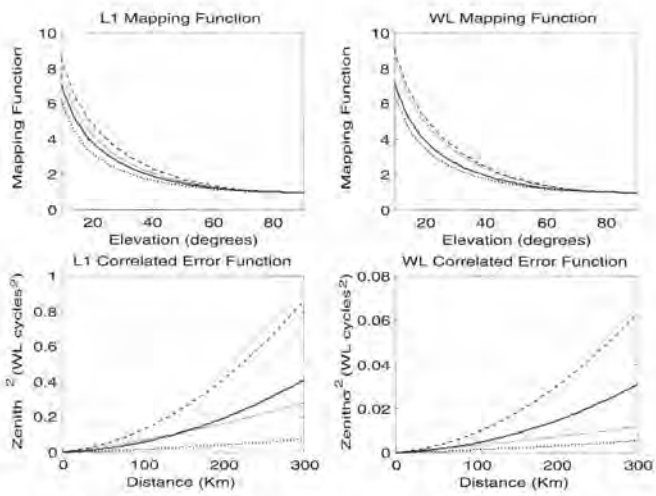

Figure 5: *Mapping functions (top figures) and correlated error functions (bottom figures) for L1 and WL using August, 1999, data from the St. Lawrence region (solid black line). Also shown are functions using data collected in September, 1997, in Norway (dotted line), November, 1998, in the same St. Lawrence region (long dash line), and in August, 1999, in Brazil (dashed line).*

peaked during the period 2000-2001 according to the Sunspot numbers plotted in Figure 6. The worst case scenario plotted in Figure 5 corresponds to the functions computed using data from Brazil. Not only was the data collected in August, 1999, which was closer to the solar maximum, but also the campaign happened under the equatorial anomaly [Fortes et al, 2000b]. The functions computed for the St. Lawrence region, in November, 1998, and August, 1999, are situated between the extreme cases. For November, 1998, the zenith correlated errors seem to be smaller, but this could have been compensated by a steeper mapping function. The different shapes for the functions related to the St. Lawrence region validate testing their use to assess the impact on the improvement brought by the Multi-Ref method.

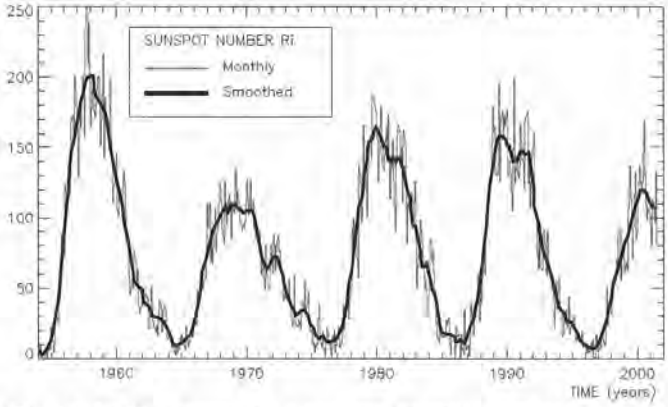

Figure 6: *The monthly (blue) and monthly smoothed (red) sunspot numbers for the four last cycles (from http://sidc.oma.be).*

The results using the August, 1999, St. Lawrence covariance functions are included in Table 4, Part 2. Figure 7 shows the raw and corrected double difference L1 and WL misclosures for Grand-Mère to Deschaillons baseline (46 km) for August 5, 1999.

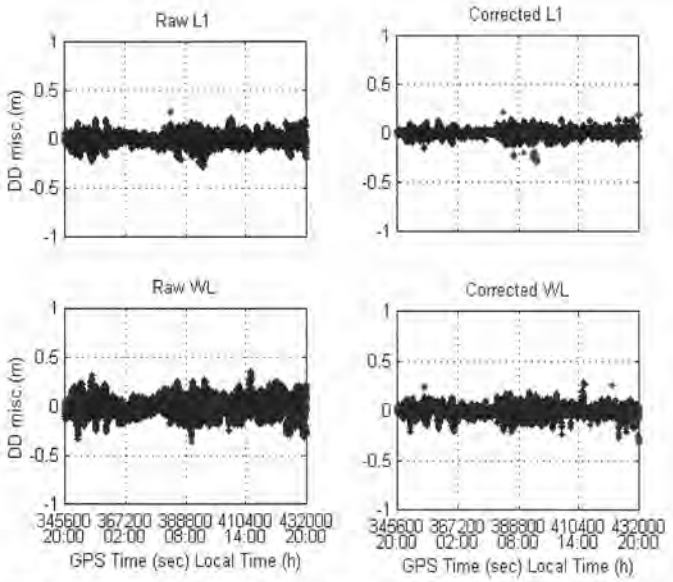

Figure 7: *Raw and corrected L1 and WL double difference misclosures for Grand-Mère to Deschaillons baseline (46 km) for August 5, 1999, using the original covariance function.*

Computation of the Covariance Functions for Ionosphere, Troposphere and Satellite Orbits Using August, 1999, Data

In the previous section, the original approach of modeling the total errors that affect the L1 and WL observables was applied. Now errors due to ionosphere, troposphere and satellite orbits are modelled separately using the geometric-free, scaled to L1, observable and the ionospheric-free observable. They are given by the following formulas:

$$\text{Geometric-free: } IS_{L1} = \frac{f_2^2}{f_2^2 - f_1^2}[\lambda_1\phi_1 - \lambda_2\phi_2] \qquad (7)$$

$$\text{Ionospheric-free: } \phi_{IF} = \phi_{L1} - (f_2 / f_1)\phi_{L2} \qquad (8)$$

where f_1, λ_1 and ϕ_1 are, respectively, the frequency, wavelength and carrier-phase observation (in cycles) for L1; and f_2, λ_2 and ϕ_2 are the equivalent quantities for L2.

The geometric-free linear combination given by Equation (7) eliminates all the geometric error sources, namely troposphere and satellites orbits, whereas the ionospheric-free linear combination (Equation (8)) eliminates the first order effect of the ionosphere on the measurements. As it can be deducted, each of the two linear combinations may be used to separately model the effects, except for the troposphere and satellite orbits, which are still modelled together using the ionospheric-free observable.

To generate the covariance function for these two observables, it was necessary to select proper mapping functions to reduce the observations to the zenith, which is analogous to what was done in the lumped case. In addition, a different formula than the one shown in Equation (5) was derived, as using the average of the mapping function values computed using the base and remote satellite elevations is an approximation. Therefore the following approach was used (for both observables):

$$\Delta\nabla I_{ab}^{xy} = I_a^x - I_a^y - \left(I_b^x - I_b^y\right) =$$
$$= \mu_a^x I_{a_z}^x - \mu_a^y I_{a_z}^y - \left(\mu_b^x I_{b_z}^x - \mu_b^y I_{b_z}^y\right) \qquad (9)$$

where $\Delta\nabla I_{ab}^{xy}$ is the double difference misclosure for the baseline defined by stations **a** and **b** and satellites **x** and **y** for either the geometric-free or the ionospheric-free observables; I_a^x is the undifferenced observation error from station **a** to satellite **x**, which is analogous for station **b** and satellite **y**; $I_{a_z}^x$ is the undifferenced observation error from station **a** to satellite **x** reduced to the zenith using the μ_a^x mapping function, which is analogous for station **b** and satellite **y**. Considering that it can be assumed that the zenith errors are independent of the satellite, and that for baselines lengths in regional networks the mapping function values computed to the same satellite from different stations are the same, the following equalities can be written:

$$I_{a_z}^x = I_{a_z}^y = I_{a_z} \qquad (10)$$

$$I_{b_z}^x = I_{b_z}^y = I_{b_z} \qquad (11)$$

$$\mu_a^x = \mu_b^x = \mu^x \qquad (12)$$

$$\mu_a^y = \mu_b^y = \mu^y \qquad (13)$$

Substituting Equations (10) to (13) into (9), the following is obtained:

$$\Delta\nabla I_{ab}^{xy} = \left(\mu^x - \mu^y\right)\left(I_{a_z} - I_{b_z}\right) \qquad (14)$$

Then:

$$\Delta I_{ab_z} = \left(I_{a_z} - I_{b_z}\right) = \left(\mu^x - \mu^y\right)^{-1} \Delta\nabla I_{ab}^{xy} \qquad (15)$$

which gives the relationship between the double difference misclosure and the differential error between stations **a** and **b** reduced to the zenith. In applying Equation (15), special care was taken in order to select double differences for which the term $(\mu^x - \mu^y)$ was not too small (> 0.2), in order to avoid numerical problems.

The mapping functions used for the geometric-free and ionospheric-free observables were [Skone, 1998; Schaer, 1999; Zhang, 1999]:

$$\text{Geometric-free: } \mu^x = \left[1 - \left(\frac{\cos\varepsilon}{1 + h/R_E}\right)^2\right]^{-1/2} \qquad (16)$$

$$\text{Ionospheric-free: } \mu^x = \frac{1}{\sin\varepsilon} \qquad (17)$$

where ε is the elevation of satellite **x**; R_E is the mean radius of the Earth (6371 km); and h is the height of the single layer model of the ionosphere (450 km, in the present case).

Equation (15) was then used to reduce the double difference misclosures to the zenith every 15 seconds, for a 24-hour period, for all 18 baselines in the network. The variances of the ΔI_{ab_z} quantities for each baseline were used as observations in a Least-

Squares adjustment to determine the coefficients (k_1 and k_2) of the covariance functions, similar to what was done for the lumped case. The mathematical model used in this case was:

$$\sigma^2_{\Delta I_{ab_z}} = k_1 d + k_2 d^2 + \sigma^2_{u_z}(a) + \sigma^2_{u_z}(b) \qquad (18)$$

One can see that Equation (18) is similar to (6), except that in the latter the quantity modelled is based on double differences and thus the entire formula is multiplied by a factor of two.

In Equation (18), the variance of the uncorrelated errors $\sigma^2_{u_z}$ was not estimated, analogous to what was done before. The following values, which were obtained using the error propagation law applied to a nominal error of 0.01 cycles for L1 and L2, were assigned:

Geometric-free scaled to L1: $\sigma^2_{u_z}$ = 2.2901e-05 m^2

Ionospheric-free: $\sigma^2_{u_z}$ = 3.7717e-05 m^2

Figures 8 and 9 show the results of the Least-Squares fit to the geometric-free and ionospheric-free observables, respectively, whereas Table 2 shows the corresponding coefficients of the covariance functions. These results can be shown to be equivalent to the L1 covariance function (Figure 3), if one combines the variances shown in Figures 8 and 9, taking into account the difference in the mapping function used, particularly between those in Equations (4) and (16).

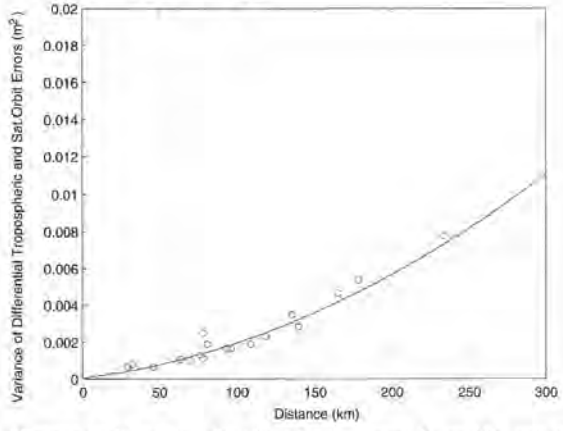

Figure 8: *Function fit after determining k_1 and k_2 coefficients for geometric-free scaled to L1 observable using August 4, 1999, data.*

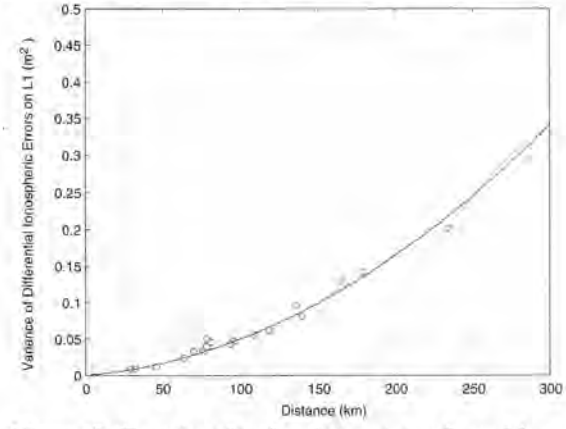

Figure 9: *Function fit after determining k_1 and k_2 coefficients for ionospheric-free observable using August 4, 1999, data.*

Table 2: *k_1 and k_2 coefficients and variances of the uncorrelated errors at the zenith ($\sigma^2_{u_z}$) for geometric-free and ionospheric-free observables using data collected on August 4, 1999.*

Coefficient	Geometric-free (Models differential ionosphere on L1)	Ionospheric-free (Models differential troposphere and satellite orbit)
k_1[a]	1.74958e-04	1.03268e-05
k_2[b]	3.21288e-06	8.83740e-08
$\sigma^2_{u_z}$[c]	2.2901e-05	3.7717e-05

a: m^2/km; b: m^2/km^2; c: m^2

Results of the application of the above covariance functions are included in Table 4, Part 3. For the sake of comparison, the ionospheric and tropospheric corrections were converted to L1 and WL.

Computation of the Covariance Function for Ionosphere in Directional Components (NS-EW) Using August, 1999 Data

Considering that the differential ionospheric errors do not necessarily have the same gradients along North-South (NS) and East-West (EW) directions, a further step was taken in order to model different covariance functions for each direction. This was carried out similarly to what was shown in the previous section, except that Equation (18) for this case is:

$$\sigma^2_{\Delta I_{ab_z}} = k_{1_N} d_N + k_{2_N} d_N^2 + k_{1_E} d_E + k_{2_E} d_E^2 + \sigma^2_{u_z}(a) + \sigma^2_{u_z}(b) \qquad (19)$$

where d_N and d_E are the baseline length components in the NS and EW directions, respectively, and $k1_N$, $k1_E$, $k2_N$, and $k2_E$ are the directional coefficients of the covariance function. The geometric-free linear combination scaled to L1 was used again in this case.

Figure 10 shows the NS and EW covariance functions based on the computed coefficients, according to Equations (20) and (21), respectively. It can be seen that the ionospheric errors along the NS direction are larger than the ones along the EW direction. Table 3 shows the values of the coefficients.

$$\sigma^2_{I_{N_z}} = k_{1_N} d_N + k_{2_N} d_N^2 \qquad (20)$$

$$\sigma^2_{I_{E_z}} = k_{1_E} d_E + k_{2_E} d_E^2 \qquad (21)$$

The results of applying the above ionospheric covariance function are included in Table 4, Part 4. For the troposphere, the same function computed in the previous section was used. The results, as before, are expressed in terms of L1 and WL improvement.

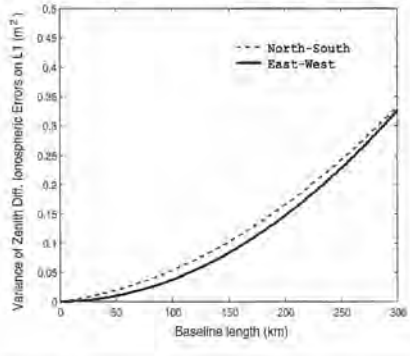

Figure 10:
NS (dashed) and EW (solid) ionospheric covariance functions using August 4 1999 data.

Table 3: k1N, k1E,k2N, and k2E coefficients and variances of the uncorrelated errors at the zenith ($\sigma^2_{u_z}$) for directional ionospheric covariance function using data collected on August 4, 1999.

Coefficients	Directional ionospheric coefficients
k_{1_N} [a]	2.51319e-04
k_{2_N} [b]	2.86767e-06
k_{1_E} [a]	2.29866e-05
k_{2_E} [b]	3.55075e-06
$\sigma^2_{u_z}$ [c]	2.2901e-05

a: m^2/km; b: m^2/km^2; c: m^2

Comparison of Results

Table 4 includes the improvement brought by the Multi-Ref approach, in the observation domain, for the three sets of covariance functions described in the previous sections, namely: the original covariance functions (modelling lumped L1 and WL errors); the ionospheric and tropospheric covariance functions; and the directional ionospheric covariance function used with the tropospheric one computed in the second case. Data collected on August 4, 1999 was used to compute the functions. For the sake of comparison, the results obtained using the original covariance computed with data collected in November, 1998, and published in Fortes et al. [2000a], are also included (see Part 1).

***Table 4:** Raw and corrected double difference misclosure RMS and respective improvement for Grand-Mère to Trois-Rivières (30 km) and Grand-Mère to Deschaillons (46 km) baselines for August 4 and 5, 1999, using various covariance functions.*

Session	L1 (m)			WL (m)		
	Raw	Corr	Imp	Raw	Corr	Imp.
Part 1: Original Covariance Function, Nov 98 data						
GMER – TRIV						
Aug 04	0.04	0.02	50%	0.06	0.03	50%
Aug 05	0.04	0.02	50%	0.06	0.03	50%
GMER – DCHA						
Aug 04	0.06	0.03	50%	0.07	0.05	29%
Aug 05	0.06	0.03	50%	0.08	0.04	50%
Part 2: Original Covariance Function, Aug 99 data						
GMER – TRIV						
Aug 04	0.04	0.02	50%	0.06	0.03	50%
Aug 05	0.04	0.02	50%	0.06	0.03	50%
GMER – DCHA						
Aug 04	0.06	0.03	50%	0.07	0.05	29%
Aug 05	0.06	0.03	50%	0.08	0.04	50%
Part 3: Iono-Tropo Cov. Function, Aug 99 data						
GMER – TRIV						
Aug 04	0.04	0.02	50%	0.06	0.03	50%
Aug 05	0.04	0.02	50%	0.06	0.03	50%
GMER – DCHA						
Aug 04	0.06	0.03	50%	0.07	0.04	43%
Aug 05	0.06	0.03	50%	0.08	0.04	50%
Part 4: Iono_NE-Tropo Cov. Function, Aug 99 data						
GMER – TRIV						
Aug 04	0.04	0.02	50%	0.06	0.03	50%
Aug 05	0.04	0.02	50%	0.06	0.03	50%
GMER – DCHA						
Aug 04	0.06	0.03	50%	0.07	0.04	43%
Aug 05	0.06	0.03	50%	0.08	0.04	50%

Analysing Table 4, it can be seen that results obtained with the original covariance function using either data collected during the campaign (August 4, 1999 – Part 2) or from a previous one (November, 1998 – Part 1) were not significantly different. Considering that covariance functions with the same characteristics were used in both cases, it could have been anticipated that the estimated parameters would be similar, according to previous work in the field of physical geodesy [Moritz, 1976]. However, the estimated correction variances are expected to change, and this is an investigation to be addressed in the future. When the ionosphere and troposphere (plus satellite orbits) are modelled separately, the results (Part 3) improved only in one case (GMER-DCHA baseline, on August 5), and this change was at the millimetre level only. A directional ionospheric covariance function also gave results (Part 4) at the same level of improvement as the other ones. In summary, all results can be considered equivalent in the tests conducted using this network. This indicates that the Multi-Ref method may not be so sensitive to the covariance function used, which shows its robustness. From an operational point of view, when one thinks about a real-time service transmitting corrections to users across the region covered by the reference network, this is a very important characteristic, as frequent covariance function updates will not be required. In addition, these results demonstrate that it is not necessary to add additional complexity to the covariance function modelling, as the lumped model gives good results. The strength of the Multi-Ref approach is therefore based on the geometry of the network, with the covariance functions only being responsible for the relative weighting of the double difference misclosures computed using the reference network data in the process of determining corrections. This is a further advantage since the network geometry is in general determined by the correction service supplier, and as such it is controlled to some extent.

Comparing the original covariance functions to those that model the errors separately, the second ones may have the advantage of reducing the number of corrections to be transmitted to users, as the tropospheric/satellite orbit corrections and the ionospheric corrections are applicable to both code and phase observations. In addition, transmitting corrections separated by error source gives more flexibility, as different update rates can be used for each correction according to the error behaviour.

Conclusions and Future Work

The results of all optimized covariance functions showed equivalent level of improvement in all cases. This indicates the Multi-Ref method robustness, as a simpler lumped model gives good results. This characteristic is very important if one thinks of a real-time service, as there will be no need of frequent covariance function updates. Comparing the original covariance functions to the ones that model the errors separately, the latter may have the advantage of reducing the number of corrections to be transmitted to the users, in addition to allowing different update rates for each type of correction (i.e. by error source). Despite the fact that all results were equivalent, it is expected that the estimated correction variances change with the covariance functions. This is going to be addressed in future investigations.

The results presented here are based on a network that does not have extremely long baselines. Despite the fact that the ionosphere

was reported to be active during the campaign (up to 7 parts per million, according to Fortes et al. [2000a]), the raw misclosures were already small. Therefore future work includes testing the optimization scheme using data collected in Brazil by a regional network with longer baselines, under the equatorial anomaly, in a region very much affected by the ionosphere, with larger directional spatial gradient differences between NS and EW. In addition, Figure 7 shows some cases of "isolated" dots in the corrected double difference misclosure plots. After investigating these occurrences, it was found that most of those misclosures correspond to satellites setting or rising, whose observation data was not so well modelled by the method, because the satellite was observed by only a few reference stations. To overcome this situation, it is planned to implement a Kalman filter approach in order to compute corrections based on data of previous epochs and not only from the current one.

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Luiz Paulo Fortes holds an M.Sc. in Computer Science applied to Geomatics and is currently a PhD candidate at the University of Calgary. He has been working during the last 20 years for IBGE Department of Geodesy (the "Geodetic Survey" of Brazil) where he was responsible for the Research and Analysis division most of the time and as the head of the department in the last two years before enrolling in the PhD program. Bolsista da CAPES – Brasília/Brasil.

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Dr. Gérard Lachapelle is Professor and Head of the Department of Geomatics Engineering, where he is responsible for teaching and research related to positioning, navigation, and hydrography. He has been involved with GPS developments and applications since 1980.

Completion of the CHA/CIDA Malaysia Hydrographic Training Project 1985–2001

By: T.D.W. McCulloch, CHA/CIDA Project Manager, Malaysia Hydrographic Survey Training

Introduction

After much waffling and panic as I realized I could end up with many pages of information that might not be of interest to the reader, I changed tack and have confined myself to the core of the story. So I will start off my submission with excerpts from a short speech I delivered at the Universiti Teknologi Malaysia (UTM) Cat. A graduation ceremony of September 13, 2001.

Summary

This is the story of the Canada-Malaysia Hydrographic Connection, and its impact on specialized hydrographic training for the surveying and mapping profession in Malaysia.

Tom McCulloch (right) receives an ISM Honorary Fellowship.

In 1974, while on a brief visit to Malaysia, I first contacted the Royal Malaysian Navy (RMN) Hydrographic Department and members of the Institution Surveyors Malaysia (ISM) who were interested in hydrographic surveying. Those contacts led, over the years, to technical cooperation between Malaysia and Canada, with specialized training on various aspects of hydrographic surveying being provided to Malaysians by Canadian instructors, both in Canada and Malaysia. In this early period of cooperation, fifty Malaysian surveyors were trained in both Malaysia and Canada, with six Canadian Hydrographic Association experts assigned to teach in Malaysia.

The training in Malaysia became formalized at the Universiti Teknologi Malaysia, Johor Bahru, in the early nineties, after studies indicated a substantial demand for such specialized training. In 1995, the UTM Centre for Hydrographic Studies was accredited by the International Federation of Surveyors/International Hydrographic Organization (FIG/IHO) Standards of Hydrographic Competence Board to conduct courses and award certification to suitable candidates at the Cat. B (Hydro I) level. In 1998, the UTM Centre for Hydrographic Studies received accreditation from the FIG/IHO Standards of Competence Board for the Cat. A (Hydro II) course standard. [Cat. A is the *Category A International Accreditation* - Standards of Hydrographic Competence - Manager of complex hydrographic surveys. Cat. B is the *Category B International Accreditation* - Standards of Hydrographic Competence - Hydrographic professional skilled in all aspects of hydrographic surveying.]

Since 1996, the UTM Centre for Hydrographic Studies has conducted four Cat. B (Hydro I) courses, and two Cat. A (Hydro II) courses, and has graduated twenty-eight hydrographic surveyors in the Cat. B (Hydro I) category and thirteen in the Cat. A (Hydro II) category.

Since UTM became the focal point for hydrographic training for the surveying profession in Malaysia, Malaysian instructors, from both the university and other Malaysian agencies, have taken over much of the curriculum for both categories of training, e.g. tidal studies, geodesy, physics, oceanography etc., leaving the Canadian Hydrographic Association (CHA) instructors to concentrate on such high-tech areas as multibeam theory, interpretation and data management utilizing CARIS software, acoustics theory, sidescan interpretation and application. UTM instructors have closely shadowed these CHA activities. The effects of exposing students to hands-on multibeam activities have been greatly aided by the RMN Hydrographic Directorate who have provided suitable vessels, equipment, and staff to ensure the success of the venture.

Main Gate UTM Skudai

In addition, Canadian commercial companies such as Universal Systems (CARIS) and Quester Tangent contributed their expertise and knowledge to the project.

We feel confident that UTM is now not only fully certified in hydrographic training to international standards, but is also completely self-sustaining in the teaching of the hydrographic survey discipline.

There are many individuals who deserve mention in recording the success of this endeavour. However, a few names spring out in front of all the others, without whose full, wholehearted commitment the project could have faltered and failed.

Captain Goh Siew Chong, RMN Ret'd, who was my original Malaysian contact, for his hearty cooperation and enthusiasm.

Dato Abdul Majid, whose support ensured the complete cooperation of both the National Directorate of Survey and Mapping and the Institution Surveyors Malaysia.

First Admiral Rasip, for making the Hydrographic Directorate a key element in our deliberations and in influencing UTM to agree to become the focal point for FIG/IHO internationally accredited hydrographic training courses.

Tuan Baharom, who wholeheartedly supported the UTM/PAC thrust.

Dean Ayob Sharif, who made sure that the Centre for Hydrographic Studies became well established at UTM.

Razali Ahmad, who headed the PAC during six tumultuous years.

Dr. Razali Mahmud, whose efforts at the Centre for Hydrographic Studies kept things running smoothly and who secured the Cat. B qualification.

Ahmad Shahlan, UTM, who persuaded the FIG/IHO that UTM was ready for the Cat. A standard.

Rusli Othman and Usmuni Din of UTM, who made sure that the course ran smoothly and kept a handle on logistics as well.

On the Canadian side, I would particularly mention the following:

Dr. David Wells of UNB and CHA, whose professionalism and reputation ensured the respect of all.

Ken McMillan, President of CHA and lecturer in ports and Harbours studies, whose enthusiasm is well known to all.

David Pugh, CHS, who ensured that UTM received the full benefit of his advice on international standards of competence for Cat. A and Cat. B courses.

Barry Lusk, CHA, my long-suffering and hard-working deputy.

And, last but not least, the officers of the **Membership and Specialized Organizations Branch (MSOP) of Canadian International Development Agency (CIDA)**, who believed in our project and helped make it the success that it certainly turned out to be.

This may well be the last hurrah for the Canada-Malaysian hydrographic connection, but now that the survey aspect of training has been taken care of, we are looking into the possibility of conducting courses in nautical cartography. So the connection is not yet severed—indeed, it may well be strengthened.

A Brief Account of How we Went about Achieving our Goals and Objectives

Roles and Relationships of Participating Agencies

The CHA, the ISM (Institution Surveyors Malaysia), the RMN Hydrographic Directorate, the National Survey and Mapping (NSM) Directorate, the CHS (Centre for Hydrographic Studies) UTM, coordinated their activities through a PAC (Project Advisory Committee) chaired by a representative of the ISM.

The PAC was created in 1994 to oversee project planning and implementation. This committee continued its advisory role into the second phase. Membership of the PAC:

Chairman	Razali Ahmad	ISM
Member	Dean Dr Ayob Sharif (replaced by Dean Dr Mohd Ibrahim in 2001)	UTM
Member	1st Admiral Rasip (replaced by Captain Yacob Ismail in 2001)	RMN
Member	Tom McCulloch	CHA Project Manager
Member	Barry Lusk	CHA Assistant Project Manager
Member	D.G. Dato Abdul Majid (replaced by substitute from 1999)	NSM
Member	Dr. Mohd Razali Mahmud (Director, Centre for Hydrographic Studies)	UTM

CHA provided overall management and coordination of the project and supplied the CHA teaching staff in specialized subjects, together with appropriate hardware and software.

UTM made available its facilities and teaching staff, and created a fully equipped centre for hydrographic studies with seven professional faculty members.

RMN's Hydrographic Directorate was the link to the broader hydrographic world through its membership in the International Hydrographic Organization (IHO) and provided a national standard through its own hydrographic surveys and charting capabilities. It also linked the PAC to the Malaysian National Hydrographic Committee with membership from all government agencies concerned with maritime matters.

K.D. Perantau

ISM was the institutional link with CHA, responsible for national surveying and mapping professional standards. It was also the voice of the private sector engaged in many hydrographic activities in Malaysia's coastal and offshore waters.

NSM was directly involved through its responsibilities to maintain a national water levels monitoring system and its role as Malaysia's lead agency in Law of the Sea boundary determination and disputes.

The Student Profile - 1995–2001

Since UTM/CHS became an FIG/IHO internationally accredited hydrographic training establishment in 1995, thirteen students attained the Cat. A standard and twenty-eight students attained the Cat. B standard.

The students were generally divided almost equally between government agencies and the private sector. Additionally, in the case of the Cat. B students, four were from outside Malaysia—one female private sector from Brunei, two males from the United Arab Emirates, government agency, and one from Oman, government agency.

Four Cat. B graduates were from the RMN Hydrographic Directorate. Four Cat. A graduates were from the RMN Hydrographic Directorate.

Several of the Malaysian Cat. B students went on to take their Cat. A at UTM.

Instructors

UTM Instructors and Subjects

Mathematics and Statistics	Assoc. Prof Dr. Mohd Nor Mohamad Mr. Hisham Lee Abdullah
Physics	Dr. Rush Abe Rahman Assoc. Prof Dr. Radzi Ahmad
Computer Programming	Assoc. Prof Dr. Hahim Setan
Geodesy	Prof Dr. Ayob Sharif Kamaluddin Hj. Omar
Hydrographic Information	Assoc. Prof Dr. Taher Buyong
Port and Coastal Engineering	Hamidi Ahmad
Hydrographic Positioning	Assoc. Prof. Tuan Baharom Mahmood
Tides: Theory and Practice	Lt. Cdr. Zainal Aziz Ahmad Shahlan Mardi
Hydrographic Surveys	Mohd Razali Mahmud/Usmuni Din
Remote Sensing	Prof. Dr. Mohd Ibrahim Seeni Mohd
Marine Meteorology	Assoc. Prof. Dr. Adi Maimun And. Malik
Seamanship and Navigation	Capt. S.K. Puri (ALAM)
Dynamic Oceanographic and Sedimentology	Assoc. Prof. Dr. Nor Aieni Hj.Mokhtar

CHA Instructors and Subjects

Dr. D. Wells	HS2	With particular emphasis on Multibeam theory, calibration, and hands-on data management. Practical at-sea exercises.
Mr. D. Dodd	HS2	Hands-on Multibeam data management and acoustics theory. Sidescan interpretation. Multibeam data processing with CARIS software.
Mr. K. McMillan	HP2	Port and Coastal Surveying, with emphasis on sidescan sonar theory and application. Conducting a short Electronics Troubleshooting course.
Mr. D. Pugh	HI2	Marine Cartography, Electronic Charts, and Data Management Processing and Analysis.
Mr. K. Czotter	HS2	Hands-on Multibeam data management and acoustics theory. Sidescan interpretation. Multibeam data processing with CARIS software.

HI Hydrographic Information - Marine Cartography
HP Hydrographic Ports and Coastal Surveying Course
HS Hydrographic Survey Course

Project Results

Outcomes

CHS/UTM now has the ability to train hydrographers to internationally accredited standards. It is the only hydrographic training establishment in SE Asia to offer both Cat. B (Hydrographic Professional) and Cat. A (Hydrographic Manager) levels. The Cat. A course is offered in a number of maritime schools around the globe, and the Cat. B in others. In Asia, only Japan offers the equivalent of the CHS/UTM curriculum. The courses taught at CHS/UTM have given Malaysia increased prominence in the SE Asian maritime community. Other maritime nations as far afield as Oman and the United Arab Emirates have recognized this fact by sending students to the courses. The government of Malaysia led by RMN and the Marine Department, with much support from the Shipping Federation of Malaysia, clearly recognizes that much more requires doing to enhance the safety of shipping. The involvement of Malaysia in the IMO proposal financed by the World Bank into a Marine Electronic Highway (MEH) for the Straits of Malacca is a clear indication of its concern.

Impact

Modern, up-to-date charts enable all shipping to navigate in greater safety. Other hydrographic data collected and analyzed is used in the search for petroleum and other minerals. The success of the training project has had an impact on other countries—note the participation of Brunei, United Arab Emirates, Oman, etc. It has also led to enquiries re nautical cartographic training from within Malaysia, but also from Singapore, Indonesia, and Hong Kong (SAR China).

Piracy is a fact of life in SE Asian waters. When Electronic Charts (ECDIS) become the backbone of the MEH, it should eventually

2001 Cat. A Graduation Ceremony, Canadian High Commissioner Jean McCloskey - Centre.

be possible to lock a watchful eye on all marine transportation with greater awareness of highjacking activities through automatic reporting of unusual occurrences, such as course alteration, communication interfaces, etc.

There is much potential for hydrocarbon exploration and development, but this usually takes place using raw hydrographic data collected by the RMN Hydrographic Directorate and private hydrographic surveying companies. The new nautical charts will provide a useful guide in conducting such activities, but it must be remembered that the finished chart is a navigational tool and will not show much of the actual large amount of data collected.

CIDA-Funded Projects from 1985 to 2001

Malaysia Hydrographic Survey Training

Project No.	
24572	$ 303,500
44601	79,000
47495	400,000
53926	151,000
60349	149,000
Total	**$ 1,082,500**

CHA in-kind contributions from 1985 to 2001:
Approx. $ 290,000

Malaysian agencies in-kind contributions from 1985 to 2001:
Approx. $ 8,000,000

Benefits to Canada

- The profession of hydrographic surveying in Canada and, in particular, the members of CHA have been recognized by their peers in other countries for their skill and determination in assisting Malaysia achieve world-class standards in hydrography. We have been reported on in all the leading hydrographic surveying magazines, and have played a prominent role at numerous hydrographic symposia and conferences. In the field of multibeam echo sounding, we have made quite an impact, led by such experts as Dr. David Wells of UNB, and supported by several first-class "hands-on" practitioners.
- Sales of hardware - $250,000
- Sales of software - $550,000
- Contracts to Canadian hydrographic survey companies - $550,000 - estimated

Sustainability of the UTM Centre for Hydrographic Studies 2002 to 2004

In-Kind Contributions

The future sustainability of the Centre for Hydrographic Studies is dependent on the in-kind contributions of the following organizations:

UTM/ CHS	Classrooms, laboratories, teaching staff, support staff, hardware, software, logistics, student accommodation, etc.
RMN	Vessel, laboratories, students, support staff, hardware, software, logistics, accommodation
ISM	Professional interface, particularly with the private sector

The UTM Faculty of Geoinformation Science and Engineering is committed to complete support for the Centre for Hydrographic Studies. A Cat. B course is scheduled to commence early in 2002, with a Cat. A course being developed for possible schedule in 2003.

The RMN Hydrographic Directorate is committed to sending its hydrographic officers for training to UTM/CHS. This will mean probably three students per year from the RMN.

ISM is a purveyor and distributor of hydrographic course information and content.

Infrastructure

UTM dedicated classrooms/laboratories/library	
3 years @ $100,000 pa	$ 300,000
RMN dedicated laboratories, vessels	
3 years @ $750,000 pa	$ 2,250,000
	$ 2,550,000

Human Resources

UTM faculty members	
15 x 3 years @ $20,000 pa	$ 900,000
RMN staff time	
100 x 3 years @ $10,000 pa	$ 300,000
Student sponsors	
20 x $20,000	$400,000
(salaries and living costs)	
	$ 1,600,000
Grand Total	**$ 4,150,000**

Conclusions

Since UTM became the focal point for hydrographic training for the surveying profession in Malaysia, Malaysian instructors, from both the university and other Malaysian agencies, have taken over much of the curriculum for both categories of training, e.g. tidal studies, geodesy, physics, oceanography, etc., leaving the CHA instructors to concentrate on such high-tech areas as multibeam theory, interpretation and data management utilizing CARIS software, acoustics theory, sidescan interpretation and application. UTM instructors have closely shadowed these CHA activities. The effects of exposing students to hands-on multibeam activities have been greatly aided by the RMN Hydrographic Directorate, who have provided suitable vessels, equipment, and staff to ensure the success of the venture.

We feel confident that UTM is now not only fully certified in hydrographic training to international standards, but is also completely self-sustaining in the teaching of the hydrographic survey discipline.

It has taken quite a few years, but I believe we have finally more than met our joint goals and objectives. As one other indication of that conclusion, I draw your attention to a Malaysia Hydrographic initiative "2001 East Asia Hydrographic Symposium & Exhibition" held in Kuala Lumpur on June 12 to 14 and sponsored jointly by the Universiti Teknologi Malaysia and the RMN Hydrographic department. It was a successful venture, with hydrographers attending from all over the region to view the many high-tech exhibits and take part in the many technical sessions. The Dominion Hydrographer of Canada also took part in the symposium.

This success and that of our hydrographic survey training project may well lead to other Canada-Malaysia Hydrographic ventures in the future. There is much interest in developing a nautical cartographic training course at UTM to serve the region. We await the outcome of this proposal.

Personal Note

The Institution Surveyors Malaysia presented the author with an Honorary Fellowship in 1998 in recognition of his contribution to the establishment of professional hydrographic survey training in Malaysia. The honorary fellowship in ISM is also a tribute to Canada and, in particular, the CHA.

It should be noted that there have been seven recipients of this award, which include Dr. Mahathir, the Prime Minister of Malaysia. We have been greatly honoured.

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About the Author...

Tom McCulloch retired from Fisheries and Oceans in 1985. After many years of field and management in the Canadian Hydrographic Service and the Marine Sciences Branch, he culminated his government career as Director General of the Bayfield Laboratory for Marine Sciences, based in Burlington, Ontario.

He was active in representing hydrographic surveying within the Canadian surveying and mapping community, being an early President of the Canadian Hydrographic Association and President of the Canadian Institute of Surveying in 1985.

Additionally, his promotion of hydrography on the international scene saw him as Chairman of FIG Commission 4 from 1980 to 1983, and International Vice President of the Canadian Bureau of FIG from 1985 to 1987. He was presented with the Hydrographic Society's President's Prize in 1990 and the Queen's Silver Jubilee Medal in 1977. He was made an honorary member of FIG in 1990 and an honorary fellow of ISM in 1998. Although slowing down somewhat at 77, he hopes to continue an active involvement in international hydrography.

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Augmentation of DGNSS With Dynamic Constraints For Marine Navigation

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Reliable and accurate GPS positions are required for general marine navigation and specialized applications such as buoy tending. The GPS signals are often masked by obstructions, which results in degraded geometry and accuracy at best, and unavailability or unreliable positions at worst. The use of combined GPS-GLONASS results in a dramatic increase in the number of satellites available above the horizon. When this combined constellation is further augmented with height and clock constraints, it results in an improvement in the reliability and precision of the navigation solutions. However, depending on the masking environment and the operational requirements, this augmented case may still not meet the user's requirements. The reliability and precision of the navigation solution can be improved even further by adding ship dynamic constraints. The improvement attained by adding the ship dynamic constraints is illustrated through software simulations and hardware simulations using a GPS Signal Simulator. These results clearly demonstrate the advantage of augmenting GPS-GLONASS with ship dynamic constraints for marine navigation.

Introduction

The introduction of public marine Differential GPS (DGPS) systems by the Canadian and United States Coast Guards has completely revolutionized marine navigation and positioning. The mariner is being offered a system with a stated accuracy of 10 m (95% of the time), and can often achieve metre level positioning accuracies. The accuracy requirements for marine navigation and positioning vary greatly depending on the application, from kilometres for oceanic navigation to centimetres for 3D navigation in constricted waterways. Table 1 lists some of the major marine positioning accuracy requirements.

Table 1: *Marine Positioning Accuracy Requirements*

Applications	2DRMS Accuracy
Safety of Navigation [FRP, 1996]	
Ocean Phase	1.8 – 3.7 km
Coastal Phase	460 m
Harbor and Harbor Approach	8 – 20 m
Inland Waterways	2 – 5 m
Other Desirable Requirements [Lachapelle, 1997]	
Hydrographic Survey (Special)	2 m
Placing Aids to Navigation	< 5 m
Resource Exploration	1 – 5 m
3D Navigation in Constricted Waterways / Channels	< 10 cm

The Coast Guards' DGPS systems can meet all of these accuracy requirements, except of course the 10 cm_{3D} navigation in constricted waterways. Only an on-the-fly carrier phase system can meet 10 cm_{3D} and this is outside the scope of current marine DGPS systems and this paper, but is being studied by other investigators (e.g. Fortes et al., 1999). Table 1 however, only addresses the precision requirements for marine navigation, the reliability requirements having not been specified. Unfortunately when it comes to marine navigation and positioning, reliability is often ignored. The Coast Guards have endeavored to make the DGPS Service as reliable as possible, through the use of redundant equipment and real-time integrity monitoring. For more information on the Canadian Coast Guard's DGPS System see [Ryan et al., 1997]. Reliable corrections however do not guarantee reliable user positions, since problems can still occur at the marine users end due to multipath, modeling problems and extremely poor geometry.

Previous analyses [Ryan et al., 1998, Ryan et al., 1999a, and Ryan et al., 1999b] have demonstrated the availability and reliability improvements attained by augmenting DGPS with the following additional satellite navigation systems and constraints:

1) single point GLONASS
2) differential GLONASS
3) differential geostationary satellites
4) height constraint
5) clock constraint

The results showed that augmenting DGPS always improved the availability and reliability, however, the most significant improvements were achieved during extreme masking conditions. These analyses however did not assume any a priori knowledge of the trajectory, thus an epoch by epoch least squares solution was computed. While augmenting DGPS greatly improved both the availability and reliability, there were still many areas of unavailability and poor reliability. The purpose of this paper is to build on the previous augmentation analyses and add dynamic constraints to the navigation solution.

Dynamic constraints can be applied in several ways. First, maximum values for acceleration and velocity can be specified for the vehicle under test and if the navigation solution exceeds these limits, observations and/or epochs can be rejected. Second, the statistical behavior of the vehicle dynamics can be used to

drive a Kalman filter. The statistical behavior of the vehicle's dynamics is used to generate the dynamics model and the process noise parameters. A Kalman filter uses previous observations to improve the availability and reliability of the current navigation solution. The filter, however, is only as good as the accuracy of the dynamics model and input process noises. The more accurate these values the better the results.

This paper addresses the improvements that one can obtain by augmenting DGPS and the various other system combinations mentioned above, with a Kalman Filter "tuned" for marine navigation, and is broken into three sections. First reliability theory as it relates to standard least squares and Kalman filtering is reviewed. In the second section software simulations are conducted to evaluate the reliability improvement when the Kalman filter is used during a typical hydrographic survey. In the final section, least squares and Kalman filtering reliability algorithms are compared using two marine user receivers tested on a differential GPS signal simulator.

Reliability Theory

Reliability refers to the ability to detect blunders in the measurements and to estimate the effects of undetected blunders on the navigation solution. Reliability can be sub-divided into internal and external reliability. Internal reliability quantifies the smallest blunder that can be detected on each observation through statistical testing of the least squares residuals / Kalman filtering innovation sequence. Once the internal reliability has been determined, external reliability quantifies the impact that an undetected blunder can have on the navigation solution. Least squares reliability theory is first reviewed, followed by Kalman filtering theory, and finally the external reliability is defined for both methods.

Internal Reliability using Least Squares

In order to detect a blunder using an epoch by epoch least squares approach, a statistical test must be performed on the residuals. Hence, redundancy must exist in order to detect a blunder using least squares.

The least squares residuals $\hat{r}$ are biased due to an unknown blunder, ∇, as

$$\hat{r} = - C_{\hat{r}} C_l^{-1} \nabla = - R \nabla \qquad (1)$$

where $C_{\hat{r}}$ is the covariance matrix of the residuals
C_l is the covariance matrix of the observations
$R = C_{\hat{r}} C_l^{-1}$ and is the redundancy matrix

In order to detect a blunder in an observation, a statistical test must be performed on the residuals. Normally each standardized residual is tested as

$$\left| \frac{\hat{r}_i}{\sqrt{C_{\hat{r}\,ii}}} \right| \geq n_{1-\frac{\alpha}{2}} \qquad (2)$$

The underlying assumption is that the residuals are normally distributed and that a blunder, while biasing the residual, does not change its variance. There are two types of errors that can be made when performing any statistical test. A Type I error occurs whenever a good observation is rejected. The probability associated with a Type I error is denoted α. A Type II error occurs whenever a bad observation is accepted. The probability associated with a Type II error is denoted β. Figure 1 shows a graphical representation of the relationship between the Type I and II errors and the bias in the standardized residual called the non-centrality parameter δ_o. By selecting values for α and β, δ_o can be determined, as shown in Table 2.

Figure 1: *Type I/II Errors and Non Centrality Parameter*

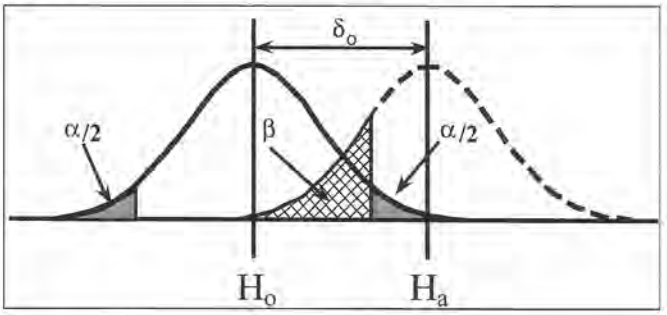

Table 2: *Non-Centrality Parameter [Leick, 1995]*

α	β	δ_o
5.0%	20%	2.80
2.5%	20%	3.10
5.0%	10%	3.24
2.5%	10%	3.52
0.1%	20%	4.12
0.1%	10%	4.57

Substituting equation (1) into (2) and calculating δ_o based on the selection of α and β, the smallest blunder that can be detected through statistical testing of the residuals is given by the following equation, and is termed the Marginally Detectable Blunder (MDB).

$$MDB_i \Rightarrow |\nabla_i| = \frac{\delta_o \sqrt{C_{ii}}}{\sqrt{R_{ii}}} \qquad (3)$$

where "i" denotes the ith observation

Internal Reliability using Kalman Filtering

Kalman filtering allows us to generate an *a priori* estimate of our current parameters using previous measurements [Brown and Hwang, 1997]. The general dynamics and measurement model for the Kalman filter are given by

$$x_k = \Phi_k * x_{k-1} + w_{k-1} \qquad (4)$$

$$z_k = A_k * \delta_k + e_k \qquad (5)$$

where:

x is the parameters
Φ_k is the transition matrix
w is the input process noise with covariance q
z is the linearized measurement vector
$\delta_k = x_k - x_{\text{linearization point}}$ parameter corrections
A is the design matrix
e is the measurement noise with covariance C_l

The Kalman filter propagates the parameters and the parameters covariance matrix ($C_{\hat{x}}$) from the previous epoch to the current epoch via

$$\hat{x}_k^- = \Phi_k * \hat{x}_{k-1}^+ \quad (6)$$

$$C_{\hat{x}k}^- = \Phi_k * C_{\hat{x}k-1}^+ * \Phi_k^T + Q_{k-1} \quad (7)$$

where Q_{k-1} is the discrete time processs noise
(+) indicates after measurement update
() indicates before measurement update
k and k-1 indicate the epoch number

The linearized measurements are used to update the parameter corrections and the parameter covariance matrix ($C_{\hat{x}}$) via

$$\hat{\delta}_k^+ = \hat{\delta}_k^- + K_k(z_k - A_k * \hat{\delta}_k^-) \quad (8)$$

$$C_{\hat{x}k}^+ = C_{\hat{x}k}^- - K_k * A_k * C_{\hat{x}k}^- \quad (9)$$

where Kalman Gain - $K_k = C_{\hat{x}k}^- A_k^T \left(A_k C_{\hat{x}k}^- A_k^T + C_{lk}\right)^{-1}$

Innovation Sequence - $i = (z_k - A_k * \hat{\delta}_k^-)$

Similar to least squares, a statistical test must now be performed on the Kalman innovation sequence to detect a blunder in the observations [Lu and Lachapelle, 1992]. The normalized sum square innovation sequence (SSI) is biased by the unknown blunder vector, ∇, as

$$SSI = \nabla^T * C_i^{-1} * \nabla \quad (10)$$

where $C_i = A_k C_{\hat{x}k}^- A_k^T + C_{lk}$

SSI – χ^2 distribution with mean $(\delta_0)^2$

The marginally detectable blunder (MDB) is calculated assuming (a) only one blunder is present in the observations at a given epoch, (b) this is the first epoch with a blunder, and (c) the α and β significance levels are the same as the least squares case, as

$$MDB_i \Rightarrow |\nabla_i| = \frac{\delta_0}{\sqrt{(C_i^{-1})_{ii}}} \quad (11)$$

While the Kalman filtering MDB has a different form than the least squares MDB, they are mathematically identical if *a priori* information on the parameters is added to the least squares model.

External Reliability

Once the MDB for each observation has been calculated using either least squares or Kalman filtering, the impact of this blunder on the unknown parameters must be determined. The underlying assumption is that only one blunder can occur at any one time. Therefore, each MDB is applied separately to assess its impact on the parameters as

$$\Delta\hat{\delta}_i = -C_{\hat{x}}^+ A^T C_l^{-1} \nabla_0 \quad (12)$$

where ∇_0 is a column vector containing all zero's except for the MDB in the i^{th} position. The resulting horizontal error for each blunder is calculated as

$$\text{Horizontal Error} = \sqrt{\Delta\varphi^2 + \Delta\lambda^2} \quad (13)$$

The MDB that produces the maximum horizontal position error (MHE) represents the external reliability for the software simulations to follow.

Kalman Filter Tuning

As previously mentioned, the Kalman filter is only as good as the accuracy of the dynamics model and process noise "q". If the dynamics model and process noise are pessimistic, the Kalman filter will not significantly improve the availability and reliability over least squares. However, if the dynamics model and the process noise are too optimistic, the filter will be unable to track the real vehicle dynamics, resulting in systemic errors. Thus it is imperative that the dynamics model and process noises match reality, or are slightly pessimistic. In order to ensure that the simulation results to follow are correct, actual ship data was used to generate the dynamics model and the input process noise for the Kalman filter. The dynamic behavior of two hydrographic survey vessels was analyzed to generate the dynamics model and process noises.

Eight hours of data was collected at one Hertz while the Canadian Coast Guard Ship (CCGS) *F.C.G. Smith* was performing a hydrographic survey on the St. Lawrence River, in October 1998 [Fortes et al., 1999]. The ship's accelerations were generated using the DGPS determined velocities. The DGPS velocities were calculated using a 1st Order central difference of the carrier phase. Previous analysis [Hebert et al., 1997] has shown that this method of determining velocity is very accurate during periods of constant velocity ($3D_{rms}$ = 2-3 mm/s), and shows a systemic error correlated with jerk during dynamics [bias = 0.18*J(t)]. Therefore generating accelerations using this method will be pessimistic, not optimistic.

The acceleration estimates during the eight hours were used to generate the acceleration auto-correlation function in the north, east, and up directions as

$$R_a(\tau) = \frac{1}{T-\tau}\int_0^{T-\tau} A(t) * A(t+\tau)\, dt \quad (14)$$

where R is the autocorrection function
T is the length of the data 8 hours
A is the acceleration.

Figure 2 shows the north auto-correlation function that was generated using the *CCGS F.C.G. Smith's* acceleration data, and the corresponding 1st Order Gauss-Markov process with a 10 second time constant. The east and up directions were also matched with the closest 1st Order Gauss-Markov process.

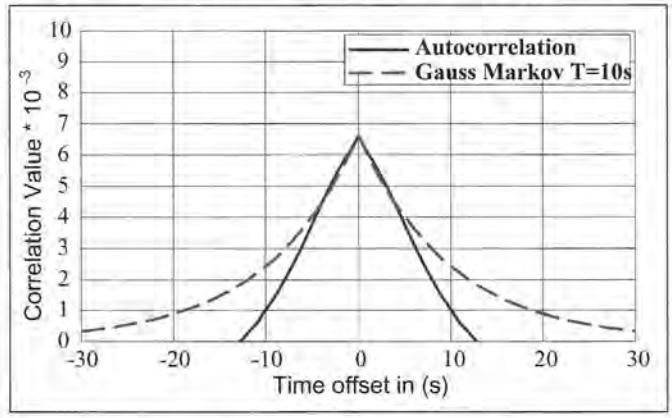

Figure 2: *North Acceleration Autocorrelation Function for the CCGS F.C.G. Smith*

The same procedure was performed using one hour of data from a Canadian Coast Guard (CCG) survey launch operating off the coast of Victoria, BC, [Ryan et al., 1999b]. The acceleration auto-correction functions were again generated and compared with 1st Order Gauss-Markov processes with different time constants. Table 3 summarizes the results from the two ship data sets. The software simulations in the next section used these two filters as well as two additional filters, one with ½ the process noise variance of the *CCGS F.C.G Smith*, and the other with twice the process noise variance of the CCG survey launch. See [Brown and Hwang, 1997, and Schwartz et al., 1989] for a discussion of dynamic models.

Table 3: *Kalman Filter Process Noise Parameters*

Kalman Filter #1		
Direction	**σ^2 (10^{-3})**	**Time Constant**
North & East	5	10 s
Up	0.5	1 s
Kalman Filter #2 - CCGS F.C.G. Smith		
Direction	**σ^2 (10^{-3})**	**Time Constant**
North & East	10	10 s
Up	1	1 s
Kalman Filter #3 – CCG Survey Launch		
Direction	**σ^2 (10^{-3})**	**Time Constant**
North & East	100	10 s
Up	5	1 s
Kalman Filter #4		
Direction	**σ^2 (10^{-3})**	**Time Constant**
North & East	300	10 s
Up	10	1 s

Software Simulation

The reliability and precision improvements obtained by augmenting DGPS with differential GLONASS, differential geostationary satellites, a height constraint, and a clock constraint under isotropic masking conditions, during hydrographic surveying, and in constricted waterways have been covered in [Ryan et al., 1998, Ryan et al., 1999a, and Ryan et al., 1999b]. The current simulations will take the hydrographic surveying environment analyzed in [Ryan et al., 1999b] and will augment the positioning modes with the four Kalman filters described in the previous section. The purpose of the new simulations is to determine the improvement that can be obtained by adding a Kalman filter.

The simulation was conducted over 24 hours in 60-second increments, using the July 25, 1997 almanacs. Vancouver Island, B.C., Canada was used as the simulation location (48° N, 123° W). The following reliability parameters were used: $\alpha = 0.1\%$, $\beta = 10\%$, and $\delta_0 = 4.57$. DGPS (25 satellites available) was augmented with two additional satellite systems, namely 15 GLONASS satellites and six geostationary satellites. Height, clock, and dynamic constraints were used. Both additional satellite systems were added in differential mode as DGLO (differential GLONASS) and DGEO (differential geostationary satellites). Single point GLONASS was not added as a separate augmentation scheme since previous analysis [Ryan et al., 1999b] had shown it to have little reliability improvement. Taking all of these combinations into account, the following four different satellite constellation combinations were simulated:

1) DGPS
2) DGPS + DGLO
3) DGPS + DGEO
4) DGPS + DGEO + DGLO

For each satellite constellation combination, the following four types of constraints were employed:

1) No Constraints – "N"
2) Height Constraint – "H"
3) Clock Constraint – "C"
4) Both Height and Clock Constraints – "B"

For each of these 16 cases , the four Kalman filters described in the previous section and standard least squares were applied. Thus a total of 80 positioning cases were simulated.

Since the simulations were being performed for hydrographic applications, high quality receivers were assumed, thus a measurement variance of 1 m^2 was assumed for all of the differential satellite navigation systems. The height constraint assumed that tidal information was being used, with a variance of 4 m^2. This information was added as a separate height observation to the filters and least squares. The Kalman filter clock constraint was implemented by changing the process noise values in the filter. When the clock constraint was applied, the process noise for a Rubidium oscillator was used, otherwise the process noise for a crystal oscillator was used. Table 4 lists the process noise for both oscillators. The oscillator parameters and the GPS receiver clock model were obtained from [Brown and Hwang, 1997]. The least squares clock constraint was implemented as a quasi-observable with a 1 m^2 variance.

Table 4: *GPS Receiver Clock's Process Noise*

Oscillator	**Clock Bias**	**Clock Drift**
Crystal Oscillator	0.0090	$3.6*10^{-2}$
Rubidium Oscillator	0.0009	$7.1*10^{-11}$

The benefits obtained by augmenting the various positioning methods with the four Kalman filters were evaluated by assessing availability and reliability improvements. The HDOP was calculated as

$$HDOP = \frac{\sqrt{C_x^+(\phi) + C_x^+(\lambda)}}{\sigma_{GPS}} \qquad (15)$$

For the purpose of this simulation, the following six geostationary satellites were simulated:

1) INMARSAT-3 @ 180° E
2) INMARSAT-3 @ 64.5° E
3) INMARSAT-3 @ 55.5° W
4) INMARSAT-3 @ 15.5° W
5) Additional SV @ 100° W
6) Additional SV @ 140° W

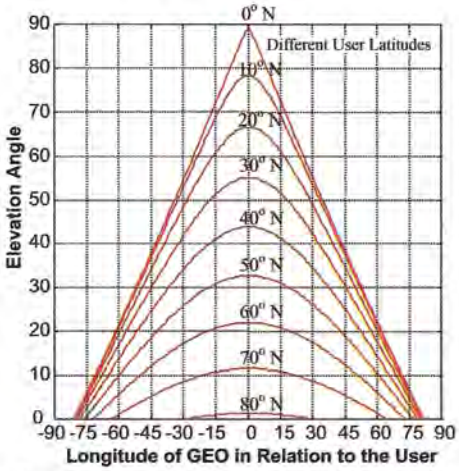

Figure 3: *Geostationary Satellite Elevation Angle*

The elevation angle of a geostationary satellite is a function of the user's latitude and the relative longitude of the geostationary satellite with respect to the user. Figure 3 shows this relationship for user latitudes varying from 0° to 80° N. For this simulation, the maximum geostationary elevation angle is approximately 32°.

An east / west survey line was analyzed for a simulated inlet 1600 m by 4000 m with 300-m-high cliffs, as shown in Figure 4. Satellite visibility therefore ranged from excellent (elevation mask angle < 10°) in the center of the inlet to poor (180° signal masking) near the cliffs. The circles indicate the computation points for the survey line. As the survey launch approaches the cliffs, the computation point spacing is shortened in order to increase the resolution of the results. A 24-hour simulation was conducted at every computation point using a time interval of 60 seconds. At each computation point and for each epoch, the HDOP and MHE were calculated.

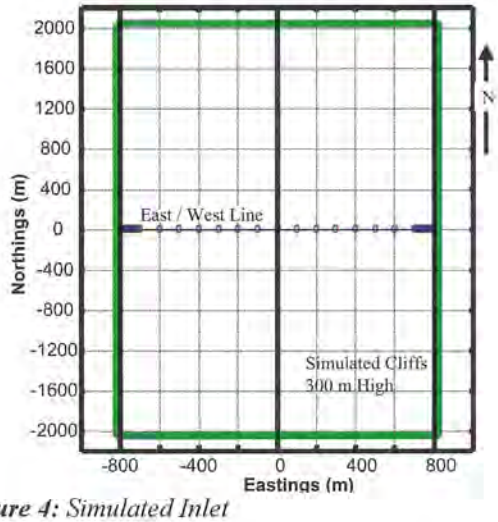

Figure 4: *Simulated Inlet*

For each epoch, the Kalman filter was first initialized $[(C_{\hat{x}}^{-})^{-1} = 0]$, and then iterated to steady state. The MHE was generated from the MDB of each observation, using the steady-state filter parameters. The underlying assumption is that the MDB did not bias the filter prior to detection. Therefore a "step" blunder is being simulated.

Simulation Results

If all of the simulation data were to be presented, a four dimensional figure would be required (positioning method, survey line location, time, and HDOP / MHE). Instead of presenting the entire time series of HDOP and MHE values, the 95th percentile results are presented, in Figures 5, 6 and 7. Thus for each survey line position and positioning method the 95th percentile is plotted for the HDOP and MHE using contour graphs. The survey line position is plotted along the y-axis. Thus 800 m corresponds to the east cliff wall, and –800 m corresponds to the west cliff wall. The positioning methods are shown on the x-axis. The positioning cases are first grouped according to the satellite constellations and Kalman filter employed. Then for each satellite constellation and Kalman filter, the following four constraints are used: N = none, H = height constraint, C = clock constraint, and B = both height and clock constraints.

It was impractical to show all 80 positioning cases on the same figure. Thus several contour graphs are presented illustrating the various positioning cases, as shown in Figures 5, 6 and 7. For comparison purposes the least squares results for DGPS + constraints and DGPS+DGLO+DGEO + constraints are presented with the Kalman filtering results.

The availability (95% HDOP) results are shown in Figures 5 and 6. Figure 5 shows the results for least squares, and each Kalman filter augmenting DGPS. The four filters give almost identical results. A slight availability improvement is noticeable between the 1st and 4th filters, however, they are essentially identical. When the filter's constraints are compared there is only a slight improvement between the "N" and "C" cases. This is due to the fact that a clock constraint is always being applied: the "N" case uses a crystal oscillator while the "C" case uses a Rubidium oscillator. The Rubidium oscillator improves the availability in the middle of the channel, but only shows minor improvement at the cliff walls. The minor improvements along the cliff wall are due to the simulation assumption, that the filter is initialized for each epoch. Thus if only three observations are available for a given epoch the filter cannot determine the initial clock bias and therefore can never generate a position regardless of the clock's accuracy. This is also the reason why the least squares clock constraint performs better than the Kalman filter clock constraint. In the least squares simulations the clock constraint is added as a quasi-observable thus it assumes that the initial clock bias is know, however, the filter starts with no knowledge of the clock bias. Thus the different assumptions cause the difference in results. The addition of the Kalman filter slightly improves the available of DGPS alone and DGPS with a height constraint.

Figure 6 now compares least squares with Kalman filter #4. Once the Kalman filter is augmented with at least one additional satellite

system, its results are essentially equivalent with the most augmented least squares case. When the most augmented Kalman filtering case is examined, the 95% HDOP < 2.0 next to the cliff. While the filter improves the availability, least squares DGPS with both constraints still has a 95% HDOP < 4.0 next to the cliff, which may meet operational requirements. Although the addition of the Kalman filter improves the availability the improvement is not dramatic.

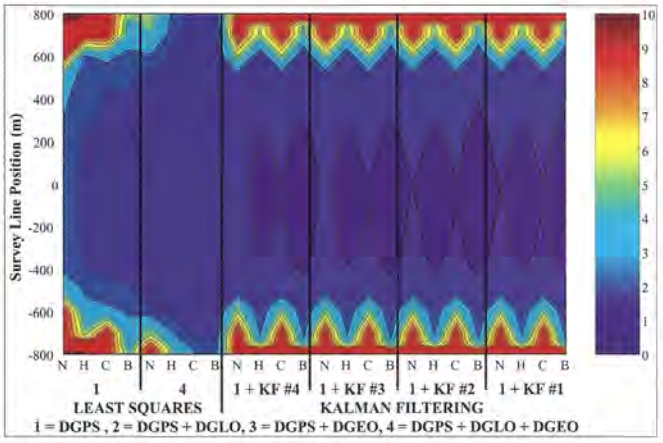

Figure 5:
East/West Line - HDOP 95% - DGPS & All Kalman Filters

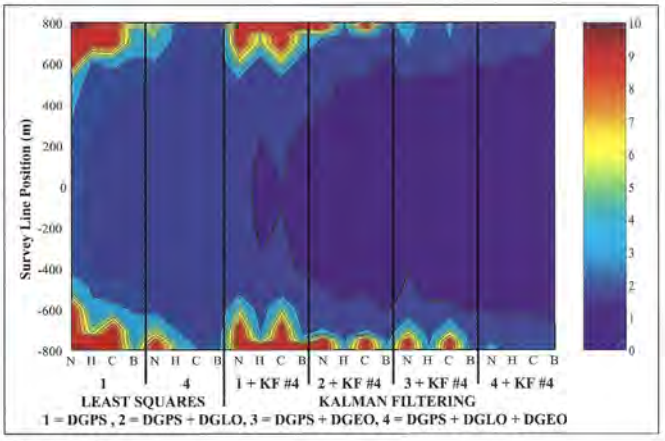

Figure 6:
East/West Line - HDOP 95% - DGPS & Kalman Filter #4

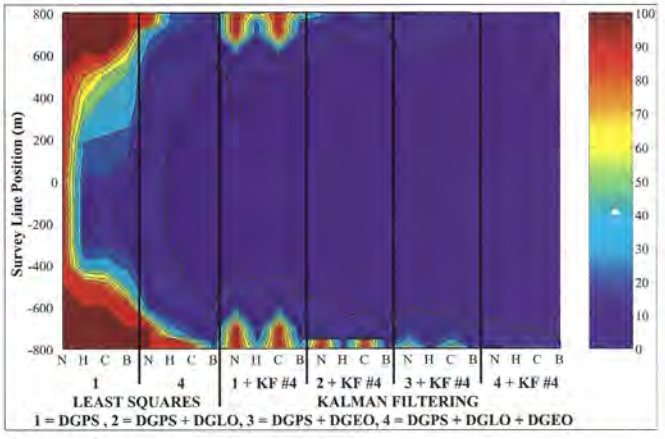

Figure 7:
East/West Line - MHE 95% - DGPS & Kalman Filter #4

The reliability results for the four Kalman filters were again almost identical to each other, therefore, only the reliability results for filter #4 are presented. The reliability results for least squares and Kalman filter #4 are shown in Figure 7. In the most augmented least squares case the 95% MHE < 25 m next to the cliff, and is < 10 m 100 m from the cliff. However the Kalman filter only needs to augment DGPS with one additional satellite system, and the constraints to exceed these results. The most augmented Kalman filter case has a 95% MHE of < 10m next to the cliff. The addition of the Kalman filter is essentially equivalent to adding an additional satellite system, and its most augmented case allows reliable positioning throughout the entire survey line. However, one word of caution: these results assumed that the blunder did not bias the filter prior to detection. The results may be different if a different blunder type (i.e. slow ramp) was simulated. For the "step" blunder simulated herein, the filter improves the availability and greatly enhances the reliability.

DGPS Receiver Reliability Evaluations

In [Ryan et al., 1999a] it was shown that the four marine user receivers tested did not perform any internal reliability checking. Least squares reliability checking was then performed in post mission to demonstrate the reliability improvement that could be obtained. Now two of the four receivers will be investigated, but this time the relative reliability improvement between least squares and Kalman filtering will be examined. Blunders, in the form of stepwise multipath ramps, were added to a single satellite (SV #8) and then external least squares and Kalman filtering reliability algorithms were used to determine if the blunder could be detected and / or removed. The following two receivers were used for this test:

1) RX "A" – DGPS Survey Receiver
   - 12 Channel Dual Frequency Receiver
   - Raw Data Output
   - High Performance Correlator

2) RX "B" – Older DGPS Sensor
   - 12 Channel L1 only Receiver
   - Raw Data Output
   - Wide Correlator

The GPS simulation lasted 75 minutes with each user receiver following the trajectory shown in Figure 8. A fairly benign environment was simulated with SA and AS off, no satellite clock or ephemeris errors, and the sea state ranged from 0 to 3. During the straight portions of the trajectory the ship moved at a constant speed of 36 km/h. The ship decelerated into the turns and accelerated out of the turns. Figure 8 also shows where the six multipath ramps were introduced in the simulation. Just prior to the multipath being added to SV #8, its signal was turned off for 30 seconds, thereby limiting the performance of carrier smoothing.

Figure 9 shows the multipath induced range errors and multipath signal power on SV #8 for two correlator spacings (1.0 chips and 0.1 chips). These errors were calculated assuming an infinite receiver bandwidth [van Nee, 1995]. Receiver "A" will have range errors close to that of the 0.1 chip correlator, while receiver "B" will behave similar to that of the wider 1.0 chip correlator.

Continued on page 63.

SANI - INTERNATIONAL TECHNOLOGY ADVISORS INC.

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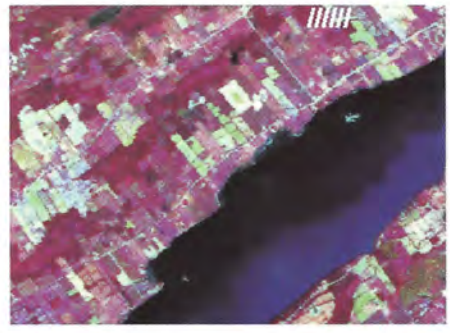

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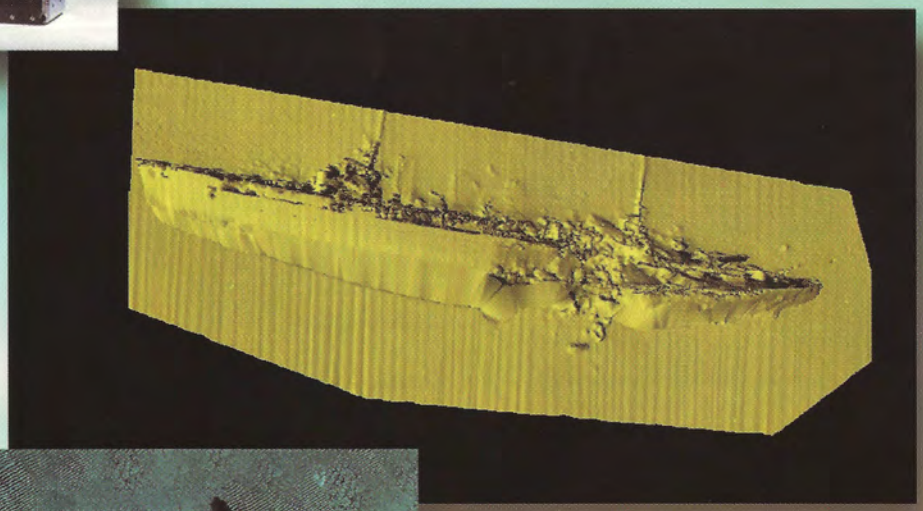

8125 multibeam data of SMS Koln shipwreck at 35m (courtesy of ScapaMAP)

8125 multibeam data of shipwreck in the Persian Gulf, depth 50m

SURVEY

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May 28 - 31, 2002

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The Westin Harbour Castle Hotel, Toronto, Canada

KEYNOTE SPEAKERS:
WILLIAM STOEHR, President of National Geographic Maps
TED RANKINE, Host of PowerBoat Television

FINAL PROGRAM

More details at www.chc2002.com

MESSAGE FROM CO-CHAIRS

Welcome to Toronto and the Canadian Hydrographic Conference. This year's theme, "Innovation and Excellence," focuses on the changing needs of our clients. With this in mind we encourage you to take advantage of the program's technical sessions and workshops; browse through the indoor and marine exhibits; review presentation papers and enjoy the poster sessions. Generally, expand your knowledge of hydrography. After all, it is your responsibility to help the world community better understand and appreciate the marine environment.

Above all, take the opportunity to meet each other. Introduce yourselves to those around you because they are your future information network.

So, now you know what your organizing committee expects from you on the educational front. Socially we have a variety of activities planned, which we will advise you of as the conference progresses. The combination of learning and fun is a part of the hydrographic culture. At the conclusion of the conference we hope you leave with newly acquired knowledge, contacts and good memories.

To those who have worked so diligently behind the scenes to make this conference a success, the organizing committee extends its gratitude.

Mike Bennett

George Fenn

CHC2002 conference co-chairs

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GENERAL INFORMATION

FOR INFORMATION, PLEASE CONTACT:

Canadian Hydrographic Conference 2002
c/o Absolute Conferences & Events Inc.
144 Front St. W., Suite 640
Toronto, ON
M5J 2L7

DATE AND SITE OF THE CONFERENCE

Tuesday, May 28 to Friday, May 31, 2002
The Westin Harbour Castle Hotel
One Harbour Square
Toronto, Ontario Canada
M5J 1A6
Phone: 416-869-1600
Toll Free Reservations: 1-800-WESTIN-1
Fax: 416-368-6838
http: //www.westin.com

REGISTRATION/INFORMATION DESK – Sponsored by IIC Technologies Inc.

The main Conference registration/information desk is located in the Coat Check area on the street level of the Westin Harbour Castle Conference Centre and will be open at the following times:

Sunday May 26, 08:00 to 10:00
Monday May 27, 08:30 to 10:30 and 17:00 to 19:00
Tuesday May 28, 07:30 to 09:30 and 12:00 to 20:00
Wednesday May 29, 07:30 to 17:00
Thursday May 30, 08:00 to 17:00
Friday May 31, 07:00 to 13:00

Outstanding registration fees and payment for tours should be made at the registration desk. Additional tickets for the, Receptions, World of Hockey Dinner and Optional Tours are available at the time of printing, please check with the registration desk, if you would like to participate, but have not already purchased tickets.

Welcome Reception tickets	$25.00 each
Ice Breaker Reception	$45.00 each
World of Hockey Dinner tickets	$125.00 each

FULL REGISTRATION INCLUDES:

Access to all technical sessions, exhibit areas, refreshment breaks, Wednesday and Thursday's lunch and entertainment, Tuesday's "Welcome Reception", Wednesday's "Ice-Breaker Reception" and Thursday's "World of Hockey Dinner"

RECREATIONAL BOATERS' DAY REGISTRATION INCLUDES:

Access to all daytime conference activities including technical sessions, exhibit areas, refreshment breaks, on the water demonstrations, lunch and entertainment.

MESSAGE CENTRE

Attendees cannot be paged while attending the Conference. However, a message board will be located in the Registration/information area. If you are expecting a message or wish to leave one for a colleague attending the Conference, please direct your caller to the Westin Harbour Castle Hotel main switchboard at (416) 869-1600 and ask for the "CHC2002" registration desk.

GENERAL INFORMATION

BADGES – Sponsored by TSS (US) Ltd.

Delegates, speakers and guests must wear their identification badges at all times to gain admission to the conference sessions and special events. In the event that your badge is lost or misplaced, a replacement may be obtained at the Registration/information desk during published hours.

LANGUAGES OF COMMUNICATION

The presentations will be given in English or in French. Workshops will be presented in English only. Simultaneous translation will be available for the duration of the conference, however, written documents will be published in the language in which they were originally written.

CONFERENCE PROCEEDINGS

All fully registered conference participants (three days) will receive a copy of the proceedings (CD-ROM). Additional copies are available for purchase at the registration desk at a cost of $25 each.

DRESS

Business casual attire is appropriate for all sessions and events.

SPEAKER PREPARATION ROOM

A speaker preparation room is located in the Wellington Room located on the street level of the hotel conference centre.

MEDICAL OR OTHER EMERGENCIES

If you should experience an emergency situation, please contact the Conference Registration/information desk, or call the main switchboard of the hotel for assistance.

ELECTRICAL CURRENT

The electrical current in Canada is 110 volts 60hz.

TEMPERATURES

Canada uses the metric system of measurement. Temperatures are in Celsius
Celsius to Fahrenheit C x 9/5 +32 = F
Fahrenheit to Celsius F - 32 x 5/9 = C

TIPPING

It is customary in Ontario to tip in restaurants, taxis or for other special services, generally 15%.

AIRLINES

For those flying home after the Conference, please ensure that you have reconfirmed your flight arrangements. Should you require information regarding the airlines, please contact the Registration/information desk during the published hours.

INSURANCE

The Organizing Committee will accept no liability for personal injuries sustained by or for loss or damage to property belonging to Conference participants, either during or as a result of the Conference or during all tours.

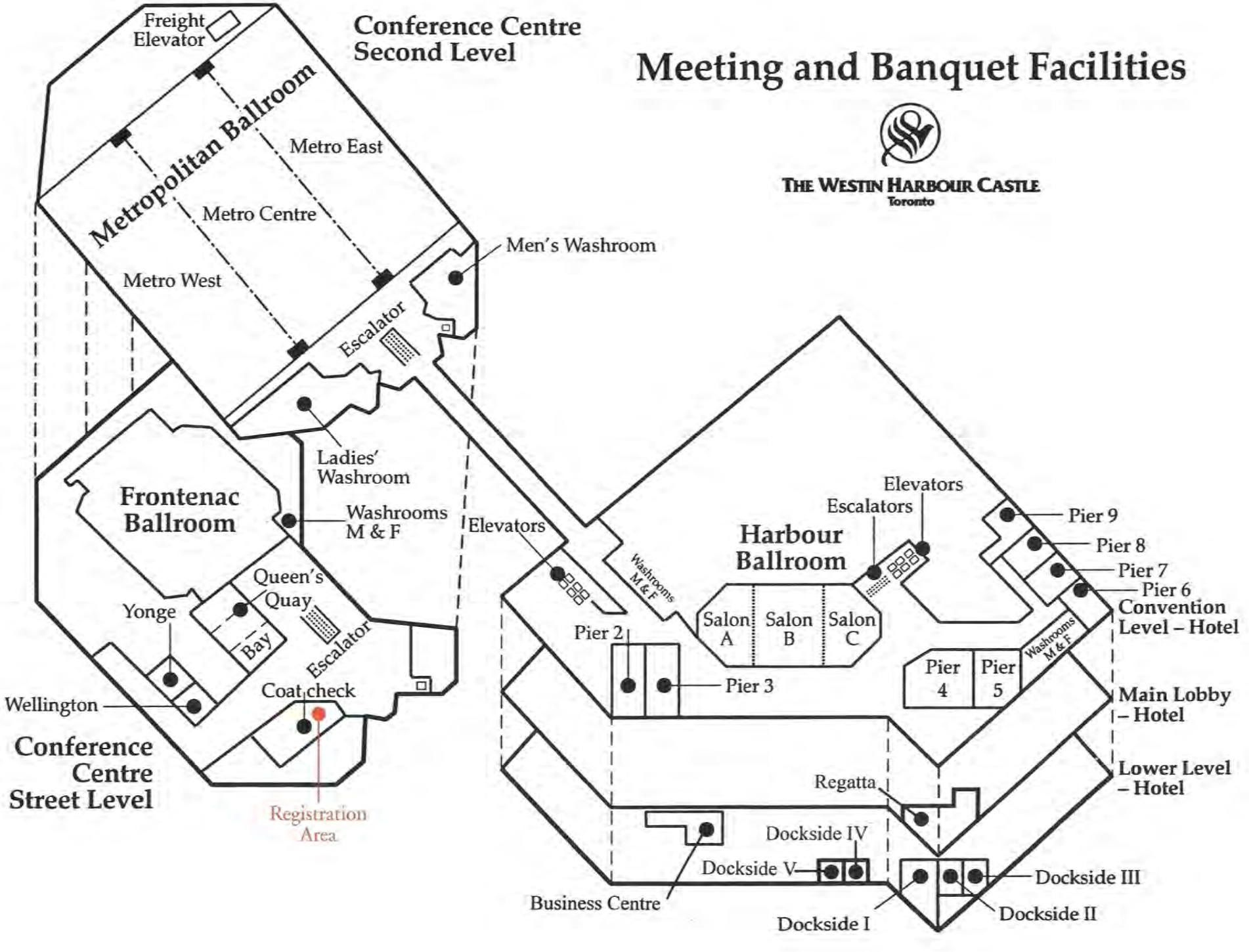
We would like to remind you to be aware of the possibility of theft in meeting rooms and public areas, please be careful with your personal possessions.

LOST AND FOUND

Enquiries concerning lost property should be addressed to the conference registration/information desk.

Meeting and Banquet Facilities

THE WESTIN HARBOUR CASTLE
Toronto



EXHIBITORS CONFIRMED TO DATE

Aanderaa Instruments, Inc.
Applanix LLC
Association of Canada Lands Surveyors
Brooke Ocean Technology Ltd.
Canadian Coast Guard, Office of Boating Safety
Canadian Hydrographic Association
Canadian Power and Sail Squadrons (CPS)
CARIS
Coastal Oceanographics Inc.
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Canadian Ice Service/service canadien des glaces
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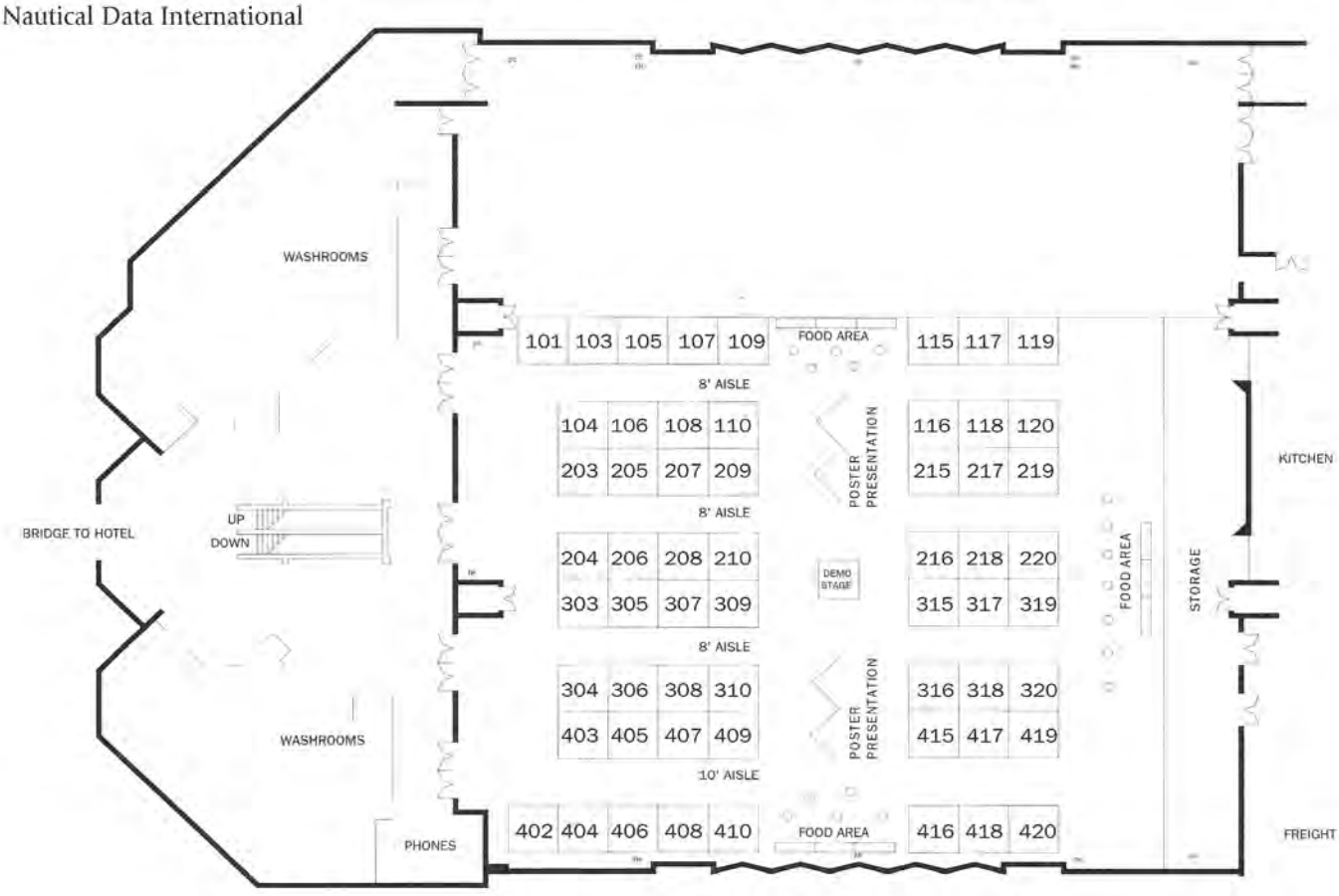

CANADIAN HYDROGRAPHIC CONFERENCE 2002 – Marine Exhibits

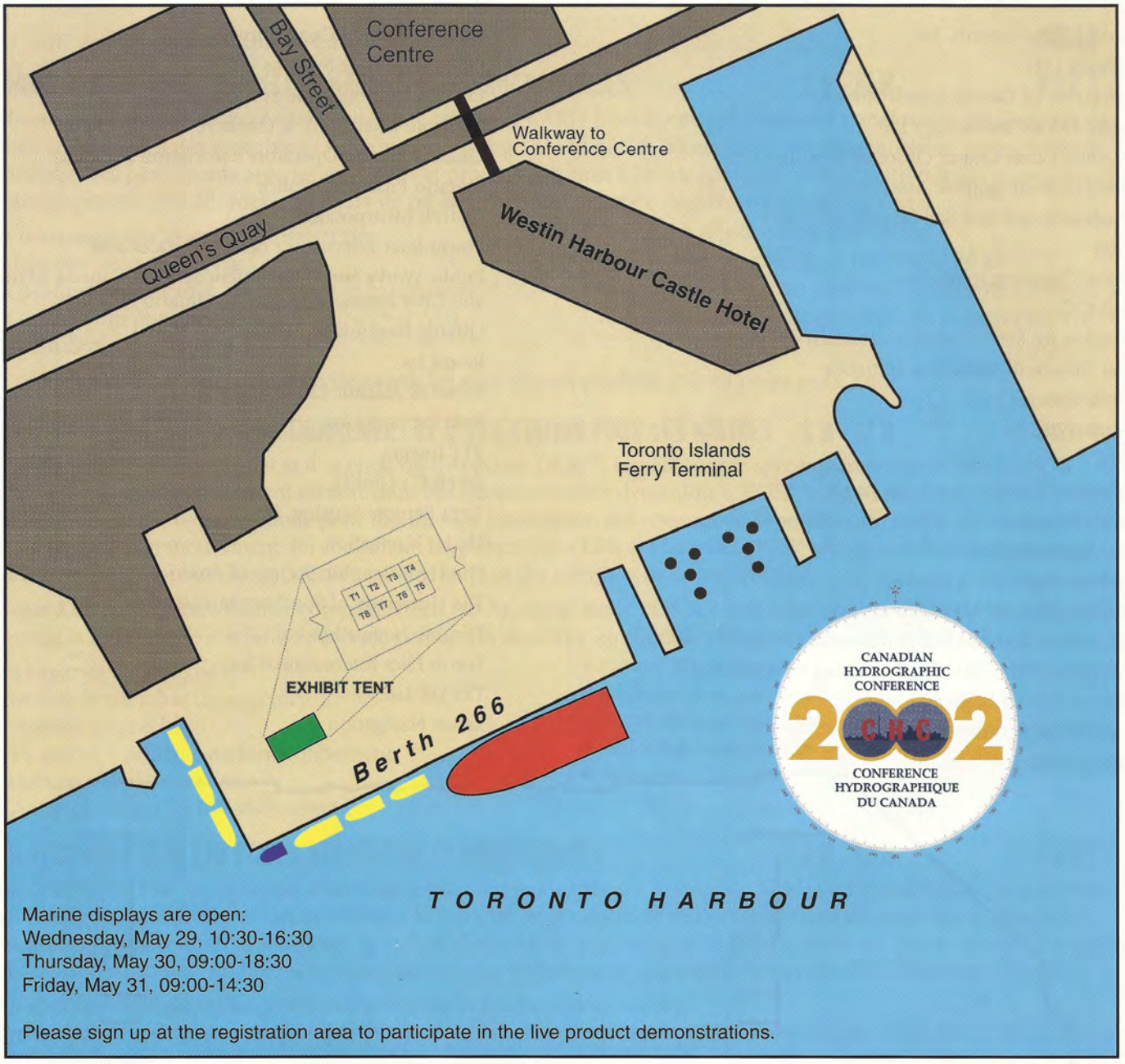

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Exhibit Tent Area
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FEATURE PRESENTATIONS

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This year's event will also feature a segment for recreational boaters, addressing their concerns and interests.

WORKSHOPS AND TECHNICAL SESSIONS:

"Innovation and Excellence – Focusing on client requirements and their changing needs" was selected as the theme for this conference. It reflects the ever-increasing demand by today's marine clients for new technologies to provide innovative ways to satisfy their requirements.

CHC2002 will focus on technologies for both the commercial and recreational boating communities, looking at data acquisition and management in addition to charting. The call for papers has generated presentations focusing on:

- Hydrographic database management
- Marine and coastal Geographic Information Systems
- Real-time Geographic Information Systems for marine applications
- Law of the Sea
- Multibeam surveys
- New technologies in digital mapping
- Digital Charts (ENC, DNC®, EC)
- Electronic Chart Systems (ECS)
- Electronic Chart Display and Information Systems (ECDIS)
- Managing ports and harbours
- Marketing

CHC2002 is pleased to offer the following 4 workshops: ROOM

1. CARIS MARINE AND HYDROGRAPHIC SOFTWARE SOLUTIONS 08:00 - 17:00 PIER 5

Users and non-users alike are welcome to join CARIS as they reveal insights into how marine and hydrographic technologies are turning data into information. This event includes a number of individual lectures designed to familiarize participants with the methods and procedures of handling digital hydrographic and oceanographic information. The day-long workshop will cover information associated with:

- multibeam, singlebeam and sonar image processing,
- digital and raster chart production,
- S-57 ENC, DNC® and AML data management,
- data distribution,
- port and harbour data management,
- Maritime Boundary Delimitation and Article 76, and
- hydrographic database management using Oracle8i technology and much, much more.

Participants will also gain insight into the latest product features developed by CARIS.

2. POS/MV – POSITION AND ORIENTATION SYSTEM FOR MARINE VESSELS 08:00 - 17:00 PIER 4

Applanix Position and Orientation Systems (POS™) were developed specifically for surveying, mapping and robust positioning in dynamic environments. POS™ integrates precision GPS with advanced inertial technology to provide uninterrupted measurements of the position, roll, pitch and true heading of moving vehicles. By combining GPS and inertial technologies, POS™ offers a fully integrated, turnkey solution for high-productivity surveying and mapping. Join Applanix for a full day training session on POS MV, a user friendly, turnkey solution that represents the latest in state of the art aided inertial technology. The training session will include:

- system origins,
- system overview,
- the need for accuracy,
- aided INS – theory of operation,
- complementary sensors,
- GAMS – theory of operation,
- heave measurement,
- performance and specifications,
- installation and calibration,
- controller software,
- maintenance.

3. ICAN LTD. ALDEBARAN AND ITS USES IN HYDROGRAPHY 08:00 - 17:00 PIER 2

ICAN Ltd. is pleased to offer a full day workshop on Aldebaran. The Aldebaran family of electronic chart system software products offers multiple data format capability, and offers the professional mariner flexibility, ease of use, and stability of operation. The day will unfold with an introductory session in the morning and progress to a more advanced level in the afternoon. Topics will include:

- Aldebaran: configurability, chart data, and available modules,
- Automatic Identification Systems (AIS): discussion of standards, description of functionality, demonstration of software and adaptation to hydrographic surveying,
- a demonstration of 3D navigation software.

4. A QUALITY MANAGEMENT SYSTEM AND ISO 9001:2000 13:00 - 16:00 PIER 3

This workshop will be an opportunity for hydrographic and related organizations to discover how implementation of a Quality Management System, using the newly updated ISO 9001:2000 standard, can contribute towards the development of better management practices. Topics will include:

- how to develop a high level process based view of the organisation,
- designing an effective system for multi locations, while combining the best of national standards and individual business unit processes,
- linking the quality management approach as a tool for improved organisational planning,
- the importance of performance measurement in managing and improving the business,
- the unfinished business – what ISO taught us and where we go from here. This session will be based on the recent successful certification of the Canadian Hydrographic Service in the ISO 9001:2000 standard.

Registration fee is $125.00 CAN for full day and $60.00 CAN for 1/2 day workshops.
Please note that lunch and refreshments will be provided with all full day workshop registrations.

TECHNICAL SESSIONS — WEDNESDAY MAY 29, 2002

	SESSION	PAPERS & EVENTS	AUTHORS & SPEAKERS	ROOM
08:30 - 08:40	Opening Ceremonies	Objectives	M. Bennett/G. Fenn	Frontenac
08:40 - 09:10	Opening Address	Science and Hydrography	To Be Announced	Frontenac
09:10 - 09:25	Entertainment	Folk Singer	Lee Murdock	Frontenac
09:25 - 10:10	Keynote Address	Down the Client Rabbit Hole; Lesson from Alice in Wonderland	W. Stoehr	Frontenac
10:10 - 10:30	The Canadian Hydrographic Service	CHS's Role in Canada and the World	A.D. O'Connor	Frontenac
10:30 - 12:15	Trade Show Opening	Exhibit Hall and Marine Displays Open	A.D. O'Connor	Metro Centre/East & Berth 266
12:15 - 14:15	Lunch & Entertainment	Great Lakes Ballads	Lee Murdock	Metro West
14:15 - 15:00	Innovation	Multibeam Reveals Submerged Wonders. Presented in 3D.	P. Travaglini, S. Blasco	Frontenac
15:00 - 15:30	Coffee			Metro Centre/East
15:30 - 15:55	Multibeam Innovations	Multibeam Surveys on the Fraser River Delta, Coping with an Extreme Refraction Environment	D. Cartwright, J. Hughes Clarke	Frontenac
	Quality in Management	Managing for Results: Demonstrating Excellence and Innovation in CCG Through Performance Measurement	A.-M. Lebel et al.	Salon A
	Hydrography and Education	Continuing Development of the FIG/IHO Approved Category A "Master of Science Degree in Hydrographic Science" Program at the University of Southern Mississippi	D. Dodd, K. Barbor, S. Howden, C. Meador, D. Wells	Salon B
16:00 - 16:25	Multibeam Innovations	Acoustical Measurement Accuracy Modeling for Bathymetric Sonar Systems	X. Lurton	Frontenac
	Quality in Management	Implementing and Learning with ISO 9000	M. Johnston, N. Shepherd	Salon A
	Hydrography and Education	Open Access Learning at Sea	D. Wells, J. Richer, K. Purves, I. Allen, P. Dare, D. Wiesenburg, D. Dodd, S. Howden, S. Dijkstra, L. Alexander, D. Monahan, A Godin, J. Chance	Salon B
16:30 - 16:55	Multibeam Innovations	Geometric and Radiometric Correction of Multibeam Backscatter Derived from Reson 8101 Systems	J. Beaudoin, J. Hughes Clarke, E. Van Den Ameele, J. Gardner	Frontenac
	Quality in Management	A Risk-Managed Approach to Managing a Large Chart Portfolio	M. Casey	Salon A
	Hydrography and Education	Results from the ACLS Offshore Issues Consultation Workshop	T. Lawrence	Salon B
17:00 - 19:30	Ice-breaker Reception	Mix and mingle with fellow delegates and the exhibitors who helped bring you this conference		Metro Centre/East
19:30	Pub Crawl	Experience Toronto nightlife with friends and colleagues. Sign up at the registration desk. Event sponsored by Kongsberg Simrad		Various local establishments

* Exhibits open 10:30 to 19:30

TECHNICAL SESSIONS — THURSDAY MAY 30, 2002

	SESSION	PAPERS & EVENTS	AUTHORS & SPEAKERS	ROOM
08:30 - 08:40	Housekeeping		M. Bennett/G. Fenn	Frontenac
08:40 - 09:00	Plenary	Recreational Boating	G. Springate	Frontenac
09:00 - 09:25	Panel session	Recreational Boating Issues	Selected panel members	Frontenac
09:30 - 09:55	Recreational Boating 101	De-Mystifying Electronic Charts for the Boating Public: A New Canadian Education and Training Initiative	T. Gardiner, B. Terry	Frontenac
	Recreational Boating 201	Marine Aids Modernization	M. Clements	Salon A
	Excellence in Surveys	Unama'ki Mapping Project	K. Paul, A. Craft	Salon B
10:00 - 10:25	Recreational Boating 101	Improving Boating Safety by Partnership	B. Schlorff	Frontenac
	Recreational Boating 201	Modern Paper Chart Construction	R. Palmer	Salon A
	Excellence in Surveys	Georges Bank: A Success Story in Private-Public Partnering	M. Lamplugh, B. Todd	Salon B
10:30 - 11:00	Coffee			Metro Centre/East
11:00 - 11:25	Recreational Boating 101	Accomplishments of an Era: Modern Surveys and Charts of Franklin's NW Passage	J. Wilcox	Frontenac
	Recreational Boating 201	NOAA's Electronic Navigational Chart Program: An Update	Capt. N. Perugini	Salon A
	Excellence in Surveys	SHOALS Airborne Laser Hydrography to Support Lake Ontario-St. Lawrence River Water Level Study	J. Wozencraft, K. Francis, J. Pope	Salon B
11:30 - 11:55	Recreational Boating 101	Importance of Hydrography to Recreational Boating	R. Pierce, J. Goodyear	Frontenac
	Recreational Boating 201	Variations in Great Lakes' Water Levels Relative to Chart Datum During Periods of Low Water Levels	S. Gill, K. Tronvig	Salon A
	Excellence in Surveys	Acoustic Imaging of Salmonid Mariculture Sites	J. Hughes Clarke, D. Wildish, A. Duxfield	Salon B
12:00 - 14:00	Lunch and Entertainment	"PowerBoat Television" TV Bloopers	Ted Rankine	Metro West
14:00 - 18:30	Trade Show	Take advantage of this opportunity to meet with the exhibitors		Metro Centre/East, & Berth 266
19:00 - 24:00	World of Hockey Dinner	Don't miss this exciting and interactive evening at Toronto's legendary Hockey Hall of Fame		Hockey Hall of Fame

* Exhibits open 09:00 to 18:30

TECHNICAL SESSIONS — FRIDAY MAY 31, 2002

	SESSION	PAPERS & EVENTS	AUTHORS & SPEAKERS	ROOM
07:00 - 08:15	Toast & Topics	Breakfast Discussions	Limited tickets available	Regatta
08:30 - 08:40	Housekeeping		M. Bennett/G. Fenn	Frontenac
08:40 - 09:00	Plenary	Will Charts be Irrelevant?	R. MacDougall	Frontenac
09:00 - 09:25	Panel session	Charting Issues	Selected panel members	Frontenac
09:30 - 09:55	Charts in the Electronic Age	MGDI: Information Infrastructure for the Maritime Community	M. Poulin, R. Gillespie	Frontenac
	Innovations in Data Processing	Bathymetry Error Modeling: Approaches, Improvements and Applications	R. Hare	Salon A
	Offshore Issues	Determining User Needs In a Marine Cadastre	S. Ng'ang, M. Sutherland, S. Nichols	Salon B
10:00 - 10:25	Charts in the Electronic Age	Cartographic Innovation – The Vector/Raster Hybrid	C. Zeller	Frontenac
	Innovations in Data Processing	Data Validation Tools Based on HHCode Technology	H. Varma, S. Forbes, C. MacIsaac, K. MacDonald, K. Paul, B. MacGowan, J Cunningham	Salon A
	Offshore Issues	Hydrography's Role in Marine Boundary Delimitation	S. Nichols, D. Monahan	Salon B
10:30 - 11:00	Coffee			Metro Centre/East
11:00 - 11:25	Charts in the Electronic Age	Back-up Arrangements for ECDIS: Needs and Opportunities	L. Alexander	Frontenac
	Innovations in Data Processing	A Comparison of the Automated Navigation Surface to Traditional Smooth Sheet Compilation	B. Calder, S. Smith	Salon A
	Offshore Issues	The Delineation of the Seaward Limits of a Marine Protected Area Using Non-Terrestrial (Submarine) Boundaries – The Musquash Estuary MPA	T. Bryne, J. Hughes Clarke, S. Nichols, M-I. Buzeta	Salon B
11:30 - 11:55	Charts in the Electronic Age	Print On Demand for Nautical Charting Products	D. Enabnit, R. Sillcox, B. Hess, B. Gray N. Smith, T. Loeper,	Frontenac
	Innovations in Data Processing	Détection Automatique d'Erreurs Ponctuelles Présentes dans les Données Bathymétriques Multifaisceaux Petits Fonds	N. Debese, P. Michaux	Salon A
	Offshore Issues	The Seabed Base Map	R. MacDougall	Salon B
12:00 - 13:30	Lunch break – Try our local eateries			
13:30 - 13:55	Electronic Navigation	CDGPS – Canada-wide DGPS Service Quality Real Time GPS Positioning	K. Lochhead, A. Kassam, R. Hare, L. LeBlanc	Frontenac
	The Vertical Dimension	GPS Tide Detection: Implementation of a Full Integrated Solution for Hydrographic Surveys from Data Collection to Data Processing	L. Maltais	Salon A

Continued...

TECHNICAL SESSIONS — FRIDAY MAY 31, 2002

	SESSION	PAPERS & EVENTS	AUTHORS & SPEAKERS	ROOM
13:30 - 13:55	Client Requirements	Keeping the Pulse – Meeting Evolving Client Requirements for Digital Hydrographic Data	G. Schlagintweit, J. Box	Salon B
14:00 - 14:25	Electronic Navigation	An ECDIS Laboratory: Facilitating Electronic Charting for Navy Missions	D. Brunt, L. Alexander, K. Barbor	Frontenac
	The Vertical Dimension	Automated Tide Co-Ordination for Coastal Photogrammetry	K. Hess, N. Shoji, S. Gill, D. Wright, M. Aslaksen, C. Wong	Salon A
	Client Requirements	Providing Clients with Usable Uncertainty Indices	D. Monahan, D. Wells, R. Hare	Salon B
14:30 - 14:55	Electronic Navigation	Modeling Sea Ice Conditions for Marine Navigation in Ice-Infested Waters	G. Auda, A. ElRabbany, S. Abdelazim	Frontenac
	The Vertical Dimension	Verifying the Expected and True Accuracy of Vessel Attitude Sensors for Hydrography	M. Wetzler, K. Sampadian, M. Webb	Salon A
	Client Requirements	NOAA's National Survey Plan	CAPT. S. DeBow, LCDR D. Haines, D. Sinson	Salon B
15:00 - 15:40	Closing Ceremonies	Synopsis of Conference	M. Bennett/G. Fenn	Frontenac
		Invitation to Attend U.S. Hydro 2003	K. Kieninger	Frontenac
		Closing Remarks	A.D. O'Connor, D. St. Jacques	Frontenaci

* Exhibits open 09:00 to 14:30

RECREATIONAL BOATERS' DAY — THURSDAY MAY 30, 2002

RECREATIONAL BOATERS TO PARTICIPATE IN CHC2002 – 08:30 - 18:30

This segment of the marine community is potentially the largest user group of hydrographic products. Concurrent sessions on Thursday, May 30 will provide an opportunity for papers to be presented not only for the interest of the recreational boater, but for all users of hydrographic products. There will be a draw for a Pocket PC navigation system – a $1,300 value – provided by Nautical Data International. This versatile tool can also be used for office applications. All delegates present at the start of the first session are eligible to win. So come out and enjoy the day!

Go to: www.chc2002.com for the recreational boaters' registration form.

Photo courtesy of Gettyimages

TRADE SHOW

Our theme, "Innovation and Excellence - Focusing on client requirements and their changing needs", reflects the ever-increasing demand by today's marine clients for new technologies to provide innovative ways to satisfy their requirements.

CHC2002 will focus on exhibiting the latest technologies for data acquisition and processing, cartography and electronic chart systems. To complement the trade show, which is taking place in the Westin Harbour Castle's Conference Centre, a number of vessels will be on hand to provide real-time hardware/software demonstrations and tours of Toronto Harbour from Berth 266, adjacent to the hotel. The trade show will open on Wednesday, May 29, at 10:30 and remain open throughout the ice-breaker reception* until 19:30. On Thursday, the trade show will be open from 09:00 to 18:30 and on Friday from 09:00 to 14:30.

SOME OF OUR VISITING VESSELS

CCGS Griffon

CSL Merlin

CSL Petrel

Ontario Surveyor

CCGS Griffon *is a 71m long, DFO/CCG light icebreaker/major navaids tender and hydrographic survey platform, which in addition to providing launch support, will be offering electronic chart systems demonstrations.*

CSL Merlin *is a 10m long, Metalcraft, DFO/CHS survey launch, which will be offering sidescan sonar demonstrations.*

CSL Petrel *is a 10m long Nelson, DFO/CHS survey launch that will be demonstrating multibeam and other data-acquisition technologies.*

Ontario Surveyor *is an eight meter long Henley, Public Works and Government Services Canada (PWGSC) survey vessel, which will be demonstrating multi-transducer technologies.*

* The marine exhibits (berth 266) will close at 16:30, prior to the ice-breaker reception.

CRUISING ON TORONTO HARBOUR — MONDAY MAY 27, 2002

STARTS IN HOTEL LOBBY – 18:30 - 23:00

Cost per person: $37.50 *(Taxes included – limited space so book early)*

This is a pre-conference event that will allow you to experience the breathtaking view of Toronto's skyline while cruising our exclusive charter aboard the Schooner *Challenge*. Enjoy an evening of dinner and dancing on the waters of Lake Ontario. Boarding is from 18:30 until 19:00. Don't miss the boat, sign up in advance! For more information about the vessel, go to: www.greatlakesschooner.com

WELCOME RECEPTION — TUESDAY MAY 28, 2002

HARBOUR BALLROOM – 19:30 - 22:00

This event will be a great opportunity to make new acquaintances and rekindle old friendships. Join us at The Westin Harbour Castle Hotel for a most enjoyable evening that will be the perfect kick-off to the Conference!

ICE-BREAKER RECEPTION — WEDNESDAY MAY 29, 2002

METRO CENTRE EAST – 17:00 - 19:30

Socialize with the exhibitors and see all they have to offer at this evening's reception.

PUB CRAWL – Sponsored by Kongsberg Simrad — WEDNESDAY MAY 29, 2002

STARTS IN HOTEL LOBBY – 19:30

Be sure to sign up for this event on the sheets posted at the registration desk. It will be an excellent opportunity to experience some of Toronto's nightlife from street level. Space will be limited so participation will be on a first signed first served basis. Participants will gather to start the event and get their Pub Crawl package in the lobby of the hotel at 19:30.

THE WORLD OF HOCKEY DINNER — THURSDAY MAY 30, 2002

HOCKEY HALL OF FAME – 19:00 - 24:00 *(business casual)*

He shoots! He scores! One of Toronto's most memorable places, the Hockey Hall of Fame provides an ideal setting to both relax and network in an informal and friendly atmosphere. You will experience superb cuisine from the original six hockey countries – Canada, United States, Russia, Czechoslovakia, Sweden and Finland. Create your own memories by participating in this exciting and interactive environment. Attend this Hockey Night in Canada, it is sure to draw a sell-out crowd!

Please indicate your attendance on the registration form.

Photo courtesy of Hockey Hall of fame

TOAST AND TOPICS – Sponsored in part by the CHA — FRIDAY MAY 31, 2002

REGATTA – 07:00 - 08:15

Advance reservation required. Informal discussion of business and industry topics. Continental breakfast provided.

Sign up at the registration desk.

CHC2002 FITNESS — MONDAY TO FRIDAY

STARTS IN HOTEL LOBBY – 07:00

Enjoy an early morning jog or leisurely walk with your colleagues around the beautiful Toronto harbour front. Sign up sheets at the registration desk.

CENTRE TEAR OUT DÉTACHEZ

TECHNICAL SESSIONS / SÉANCES TECHNIQUES # 2 THURSDAY MAY 30, 2002 / LE JEUDI 30 MAI 2002

	SESSION / SÉANCE	PAPERS & EVENTS / COMMUNICATIONS ET ÉVÉNEMENTS	AUTHORS & SPEAKERS / AUTEURS ET CONFÉRENCIERS	ROOM / SALLE
08:30 - 08:40	Housekeeping / Affaires courantes		M. Bennett / G. Fenn	Frontenac
08:40 - 09:00	Plenary / Séance plénière	Recreational Boating / La navigation de plaisance	G. Springate	Frontenac
09:00 - 09:25	Panel session / Réunion d'experts	Recreational Boating Issues / La navigation de plaisance	Selected panel members / Groupe d'experts	Frontenac
09:30 - 09:55	Recreational Boating 101 / Navigation de plaisance 101	De-Mystifying Electronic Charts for the Boating Public: A New Canadian Education and Training Initiative	T. Gardiner, B. Terry	Frontenac
	Recreational Boating 201 / Navigation de plaisance 201	Marine Aids Modernization	M. Clements	Salon A
	Excellence in Surveys / L'excellence dans les levés	Unama'ki Mapping Project	K. Paul, A. Craft	Salon B
10:00 - 10:25	Recreational Boating 101 / Navigation de plaisance 101	Improving Boating Safety by Partnership	B. Schlorff	Frontenac
	Recreational Boating 201 / Navigation de plaisance 201	Modern Paper Chart Construction	R. Palmer	Salon A
	Excellence in Surveys / L'excellence dans les levés	Georges Bank: A Success Story in Private-Public Partnering	M. Lamplugh, B. Todd	Salon B
10:30 - 11:00	**Coffee / Pause santé**			Metro Centre/East
11:00 - 11:25	Recreational Boating 101 / Navigation de plaisance 101	Accomplishments of an Era: Modern Surveys and Charts of Franklin's NW Passage	J. Wilcox	Frontenac
	Recreational Boating 201 / Navigation de plaisance 201	NOAA's Electronic Navigational Chart Program: An Update	Capt. N. Perugini	Salon A
	Excellence in Surveys / L'excellence dans les levés	SHOALS Airborne Laser Hydrography to Support Lake Ontario-St. Lawrence River Water Level Study	J. Wozencraft, K. Francis, J. Pope	Salon B
11:30 - 11:55	Recreational Boating 101 / Navigation de plaisance 101	Importance of Hydrography to Recreational Boating	R. Pierce, J. Goodyear	Frontenac
	Recreational Boating 201 / Navigation de plaisance 201	Variations in Great Lakes' Water Levels Relative to Chart Datum During Periods of Low Water Levels	S. Gill, K. Tronvig	Salon A
	Excellence in Surveys / L'excellence dans les levés	Acoustic Imaging of Salmonid Mariculture Sites	J. Hughes Clarke, D. Wildish, A. Duxfield	Salon B
12:00 - 14:00	**Lunch and Entertainment/ Déjeuner**	"PowerBoat Television" TV Bloopers / Ratés de tournages télévisuels	Ted Rankine	Metro West
14:00 - 18:30	Trade Show / Exposition	Take advantage of this opportunity to meet with the exhibitors/ Saisissez cette occasion de rencontrer les exposants!	Metro Centre/East, & Berth 266	
19:00 - 24:00	**World of Hockey Dinner / « La soirée du hockey »**	Don't miss this exciting and interactive evening at Toronto's legendary Hockey Hall of Fame / Ne manquez pas cette soirée passionnante et interactive au ilégendaire Temple de la renommée du hockey de Toronto	Hockey Hall of Fame/ Temple de la renommée du hockey	

* Exhibits open 09:00 to 18:30 *Heures d'ouverture de l'exposition : de 9 h à 18 h 30

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SOCIAL ACTIVITIES / ACTIVITÉS SOCIALES

TOUR / EXCURSIONS — **SUNDAY MAY 26, 2002 / LE DIMANCHE 26 MAI 2002**

CITY BUS TOUR INCLUDING CN TOWER - 09:00 - 13:00
TOUR DE VILLE ET VISITE À LA TOUR DU CN – 9 H - 13 H
Cost per person: $49.95 (taxes included - cost includes transportation and admission to CN Tower)
Coût par personne : 49,95 $ (taxes incluses – comprend le transport et l'entrée à la tour du CN)
Meet in Hotel lobby / Rassemblement dans l'entrée d'hôtel

TOUR / EXCURSIONS — **MONDAY MAY 27, 2002 / LE LUNDI 27 MAI 2002**

NIAGARA FALLS AND CASINO NIAGARA BUS TOUR – 09:00 - 18:00
LES CHUTES NIAGARA ET LE CASINO NIAGARA – 9 H - 18 H
Cost per person: $119.50 / Coût par personne : 119,50 $
(Taxes included – cost includes transportation, lunch, Journey Behind the Falls, & Maid of The Mist Tour)
(taxes incluses- comprend le transport, le déjeuner et l'entrée à Journey Behind the Falls et Maid of the Mist)
Meet in Hotel lobby / Rassemblement dans l'entrée d'hôtel

TOUR / EXCURSIONS — **MONDAY MAY 27, 2002 / LE LUNDI 27 MAI 2002**

CRUISING ON TORONTO HARBOUR – 18:30 - 23:00
CROISIÈRE DANS LE PORT DE TORONTO – 18 H 30 - 23 H
Cost per person: $37.50 (Taxes included – limited space so book early)
Coût par personne : 37,50 $ (taxes incluses) (nombre de places limité, réservez sans tarder)
Meet in Hotel lobby / Rassemblement dans l'entrée d'hôtel

WELCOME RECEPTION / RÉCEPTION D'ACCUEIL — **TUESDAY MAY 28, 2002 / LE MARDI 28 MAI 2002**

Harbour Ballroom – 18:00 - 22:00 — *Harbour Ballroom – 18 H - 22 H*

ICE BREAKER RECEPTION / RÉCEPTION « BRISE-GLACE » — **WEDNESDAY MAY 29, 2002 / LE MERCREDI 29 MAI 2002**

Metro Centre East - 17:00 - 19:30 — *Metro Centre East – 17 H - 19 H 30*

PUB CRAWL / TOURNÉE DES PUBS — **WEDNESDAY MAY 29, 2002 / LE MERCREDI 29 MAI 2002**

Sponsored by Kongsberg Simrad / Organisée par Kongsberg Simrad
Starts in Hotel lobby – 19:30 / Soyez dans le hall de l'hôtel à 19 H 30

WORLD OF HOCKEY DINNER / REPAS DE LA SOIRÉE DU HOCKEY — **THURSDAY MAY 30, 2002 / LE JEUDI 30 MAI 2002**

HOCKEY HALL OF FAME – 19:00 - 24:00 (business casual)
TEMPLE DE LA RENOMMÉE DU HOCKEY –19 H - 24 H (tenue d'affaires décontractée)

TOAST AND TOPICS / DÉJEUNER CAUSERIE — **FRIDAY MAY 31, 2002 / VENDREDI 31 MAI 2002**

Sponsored in part by the CHA 07:00 - 08:15
Organisé en partie par l'AHC 7 H - 8 H 15
Location to be announced / Emplacement à être annoncer

CHC2002 FITNESS / CHC2002 EN BONNE FORME — **MONDAY TO FRIDAY / DU LUNDI AU VENDREDI**

Starts in Hotel lobby - 07:00 — *Tous les Jours - 7 H*

CENTRE TEAR OUT DÉTACHEZ

TECHNICAL SESSIONS / SÉANCES TECHNIQUES # 1 WEDNESDAY MAY 29, 2002 / LE MERCREDI 29 MAI 2002

	SESSION / SÉANCE	PAPERS & EVENTS / COMMUNICATIONS ET ÉVÉNEMENTS	AUTHORS & SPEAKERS / AUTEURS ET CONFÉRENCIERS	ROOM / SALLE
08:30 - 08:40	Opening Ceremonies / Cérémonies d'ouverture	Objectives / Objectifs	M. Bennett / G. Fenn	Frontenac
08:40 - 09:10	Opening Address / Exposé introductif	Science and Hydrography	To Be Announced / À venir	Frontenac
09:10 - 09:25	Entertainment / Divertissement	Folk Singer / Chanteur folk	Lee Murdock	Frontenac
09:25 - 10:10	Keynote Address / Discours-programme	Down the Client Rabit Hole: Lesson from Alice in Wonderland	W. Stoehr	Frontenac
10:10 - 10:30	The Canadian Hydrographic Service / Service hydrographique du Canada	CHS's Role in Canada and the World	A.D. O'Connor	Frontenac
10:30 - 12:15	Trade Show Opening / Ouverture de l'exposition	Exhibit Hall and Marine Displays Open /Ouverture du Hall d'exposition et de la présentation marine	A.D. O'Connor	Metro Centre/East & Berth 266
12:15 - 14:15	**Lunch & Entertainment /** Déjeuner en musique	**Great Lakes Ballads /** Ballades des Grands lacs	**Lee Murdock**	Metro West
14:15 - 15:00	Innovation	Multibeam Reveals Submerged Wonders. Presented in 3D / Démonstration en 3D	P. Travaglini, S. Blasco	Frontenac
15:00 - 15:30	**Coffee /** Pause santé			Metro Centre/East
15:30 - 15:55	Multibeam Innovations / Innovations, multifaisceau	Multibeam Surveys on the Fraser River Delta, Coping with an Extreme Refraction Environment	D. Cartwright, J. Hughes Clarke	Frontenac
	Quality in Management / La qualité en gestion	Managing for Results: Demonstrating Excellence and Innovation in CCG Through Performance Measurement	A. M. Lebel et al.	Salon A
	Hydrography and Education / Hydrographie et éducation	Continuing Development of the FIG/IHO Approved Category A "Master of Science Degree in Hydrographic Science" Program at the University of Southern Mississippi	D. Dodd, K. Barbor, S. Howden, C. Meador, D. Wells	Salon B
16:00 - 16:25	Multibeam Innovations / Innovations, multifaisceau	Acoustical Measurement Accuracy Modeling for Bathymetric Sonar Systems	X. Lurton	Frontenac
	Quality in Management / La qualité en gestion	Implementing and Learning with ISO 9000	M. Johnston, N. Shepherd	Salon A
	Hydrography and Education / Hydrographie et éducation	Open Access Learning at Sea	D. Wells, J. Richer, K. Purves, I. Allen, P. Dare, D. Wiesenburg, D. Dodd, S. Howden, S. Dijkstra, L. Alexander, D. Monahan, A Godin, J. Chance	Salon B
16:30 - 16:55	Multibeam Innovations / Innovations, multifaisceau	Geometric and Radiometric Correction of Multibeam Backscatter Derived from Reson 8101 Systems	J. Beaudoin, J. Hughes Clarke, E. Van Den Ameele, J. Gardner	Frontenac
	Quality in Management / La qualité en gestion	A Risk-Managed Approach to Managing a Large Chart Portfolio	M. Casey	Salon A
	Hydrography and Education / Hydrographie et éducation	Results from the ACLS Offshore Issues Consultation Workshop	T. Lawrence	Salon B
17:00 - 19:30	**Ice-breaker Reception /** Réception « brise-glace »	Mix and mingle with fellow delegates and the exhibitors who helped bring you this conference / Rencontrez vos collègues et les exposants grâce auxquels cette conférence a lieu		Metro Centre/East
19:30	**Pub Crawl /** Tournée des pubs	Experience Toronto nightlife with friends and colleagues. Sign up at the registration desk. Event Faites l'expérience de la vie nocturne de Toronto avec amis et collègues. Inscrivez-vous au comptoir d'inscription.Soirée organisée par Kongsberg Simrad		Various local establishments / Divers établissements locaux

* Exhibits open 10:30 to 19:30 *Heures d'ouverture de l'exposition : de 10 h à 19 h 30

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WORKSHOPS / ATELIERS

Tuesday, May 28, 2002
le Mardi, 28 Mai, 2002

CARIS - CARIS Marine and Hydrographic Software Solutions
8:00 - 5:00, **Pier 5**
CARIS - SOLUTIONS LOGICIELLES MARINES ET HYDROGRAPHIQUES
8 H - 17 H, **Pier 5**

ICAN - Aldebaran and its Uses in Hydrography 8:00 - 5:00, **Pier 2**
ALDEBARAN D'ICAN LTD ET SON UTILISATION EN HYDROGRAPHIE
8 H - 17 H, **Pier 2**

APPLANIX - POS/MV - Position and Orientation System for Marine Vessels
8:00 - 5:00, **Pier 4**
POS/MV - SYSTÈMES DE POSITIONNEMENT ET D'ORIENTATION POUR LES NAVIRES 8H - 17H, **Pier 4**

CHS/EDUVISION - A Quality Management System and ISO 9000 1:00 - 4:00, **Pier 3**
UN SYSTÈME DE GESTION DE LA QUALITÉ ET ISO 9001 13 H -16 H, **Pier 3**

Registration fee is $125 CDN for full day and $60 CDN for the ½ day workshops. Please note that lunch and refreshments will be provided for all full day workshop registrations.

Frais d'inscription : 125 $CAN pour les ateliers d'une journée complète et 60 $CAN pour l'atelier d'une demi-journée. Veuillez prendre note que le déjeuner et les boissons sont comprises dans le cas des ateliers d'une journée complète.

CENTRE TEAR OUT DÉTACHEZ

Marine displays are open:
Wednesday, May 29, 10:30-16:30
Thursday, May 30, 09:00-18:30
Friday, May 31, 09:00-14:30

Please sign up at the registration area to participate in the live product demonstrations.

Les expositions nautiques sont ouvertes:
le Mercredi 29 Mai 10h30 - 16h30
le Jeudi 30 Mai 09h00 - 18h30
le Vendredi 31 Mai 09h00 - 14h30

Pour participer aux démonstrations de produit en direct veuillez vous inscrire à l'aire d'inscription.

CANADIAN HYDROGRAPHIC CONFERENCE 2002
CONFÉRENCE HYDROGRAPHIQUE DU CANADA 2002

Marine Exhibits / Expositions nautiques

CCGS Griffon
- Canadian Coast Guard
  Garde cotiere canadienne
- Canadian Hydrographic Service
  Service hydrographique du Canada

M/V Ontario Surveyor
- Public Works and Government Services Canada
  Travaux publics et Services gouvernementaux Canada

CSL Merlin
- McQuest Marine Sciences Ltd.
- Trimble Navigation Ltd.
- Klein Associates Inc.

M/V Agile
- Reson Inc.

CSL Pintail
- Knudsen Engineering Ltd.

CSL Petrel
- Kongsberg Simrad Ltd.

CSL Pelican
- Quality Positioning Services Inc.

Admiralty Launch Surveyor
- Canadian Hydrographic Association
  Association canadienne d'hydrographique

Exhibit Tent Area
- Exhibitors conducting live product demonstrations

Tente d'exposition
Exposants faisant des démonstrations de produit en direct

TECHNICAL SESSIONS / SÉANCES TECHNIQUES # 3 — FRIDAY MAY 31, 2002 / LE VENDREDI 31 MAI 2002

	SESSION / SÉANCE	PAPERS & EVENTS / COMMUNICATIONS ET ÉVÉNEMENTS	AUTHORS & SPEAKERS / AUTEURS ET CONFÉRENCIERS	ROOM / SALLE
07:00 - 08:15	Toast & Topics / Petit déjeuner-causerie	Breakfast Discussions /Petit déjeuner-causerie	Limited tickets available / Nombre de places limité	TBD / À déterminer
08:30 - 08:40	Housekeeping / Affaires courantes		M. Bennett / G. Fenn	Frontenac
08:40 – 09:00	Plenary / Séance plénière	Will Charts be Irrelevant?	R. MacDougall	Frontenac
09:00 - 09:25	Panel session / Réunion d'experts	Charting Issues	Selected panel members / Groupe d'experts	Frontenac
09:30 - 09:55	Charts in the Electronic Age/ Les cartes marines à l'ère de l'électronique	MGDI: Information Infrastructure for the Maritime Community	M. Poulin, R. Gillespie	Frontenac
	Innovations in Data Processing / Innovations dans le traitement des données	Bathymetry Error Modeling: Approaches, Improvements and Applications	R. Hare	Salon A
	Offshore Issues / Zone extra-côtière	Determining User Needs In a Marine Cadastre	S. Ng'ang, M. Sutherland, S. Nichols	Salon B
10:00 - 10:25	Charts in the Electronic Age / Les cartes marines à l'ère de l'électronique	Cartographic Innovation – The Vector/Raster Hybrid	C. Zeller	Frontenac
	Innovations in Data Processing / Innovations dans le traitement des données	Data Validation Tools Based on HHCode Technology	H. Varma, S. Forbes, C. MacIsaac, K. MacDonald, K. Paul, B. MacGowan, J. Cunningham	Salon A
	Offshore Issues / Zone extra-côtière	Hydrography's Role in Marine Boundary Delimitation	S. Nichols, D. Monahan	Salon B
10:30 - 11:00	**Coffee / Pause santé**			Metro Centre/East
11:00 - 11:25	Charts in the Electronic Age/ Les cartes marines à l'ère de l'électronique	Back-up Arrangements for ECDIS: Needs and Opportunities	L. Alexander	Frontenac
	Innovations in Data Processing / Innovations dans le traitement des données	A Comparison of the Automated Navigation Surface to Traditional Smooth Sheet Compilation	B. Calder, S. Smith	Salon A
	Offshore Issues / Zone extra-côtière	The Delineation of the Seaward Limits of a Marine Protected Area Using Non-Terrestrial (Submarine) Boundaries – The Musquash Estuary MPA	T. Bryne, J. Hughes Clarke, S. Nichols, M-I. Buzeta	Salon B
11:30 - 11:55	Charts in the Electronic Age / Les cartes marines à l'ère de l'électronique	Print On Demand for Nautical Charting Products	D. Enabnit, R. Sillcox, B. Hess, B. Gray, N. Smith, T. Loeper,	Frontenac
	Innovations in Data Processing / Innovations dans le traitement des données	Détection Automatique d'Erreurs Ponctuelles Présentes dans les Données Bathymétriques Multifaisceaux Petits Fonds	N. Debese, P. Michaux	Salon A
	Offshore Issues / Zone extra-côtière	The Seabed Base Map	R. MacDougall	Salon B
12:00 - 13:30	**Lunch break / Déjeuner**	**Try our local eateries / Essayez les restaurants du coin**		
13:30 - 13:55	Electronic Navigation / La navigation électronique	CDGPS – Canada-wide DGPS Service Quality Real Time GPS Positioning	K. Lochhead, A. Kassam, R. Hare, L. LeBlanc	Frontenac
	The Vertical Dimension / La dimension verticale	GPS Tide Detection: Implementation of a Full Integrated Solution for Hydrographic Surveys from Data Collection to Data Processing	L. Maltais	Salon A
13:30 - 13:55	Client Requirements / Exigences des clients	Keeping the Pulse – Meeting Evolving Client Requirements for Digital Hydrographic Data	G. Schlagintweit, J. Box	Salon B
14:00 - 14:25	Electronic Navigation / La navigation électronique	An ECDIS Laboratory: Facilitating Electronic Charting for Navy Missions	D. Brunt, L. Alexander, K. Barbor	Frontenac
	The Vertical Dimension / La dimension verticale	Automated Tide Co-Ordination for Coastal Photogrammetry	K. Hess, N. Shoji, S. Gill, D. Wright, M. Aslaksen, C. Wong	Salon A
	Client Requirements / Exigences des clients	Providing Clients with Usable Uncertainty Indices	D. Monahan, D. Wells, R. Hare	Salon B
14:30 - 14:55	Electronic Navigation / La navigation électronique	Modeling Sea Ice Conditions for Marine Navigation in Ice-Infested Waters	G. Auda, A. ElRabbany, S. Abdelazim	Frontenac
	The Vertical Dimension / La dimension verticale	Verifying the Expected and True Accuracy of Vessel Attitude Sensors for Hydrography	M. Wetzler, K. Sampadian, M. Webb	Salon A
	Client Requirements / Exigences des clients	NOAA's National Survey Plan	CAPT. S. DeBow, LCDR D. Haines, D. Sinson	Salon B
15:00 - 15:40	Closing Ceremonies / Cérémonies de clôture	Synopsis of Conference /Sommaire de la conférence	M. Bennett / G. Fenn	Frontenac
		Invitation to Attend Hydro 2003 / Invitation à assister à la conférence Hydro 2003	K. Kieninger	Frontenac
		Closing Remarks /Allocution de clôture	A.D. O'Connor, D. St. Jacques	Frontenac

* Exhibits open 09:00 to 14:30 *Heures d'ouverture de l'exposition : de 9 h à 14 h 30

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Platinum Sponsors / Commanditaires Platine

Canadian Hydrographic Service
Service hydrographique du Canada

Canadian Coast Guard
Gard côtière canadienne

Fisheries and Oceans Canada / Pêches et Océans Canada

Bronze Sponsors / Commanditaires Bronze

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KONGSBERG

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NDI digital ocean — NAUTICAL DATA INTERNATIONAL, INC.

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Supporting Organizations
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FIG

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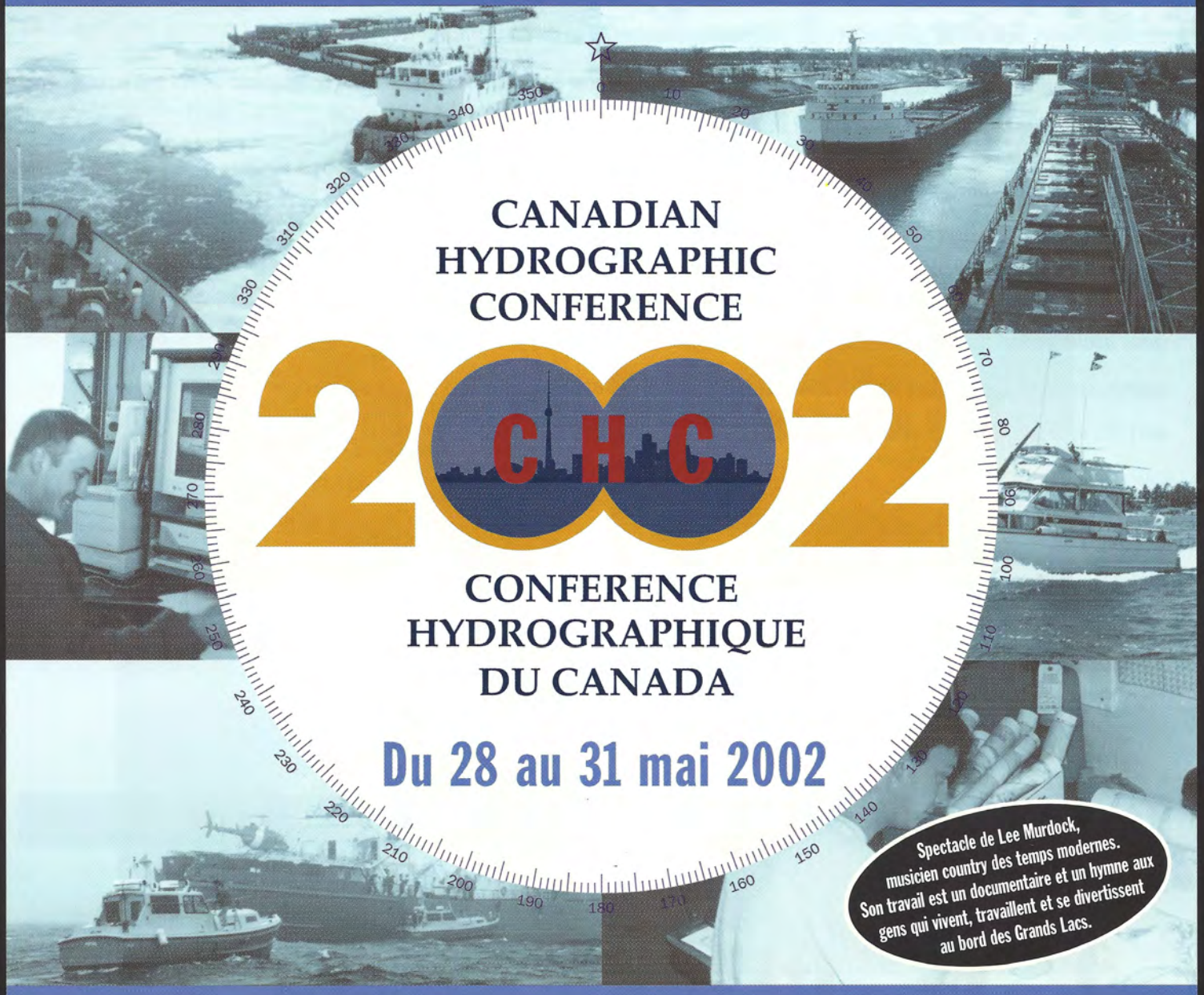
CENTRE TEAR OUT DÉTACHEZ

Innovation et excellence

Donner la priorité aux exigences et aux besoins en évolution des clients



CANADIAN HYDROGRAPHIC CONFERENCE

2002

CHC

CONFERENCE HYDROGRAPHIQUE DU CANADA

Du 28 au 31 mai 2002

Spectacle de Lee Murdock, musicien country des temps modernes. Son travail est un documentaire et un hymne aux gens qui vivent, travaillent et se divertissent au bord des Grands Lacs.

Le Westin Harbour Castle Toronto, Canada

CONFÉRENCIERS PRINCIPAUX :
WILLIAM STOEHR, président de National Geographics Maps
TED RANKINE, hôte de Powerboat Television

PROGRAMME FINAL

Plus de détails au www.chc2002.com

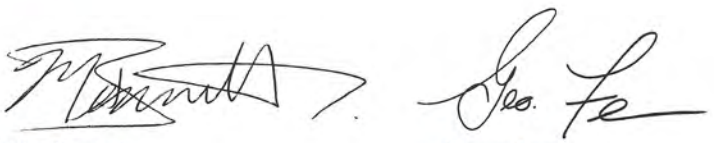
MESSAGE DES CO-PRÉSIDENTS

Bienvenue à Toronto et à la Conférence hydrographique du Canada. Le thème de cette année, « Innovation et excellence », montre que la priorité est donnée à l'évolution des besoins de nos clients. Par conséquent, nous vous encourageons à profiter des séances techniques et des ateliers du programme; venez admirer les expositions à l'intérieur et à quai; analysez les exposés et admirez les présentations par affiches. Venez accroître vos connaissances de l'hydrographie. Après tout, vous avez la responsabilité d'aider la communauté internationale à mieux comprendre et apprécier l'environnement marin.

Mais le plus important, c'est d'avoir la possibilité de rencontrer les participants. Présentez-vous aux personnes qui vous entourent, elles constituent votre futur réseau d'information.

Donc, maintenant vous connaissez les attentes du comité organisateur au point de vue éducatif. Au point de vue social, nous avons prévu diverses activités. Nous vous en informerons à mesure que la conférence progresse. La combinaison apprentissage et plaisirs fait partie de la culture de l'hydrographie. Nous espérons qu'à la fin de la conférence vous partirez avec de nouvelles connaissances, de nouveaux contacts et de bons souvenirs.

Le comité organisateur remercie tous ceux qui ont travaillé sans relâche dans les coulisses pour que cette conférence soit une réussite.



Mike Bennett George Fenn

Coprésidents, CHC2002

ORGANISMES QUI PARRAINENT ET SOUTIENNENT LA CONFÉRENCE

PLATINE

Pêches et Océans Canada

BRONZE

ORGANISMES DE SOUTIEN

CHARGÉ DE COMITÉS

Co-président

Mike Bennett
Service hydrographique du Canada

George Fenn
Service hydrographique du Canada

Ateliers

Paola Travaglini
Association canadienne d'hydrographie

Jon Biggar
Canadian Hydrographic Service

Audiovisuel

Jeff Walker
Service hydrographique du Canada

Commanditaire

Brian Power
Service hydrographique du Canada

Coordonatrice réunion/plénière

Terese Herron
Service hydrographique du Canada

Exposants (extérieur)

Andrew Leyzack
Association canadienne d'hydrographie

Ken McMillan
McQuest Marine Sciences Ltd.

Exposants (intérieur)

Tim Janzen
Association canadienne d'hydrographie

Ken McMillan
McQuest Marine Sciences Ltd.

Finance

Rick Sandilands
Service hydrographique du Canada

Inscription

Scott Youngblut
Association canadienne d'hydrographie

Fred Oliff
Service hydrographique du Canada

Logement

Bob Covey
Service hydrographique du Canada

MaîtreWeb/informatique

Keith Weaver
Service hydrographique du Canada

Programme Social

Janis Davies
Service hydrographique du Canada

Heather MacArthur
Service hydrographique du Canada

Programme technique

Mike Crutchlow
Service hydrographique du Canada

Publications

Sam Weller
Service hydrographique du Canada

Publicité/Média

Al Koudys
Service hydrographique du Canada

Secrétaire

Tim Janzen
Association canadienne d'hydrographie

Sam Weller
Service hydrographique du Canada

Traduction/Installations

Daniel Brousseau
Service hydrographique du Canada

Transport

Brent Beale
Service hydrographique du Canada

RENSEIGNEMENTS GÉNÉRAUX

RENSEIGNEMENTS :

Conférence hydrographique du Canada 2002
a.s.d. Absolute Conferences & Events Inc.
144, rue Front St. Ouest, bureau 640
Toronto (Ontario)
M5J 2L7

DATE ET LIEU DE LA CONFÉRENCE

Mardi 28 mai – vendredi 31 mai 2002
Hôtel Westin Harbour Castle
One Harbour Square
Toronto (Ontario), Canada
M5J 1A6
No de tél. : 416 869-1600
Réservations sans frais : 1 800 WESTIN-1
No de téléc. : 416 368-6838
http: //www.westin.com

COMPTOIR D'INSCRIPTION ET DE RENSEIGNEMENTS – Organisé par ICC Technologies Inc.

Le comptoir principal d'inscription et de renseignements sera situé au vestiaire du centre des congrès Westin Harbour Castle. Il sera ouvert aux heures suivantes :

Dimanche 26 mai	8 h - 10 h
Lundi 27 mai	8 h 30 - 10 h 30, 17 h – 19 h
Mardi 28 mai	7 h 30 - 9 h 30, 12 h – 20 h
Mercredi 29 mai	7 h 30 - 17 h
Jeudi 30 mai	8 h - 17 h
Vendredi 31 mai	7 h - 13 h

Prière de payer les frais d'inscription exigibles et les visites à ce comptoir. Des billets supplémentaires pour les réceptions, le dîner de la soirée du hockey et les visites sont encore disponibles au moment d'aller sous presse. Demandez au comptoir d'inscription si vous n'en avez pas encore achetés.

Billets pour la réception d'accueil	25 $ chacun
Billets pour la réception brise-glace	45 $ chacun
Billets pour le dîner de la soirée du hockey	125 $ chacun

L'INSCRIPTION À LA CONFÉRENCE INTÉGRALE COMPREND :

L'accès aux séances techniques et aux aires d'exposition, les pauses, les déjeuners et divertissements de mercredi et de jeudi, la réception d'accueil de mardi, la réception brise-glace de mercredi et le dîner de la soirée du hockey de jeudi.

L'INSCRIPTION À LA JOURNÉE DES PLAISANCIERS COMPREND :

Toutes les activités de jour, dont l'accès aux séances techniques et aux aires d'exposition, les pauses, les démonstrations sur l'eau, le déjeuner et le divertissement.

CENTRE DES MESSAGES

Les délegués ne pourront pas être appelés au cours de la conférence; cependant, il y aura un centre des messages au comptoir d'inscription et de renseignements. Si vous attendez un message ou que vous désirez en laisser un pour un autre délegué, appelez le standard principal de l'hôtel Westin Harbour Castle au 416 869-1600 et demandez le comptoir d'inscription CHC2002.

RENSEIGNEMENTS GÉNÉRAUX

INSIGNES – Organisé par TSS (UK) Ltd.

Les délégués, conférenciers et invités devront porter leurs insignes d'identité en tout temps afin d'être admis aux séances et aux activités spéciales. Les insignes perdus ou égarés pourront être remplacés au comptoir d'inscription et de renseignements aux heures indiquées.

LANGUES DE COMMUNICATION

Les présentations seront faites en français ou en anglais. Les ateliers seront donnés en anglais seulement. Des services d'interprétation seront offerts pendant la conférence, mais les documents écrits seront publiés dans leur langue d'origine.

ACTES DE LA CONFÉRENCE

Ceux qui sont inscrits à la conférence intégrale (trois jours) recevront des actes de la conférence sur CD-ROM. Des copies seront vendues au comptoir d'inscription au prix de 25 $ chacune.

CODE VESTIMENTAIRE

La tenue de ville décontractée conviendra pour toutes les séances et activités.

SALLE DE PRÉPARATION DES CONFÉRENCIERS

Le salon Wellington servira de salle de préparation des conférenciers. Il est au rez-de-chaussée du centre des congrès de l'hôtel.

URGENCES MÉDICALES ET AUTRES

En cas d'urgence, communiquez avec le comptoir d'inscription et de renseignements ou appelez le standard principal de l'hôtel pour assistance.

COURANT ÉLECTRIQUE

Au Canada, le courant électrique est de 110 V 60 Hz.

TEMPÉRATURE

Comme le Canada utilise le système métrique, la température y est mesurée en degrés Celsius.
Celsius-Fahrenheit : °C x 9/5 + 32 = °F
Fahrenheit-Celsius : °F – 32 x 5/9 = °C

POURBOIRES

En Ontario, on donne des pourboires, généralement de 15 %, dans les restaurants et taxis et pour d'autres services spéciaux.

LIGNES AÉRIENNES

Ceux qui prendront l'avion pour rentrer chez eux après la conférence sont priés de reconfirmer leurs places. Pour obtenir des renseignements sur les lignes aériennes, communiquez avec le comptoir d'inscription et de renseignements aux heures indiquées.

ASSURANCES

Le comité organisateur n'acceptera aucune responsabilité pour les blessures aux assistants ou pour le dommage ou la perte de leurs biens, que ces blessures, dommages ou pertes se produisent pendant la conférence, qu'ils en soient le résultat ou qu'ils se produisent lors des visites.

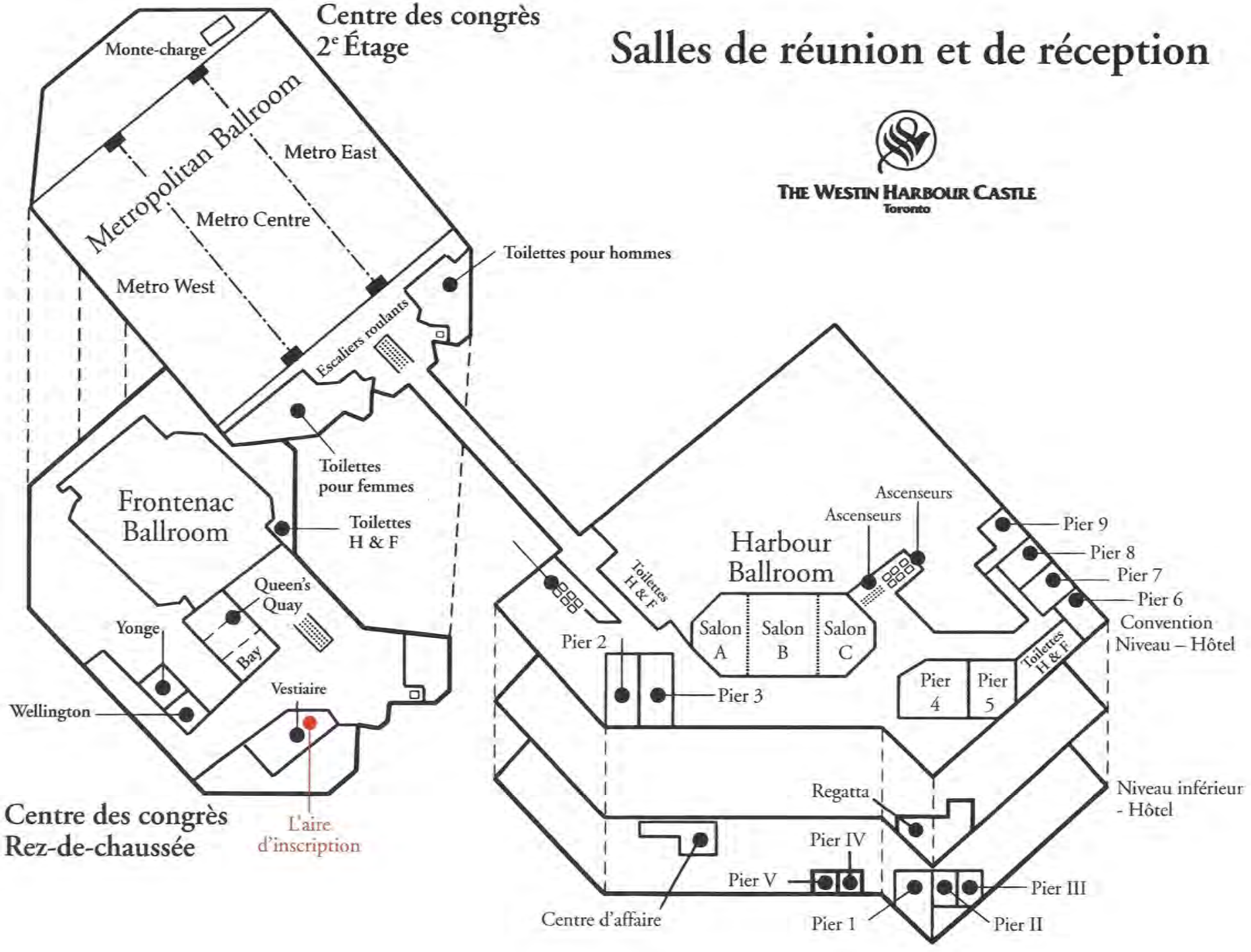
Nous vous rappelons que des vols peuvent se produire dans les salles de réunion et les aires publiques. Surveillez donc vos possessions.

OBJETS TROUVÉS

Des renseignements sur les objets perdus ou volés seront disponibles au comptoir d'inscription et de renseignements.

Salles de réunion et de réception

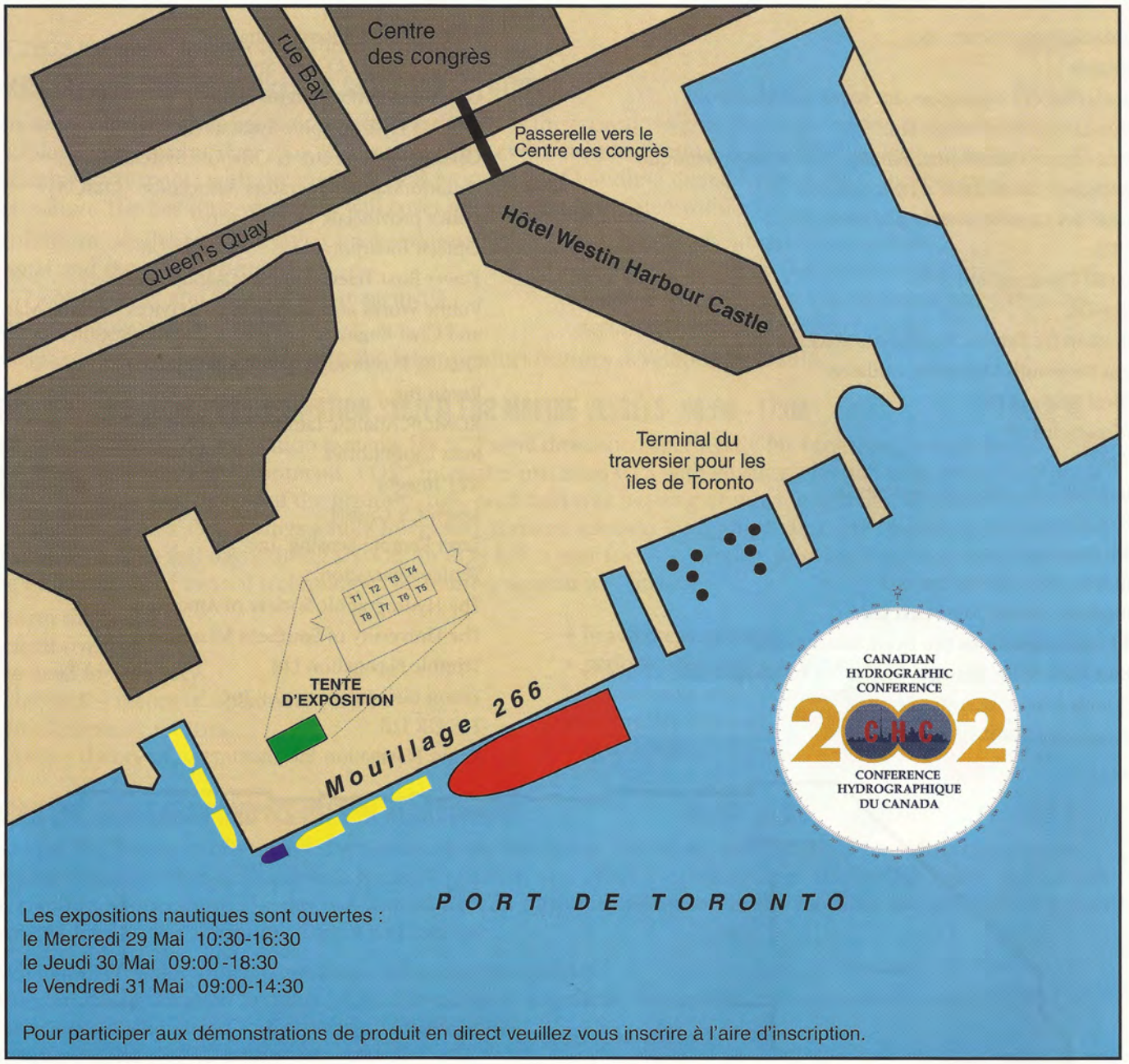
THE WESTIN HARBOUR CASTLE
Toronto



EXPOSANTS AYANT CONFIRMÉ LEUR PRÉSENCE À CE JOUR

Aanderaa Instruments, Inc.
Applanix LLC
Association des arpenteurs des terres du Canada
Brook Ocean Technology Ltd.
Garde côtière canadienne, Bureau de la sécurité nautique
Association canadienne d'hydrographie
Escadrilles canadiennes de plaisance (ECP)
CARIS
Coastal Oceanographics Inc.
DATA QC
Canadian Ice Service/Service des glaces
Great Yarmouth Marketing Initiative
Helical Systems Ltd.
Hydroservice AS
ICAN
Interactive Visualization Systems Inc.
IXSEA Oceano
Klein Associates Inc.
Knudsen Engineering Limited
Kongsberg Simrad Mesotech Ltd.
L-3 Communications Sea-Beam Instruments
Labatt WaterWise, Blaicher Marketing International
McQuest Marine Sciences Limited
Metro Police Marine Unit
Nautical Data International
NOAA Office of Coast Survey
Octopus Marine Systems Ltd.
ODOM Hydrographic Systems Inc.
Offshore Charts Ltd. & Offshore Systems Ltd.
Ontario Marine Operators Association (OMOA)
Police provinciale de l'Ontario
Optech Incorporated
Power Boat Television / boatsandplaces.com
Public Works and Government Services Canada, Marine and Civil Engineering Group, Ontario Region
Quality Positioning Services Inc. (QPS)
Reson Inc.
ROMOR Atlantic Limited/ Benthos Inc.
Ross Laboratories
RTT Integra
Seven C's GmbH
Terra Remote Sensing Inc.
Thales Navigation
The Hydrographic Society of America
The University of Southern Mississippi
Trimble Navigation Ltd.
Triton Elics International Inc.
TSS UK Ltd.
Xenex Navigation Inc.

CONFÉRENCE HYDROGRAPHIQUE DU CANADA 2002 – Exposition nautique



CCGS Griffon
- Garde côtière canadienne
- Service hydrographique du Canada

M/V Ontario Surveyor
- Travaux publics et Services gouvernementaux Canada

CSL Merlin
- McQuest Marine Sciences Ltd.
- Trimble Navigation Ltd.
- Klein Associates Inc.

M/V Agile
- Reson Inc.

CSL Pintail
- Knudsen Engineering Ltd.

CSL Petrel
- Kongsberg Simrad Ltd.

CSL Pelican
- Quality Positioning Services Inc.

Admiralty Launch Surveyor
- Association canadienne d'hydrographie

Tente d'exposition
- Exposants faisant des démonstrations de produit en direct

GRANDE PRÉSENTATIONS

Les faisceaux multiples révèlent des merveilles immergées.

Une présentation en 3D. Volez autour de chutes sous-marines, glissez le long d'affouillements et plongez dans des dépressions en compagnie de Paola Travaglini (SHC) et de Steve Blasco (RNCan) au cœur d'une présentation en 3D des activités passées et actuelles de relevés multifaisceaux faits dans la région du Centre et de l'Arctique par le ministère des Pêches et des Océans Canada.

Cette année, une partie de l'événement sera consacrée aux plaisanciers, à leurs préoccupations et intérêts.

SÉANCES TECHNIQUES ET ATELIERS :

« Innovation et excellence – Donner la priorité aux exigences et aux besoins en évolution des clients », c'est le thème choisi pour la conférence. Ce thème reflète les exigences sans cesse croissantes des clients en nouvelles technologies qui répondent à leurs besoins de façon novatrice.

La CHC 2002 portera sur des technologies desservant les secteurs de la navigation commerciale et de plaisance, sur l'acquisition et la gestion des données ainsi que sur la cartographie. Des communications sur les sujets suivants seront présentées lors des séances et ateliers :

- Gestion d'une base de données hydrographiques
- Systèmes d'information géographique maritime et côtière
- Systèmes d'information géographique en temps réel pour applications maritimes
- Droit de la mer
- Relevés multifaisceaux
- Nouvelles technologies en cartographie numérique
- Cartes numériques (CEN, DNC®, EC)
- Systèmes de cartes électroniques (ECS)
- Systèmes électroniques de visualisation des cartes marines (SEVCM)
- Gestion des ports
- Marketing

CHC2002 est heureuse d'offrir les 4 ateliers suivants : SALLE

1. CARIS – SOLUTIONS LOGICIELLES MARINES ET HYDROGRAPHIQUES 8 H - 17 H PIER 5

Utilisateurs et non utilisateurs sont invités à se joindre à CARIS pour découvrir comment transformer des données en information grâce à des technologies marines et hydrographiques. Cet événement comporte plusieurs exposés pour familiariser les participants avec les méthodes et procédés propres à la manipulation d'information hydrographique et océanographique. On abordera, au cours de cet atelier d'une journée complète, les sujets suivants :

- le traitement des images multifaisceaux, à faisceau unique et sonar
- la production de cartes numériques et matricielles
- la gestion des données CEN S-57, DNC® et AML
- la distribution de données
- la gestion des données portuaires
- la délimitation maritime et l'article 76 et
- la gestion d'une base de données hydrographiques au moyen de la technologie Oracle8i et bien plus encore.

Les participants pourront également découvrir les plus récents produits mis au point par CARIS.

2. POS/MV – SYSTÈMES DE POSITIONNEMENT ET D'ORIENTATION POUR LES NAVIRES 8 H - 17 H PIER 4

Les systèmes de positionnement et d'orientation d'Applanix (POS™) ont été conçus spécifiquement pour les relevés, la cartographie et le positionnement robuste dans des environnements dynamiques. POS™ intègre un système GPS de précision et la technologie inertielle de pointe pour fournir sans interruption des mesures de la position, du roulis, du tangage et du cap vrai de véhicules en mouvement. En combinant les technologies GPS et inertielles, POS™ offre une solution clé en main pleinement intégrée pour une productivité élevée au plan des relevés et de la cartographie.

Assistez à cet atelier d'une journée complète, offert par Applanix, sur le POS MV, une solution conviviale, clé en main, qui constitue la technologie inertielle assistée de pointe. On abordera, au cours de cet atelier, les points suivants :

- les origines du système
- une vue d'ensemble du système
- le besoin de précision
- INS assisté – principe de fonctionnement
- capteurs complémentaires
- GAMS – principe de fonctionnement
- mesure du pilonnement
- rendement et spécifications
- installation et calibrage
- logiciel de commande
- entretien

3. ALDEBARAN D'ICAN LTD ET SON UTILISATION EN HYDROGRAPHIE 8 H - 17 H PIER 2

La société ICAN Ltd. est heureuse d'offrir un atelier d'une journée sur le système Aldebaran. Cette famille de produits logiciels de système de cartes électroniques a la capacité de produire de multiples formats de données et offre aux navigateurs professionnels la souplesse, la facilité d'utilisation et la stabilité de fonctionnement. On présentera des notions de base sur ces produits en matinée et des notions plus élaborées en après-midi. Les sujets suivants seront abordés :

- Aldebaran : configurabilité, niveau de référence et modules disponibles.
- Système d'identification automatique (SIA) : discussion sur les normes, description des fonctionnalités, démonstration du logiciel et applications aux relevés hydrographiques.
- Démonstration d'un logiciel de navigation 3D.

4. UN SYSTÈME DE GESTION DE LA QUALITÉ ET ISO 9001:2000 13 H – 16 H PIER 3

Cet atelier donnera la possibilité aux organisations hydrographiques et connexes de découvrir comment l'implantation d'un système de gestion de la qualité, au moyen de la norme ISO 9001:2000 récemment mise à jour, peut contribuer à la mise en place de meilleurs procédés de gestion. Entre autres sujets abordés :

- Comment élaborer une perspective de l'organisation de haut niveau en termes de processus?
- Concevoir un système efficace pour des établissements multiples et combiner les meilleurs éléments des normes nationales et des procédés des établissements individuels.
- Avoir recours à la gestion de la qualité en guise d'outil pour améliorer la planification organisationnelle.
- L'importance de la mesure du rendement dans la gestion et l'amélioration de l'entreprise.
- Affaire à suivre : ce qu'ISO nous a appris et ce qu'on en fait maintenant. Cette séance reposera sur les récentes certifications du Service hydrographique du Canada à la norme ISO 9001 :2000.

Frais d'inscription : 125 $CAN pour les ateliers d'une journée complète et 60 $CAN pour l'atelier d'une demi-journée. Veuillez prendre note que le déjeuner et les boissons sont comprises dans le cas des ateliers d'une journée complète.

SÉANCES TECHNIQUES — LE MERCREDI 29 MAI 2002

	SÉANCE	COMMUNICATIONS ET ÉVÉNEMENTS	AUTEURS ET CONFÉRENCIERS	SALLE
8h30 - 8h40	Cérémonies d'ouverture	Objectifs	M. Bennett/G. Fenn	Frontenac
8h40 - 9h10	Exposé introductif	Science and Hydrography	À venir	Frontenac
9h10 - 9h25	Divertissement	Chanteur folk	Lee Murdock	Frontenac
9h25 - 10h10	Discours-programme	Down the Client Rabbit Hole : Lesson from Alice in Wonderland	W. Stoehr	Frontenac
10h10 - 10h30	Service hydrographique du Canada	CHS's Role in Canada and the World	A.D. O'Connor	Frontenac
10h30 - 12h15	Ouverture de l'exposition	Ouverture du Hall d'exposition et de la présentation marine	A.D. O'Connor	Metro Centre/East
12h15 - 14h15	Déjeuner en musique	Ballades des Grands lacs	Lee Murdock	Metro West
14h15 - 15h	Innovation	Multibeam Reveals Submerged Wonders. Démonstration en 3D	P. Travaglini, S. Blasco	Frontenac
15h - 15h30	Pause santé			Metro Centre/East
15h30 - 15h55	Innovations, multifaisceau	Multibeam Surveys on the Fraser River Delta, Coping wth an Extreme Refraction Environment	D. Cartwright, J. Hughes Clarke	Frontenac
	La qualité en gestion	Managing for Results : Demonstrating Excellence and Innovation in CCG Through Performance Measurement	A.-M. Lebel et al.	Salon A
	Hydrographie et éducation	Continuing Development of the FIG/IHO Approved Category A "Master of Science Degree in Hydrography Science" Program at University of Southern Mississipi	D. Dodd, K. Barbor, S. Howden, C. Meador, D. Wells	Salon B
16h - 16h25	Innovations multifaisceau	Acoustical Measurement Accuracy Modeling for Bathymetric Sonar Systems	X. Lurton	Frontenac
	La qualité en gestion	mplementing and Learning with ISO 9000	M. Johnston, N. Shepherd	Salon A
	Hydrographie et éducation	Open Access Learning at Sea	D. Wells, J. Richer, K. Purves, I. Allen, P. Dare, D. Wiesenburg, D. Dodd, S. Howden, S. Dijkstra, A Godin, J. Chance	Salon B
16h30 - 16h55	Innovations multifaisceau	Geometric and Radiometric Correction of Multibeam Backscatter Derived from Reson 8101 Systems	J. Beaudoin, J. Hughes Clarke, E. Van Den Ameele, J. Gardner	Frontenac
	La qualité en gestion	A Risk-Managed Approach to Managing a Large Chart Portfolio	M. Casey	Salon A
	Hydrographie et éducation	Results from the ACLS Offshore Issues Consultation Workshop	J. -C. Tétreault	Salon B
17h - 19h30	Réception « brise-glace »	Rencontrez vos collègues et les exposants grâce auxquels cette conférence a lieu		Metro Centre/East
19h30	Tournée des pubs	Faites l'expérience de la vie nocturne de Toronto avec amis et collègues. Inscrivez-vous au comptoir d'inscription.Soirée organisée par Kongsberg Simrad		Divers établissements locaux

*Heures d'ouverture de l'exposition : de 10 h 30 à 19 h 30

SÉANCES TECHNIQUES — LE JEUDI 30 MAI 2002

	SÉANCE	COMMUNICATIONS ET ÉVÉNEMENTS	AUTEURS ET CONFÉRENCIERS	SALLE
8h30 - 8h40	Affaires courantes		M. Bennett/G. Fenn	Frontenac
8h40 - 9h	Séance plénière	La navigation de plaisance	G. Springate	Frontenac
9h - 9h25	Réunion d'experts	La navigation de plaisance	Groupe d'experts	Frontenac
9h30 - 9h55	Navigation de plaisance 101	De-Mystifying Electronic Charts or the Boating Public: A New Canadian Education and Training Initiative	T. Gardiner, B. Terry	Frontenac
	Navigation de plaisance 201	Marine Aids Modernization	M. Clements	Salon A
	L'excellence dans les levés	Unama'ki Mapping Project	K. Paul, A. Craft	Salon B
10h - 10h25	Navigation de plaisance 101	Improving Boating Safety by Partnership	B. Schlorff	Frontenac
	Navigation de plaisance 201	Modern Paper Chart Construction	R. Palmer	Salon A
	L'excellence dans les levés	Georges Bank: A Success Story in Private-Public Partnering	M. Lamplugh, B. Todd	Salon B
10h30 - 11h	Pause santé			Metro Centre/East
11h - 11h25	Navigation de plaisance 101	Accomplishments of an Era: Modern Surveys and Charts of Franklin's NW Passage	J. Wilcox	Frontenac
	Navigation de plaisance 201	NOAA's Electronic Navigational Chart Program: An Update	Capt. N. Perugini	Salon A
	L'excellence dans les levés	SHOALS Airborne Laser Hydrography to Support Lake Ontario-St. Lawrence River Water Level Study	J. Wozencraft, K. Francis, J. Pope	Salon B
11h30 - 11h55	Navigation de plaisance 101	Importance of Hydrography to Recreational Boating	R. Pierce, J. Goodyear	Frontenac
	Navigation de plaisance 201	Variations in Great Lakes' Water Levels Relative to Chart Datum During Periods of Low Water Levels	S. Gill, K. Tronvig	Salon A
	L'excellence dans les levés	Acoustic Imaging of Salmonid Mariculture Sites	J. Hughes Clarke, D. Wildish, A. Duxfield	Salon B
12h - 14h	Déjeuner	Powerboat Television : Ratés de tournages télévisuels	Ted Rankine	Metro West
14h - 18h30	Exposition	Saisissez cette occasion de rencontrer les exposants!		Metro Centre/East, & Mouillage 266
19h - 24h	« La soirée du hockey »	Ne manquez pas cette soirée passionnante et interactive au légendaire Temple de la renommée du hockey de Toronto		Temple de la renommée du hockey

*Heures d'ouverture de l'exposition : de 9 h à 18 h 30

SÉANCES TECHNIQUES — LE VENDREDI 31 MAI 2002

	SÉANCE	COMMUNICATIONS ET ÉVÉNEMENTS	AUTEURS ET CONFÉRENCIERS	SALLE
7h - 8h15	Petit déjeuner-causerie	Petit déjeuner-causerie	Nombre de places limité	Regatta
8h30 - 8h40	Affaires courantes		M. Bennett/G. Fenn	Frontenac
8h40 - 9h	Séance plénière	Will Charts be Irrelevant?	R. MacDougall	Frontenac
9h - 9h25	Réunion d'experts	Charting Issues	Groupe d'experts	Frontenac
9h30 - 9h55	Les cartes marines à l'ère de l'électronique	MGDI: Information Infrastructure for the Maritime Community	M. Poulin, R. Gillespie	Frontenac
	Innovations dans le traitement des données	Bathymetry Error Modeling: Approaches, Improvements and Applications	R. Hare	Salon A
	Zone extra-côtière	Determining User Needs In a Marine Cadastre	S. Ng'ang, M. Sutherland, S. Nichols	Salon B
10h - 10h25	Les cartes marines à l'ère de l'électronique	Cartographic Innovation – The Vector/Raster Hybrid	C. Zeller	Frontenac
	Innovations dans le traitement des données	Data Validation Tools Based on HHCode Technology	H. Varma, S. Forbes, C. MacIsaac, K. MacDonald, K. Paul, B. MacGowan, J Cunningham	Salon A
	Zone extra-côtière	Hydrography's Role in Marine Boundary Delimitation	S. Nichols, D. Monahan	Salon B
10h30 - 11h	Pause santé			Metro Centre/East
11h - 11h25	Les cartes marines à l'ère de l'électronique	Back-up Arrangements for ECDIS: Needs and Opportunities	L. Alexander	Frontenac
	Innovations dans le traitement des données	A Comparison of the Automated Navigation Surface to Traditional Smooth Sheet Compilation	B. Calder, S. Smith	Salon A
	Zone extra-côtière	The Delineation of the Seaward Limits of a Marine Protected Area Using Non-Terrestrial (Submarine) Boundaries – The Musquash Estuary MPA	T. Bryne, J. Hughes Clarke, S. Nichols, M-I. Buzeta	Salon B
11h30 - 11h55	Les cartes marines à l'ère de l'électronique	Print On Demand for Nautical Charting Products	D. Enabnit, R. Sillcox, B. Hess, B. Gray N. Smith, T. Loeper,	Frontenac
	Innovations dans le traitement des données	Détection Automatique d'Erreurs Ponctuelles Présentes dans les Données Bathymétriques Multifaisceaux Petits Fonds	N. Debese, P. Michaux	Salon A
	Zone extra-côtière	The Seabed Base Map	R. MacDougall	Salon B
12h - 13h30	Déjeuner	Essayez les restaurants du coin		
13h30 - 13h55	La navigation électronique	CDGPS – Canada-wide DGPS Service Quality Real Time GPS Positioning	K. Lochhead, A. Kassam, R. Hare, L. LeBlanc	Frontenac

Suite...

SÉANCES TECHNIQUES — LE VENDREDI 31 MAI 2002

	SÉANCE	COMMUNICATIONS ET ÉVÉNEMENTS	AUTEURS ET CONFÉRENCIERS	SALLE
13h30 - 13h55	La dimension verticale	GPS Tide Detection : Implementation of a Full Integrated Solution for Hydrographic Surveys from Data Collection to Data Processing	L. Maltais	Salon A
	Exigences des clients	Keeping the Pulse – Meeting Evolving Client Requirements for Digital Hydrographic Data	G. Schlagintweit, J. Box	Salon B
14h - 14h25	La navigation électronique	An ECDIS Laboratory: Facilitating Electronic Charting for Navy Missions	D. Brunt, L. Alexander, K. Barbor	Frontenac
	La dimension verticale	Automated Tide Co-Ordination for Coastal Photogrammetry	K. Hess, N. Shoji, S. Gill, D. Wright, M. Aslaksen, C. Wong	Salon A
	Exigences des clients	Providing Clients with Usable Uncertainty Indices	D. Monahan, D. Wells, R. Hare	Salon B
14h30 - 14h55	La navigation électronique	Modeling Sea Ice Conditions for Marine Navigation in Ice-Infested Waters	G. Auda, A. ElRabbany, S. Abdelazim	Frontenac
	La dimension verticale	Verifying the Expected and True Accuracy of Vessel Attitude Sensors for Hydrography	M. Wetzler, K. Sampadian, M. Webb	Salon A
	Exigences des clients	NOAA's National Survey Plan	Capt. S. DeBow, LCDR D. Haines, D. Sinson	Salon B
15h - 15h40	Cérémonies de clôture	Sommaire de la conférence	M. Bennett/G. Fenn	Frontenac
		Invitation à assister à la conférence américiane Hydro 2003	K. Kinninger	Frontenac
		Allocution de clôture	A.D. O'Connor, D. St. Jacques	Frontenac

*Heures d'ouverture de l'exposition : de 9 h à 14 h 30

JOURNÉE DES PLAISANCIERS — LE JEUDI 30 MAI 2002

LES PLAISANCIERS SONT INVITÉS À PARTICIPER À LA CHC2002 – 8 H 30 - 18 H 30.

Les plaisanciers constituent potentiellement le plus grand groupe d'utilisateurs de produits hydrographiques du secteur maritime. Au cours de séances simultanées le jeudi 30 mai, pourront être présentées des communications intéressant non seulement les plaisanciers, mais tous les utilisateurs de produits hydrographiques. Il y aura le tirage d'un système de navigation électronique de poche (PC Pocket), d'une valeur de 1 300 $, offert par Nautical Data International. Cet outil polyvalent pourra aussi être utilisé au bureau. Tous les délégués présents au début de la première séance seront admissibles au tirage. Venez donc profiter de cette magnifique journée!

Pour le formulaire d'inscription des plaisanciers, allez au www.chc2002.com

Photo offerte par Gettyimages

SALON PROFESSIONNEL

Notre thème, « Innovation et excellence – Donner la priorité aux exigences et aux besoins en évolution des clients », est le reflet des exigences sans cesse croissantes des clients du milieu maritime au plan des nouvelles technologies visant à répondre de façon novatrice à leurs besoins.

La CHC2002 présentera les plus récentes technologies en matière d'acquisition et de traitement des données, de cartographie et de systèmes de cartes électroniques. Outre le volet intérieur de l'exposition qui se tiendra au centre des congrès de l'hôtel Westin Harbour Castle, il y aura, au mouillage 266 à proximité de l'hôtel, bon nombre de navires qui offriront des démonstrations en temps réel de matériel et de logiciels ainsi que des visites dans le port de Toronto. L'exposition débutera le mercredi 29 mai à 10 h 30 et restera ouverte au cours de la réception « brise-glace » * jusqu'à 19 h 30. Jeudi, l'exposition sera ouverte de 9 h à 18 h 30 et vendredi, de 9 h à 14 h 30.

QUELQUES-UNS DES BATEAUX QUI SERONT À QUAI

CCGS Griffon

CSL Merlin

CSL Petrel

Ontario Surveyor

Le **CCGS Griffon**, *brise-glace léger/grand baliseur et plate-forme hydrographique de 71 m du MPO/GCC, offrira les services de soutien nécessaires aux embarcations et des démonstrations de systèmes de cartes électroniques*

Le **CSL Merlin**, *Metalcraft, embarcation pour relevés hydrographiques de 10 m du MPO/SHC, offrira des démonstrations de sonars à balayage latéral.*

Le **CSL Petrel**, *Nelson, embarcation pour relevés hydrographiques de 10 m du MPO/SHC, est l'une des nombreuses embarcations qui feront la démonstration de technologies multifaisceaux et d'autres technologies d'acquisition de données.*

*L'***Ontario Surveyor**, *Henley, embarcation pour relevés hydrographiques de 8 m de Travaux publics et Services gouvernementaux Canada (TPSGC) fera la démonstration de technologies multifaisceaux et transducteur multiple.*

*L'exposition au mouillage 266 fermera à 16 h 30, avant la réception « brise-glace ».

CROISIÈRE DANS LE PORT DE TORONTO — LE LUNDI 27 MAI 2002

SOYEZ DANS LE HALL DE L'HÔTEL – 18 H 30 - 23 H

Coût par personne : 37,50 $ *(taxes incluses) (nombre de places limité, réservez sans tarder)*

Cet événement pré-conférence vous permettra d'admirer la saisissante ville de Toronto à bord d'un superbe navire, le Challenge. Savourez votre dîner et dansez sur les eaux du lac Ontario. Embarquement de 18 h 30 à 19 h. Ne manquez pas le bateau, réservez votre place à l'avance! Pour en savoir plus sur le bateau : www.greatlakeschhooner.com

RÉCEPTION D'ACCUEIL — LE MARDI 28 MAI 2002

HARBOUR BALLROOM – 19 H 30 - 22 H

Cet événement sera l'occasion de faire de nouvelles rencontres et de renouer avec de vieux amis. Joignez-vous à nous à l'hôtel Westin Harbour Castle pour une soirée des plus agréables. Le parfait coup d'envoi de la conférence!

RÉCEPTION « BRISE-GLACE » — LE MERCREDI 29 MAI 2002

METRO CENTRE EAST/HARBOURFRONT – 17 H - 19 H 30

Venez rencontrer les exposants et voyez tout ce qu'ils ont a offrir lors de la réception.

TOURNÉE DES PUBS – Organisée par Kongsberg Simrad — LE MERCREDI 29 MAI 2002

SOYEZ DANS LE HALL DE L'HÔTEL À 19 H 30

Assurez-vous d'inscrire votre nom sur l'une des listes au comptoir d'inscription pour participer à cette soirée. Vous pourrez ainsi faire l'expérience de la vie nocturne de Toronto. Le nombre de places est limité : premiers arrivés premiers servis. Les participants se rassemblent dans le hall de l'hôtel pour obtenir leur carnet de « La tournée des pubs » à 19 h 30.

REPAS DE LA SOIRÉE DU HOCKEY — LE JEUDI 30 MAI 2002

TEMPLE DE LA RENOMMÉE DU HOCKEY – 19 H - 24 H

(tenue d'affaires décontractée)

Il lance et compte! L'un des endroits les plus mémorables de Toronto, le Temple de la renommée du hockey est l'endroit idéal pour se détendre et réseauter dans une ambiance informelle et conviviale. Des mets des six pays originaux du hockey vous seront offerts – le Canada, les États-Unis, la Russie, la Tchéchoslovaquie, la Suède et la Finlande. Créez vos propres souvenirs en participant aux activités interactives. Assistez à cette Soirée du hockey qui nemanquera pas de faire salle comble!

Veuillez indiquer votre présence sur le formulaire d'inscription.

Photo offerte par Temple de la renommée du Hockey

DÉJEUNER CAUSERIE – Organisé en partie par l'AHC — VENDREDI 31 MAI 2002

REGATTA – 7 H - 8 H 15

Inscription anticipée exigée. Discussions d'affaires informelles et questions d'ordre industriel. Petit déjeuner continental offert. Donnez votre nom au comptoir d'inscription

CHC2002 EN BONNE FORME — DU LUNDI AU VENDREDI

TOUS LES JOURS – 7 H

Joignez-vous à vos collègues pour faire du jogging ou de la marche le long du magnifique Harbourfront de Toronto. Inscrivez-vous au comptoir d'inscription.

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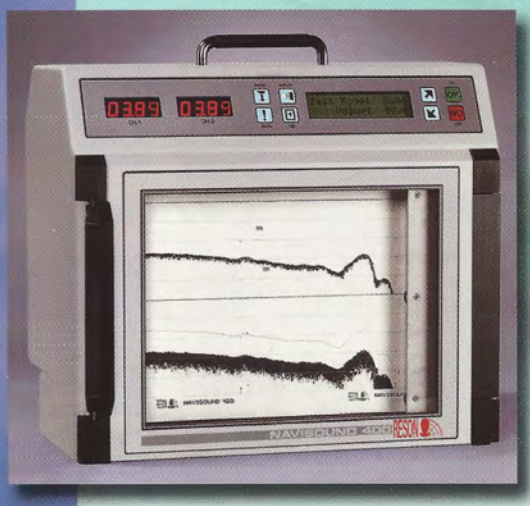

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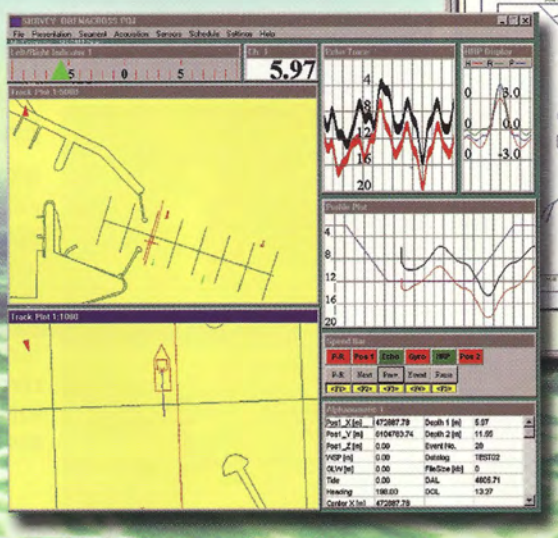

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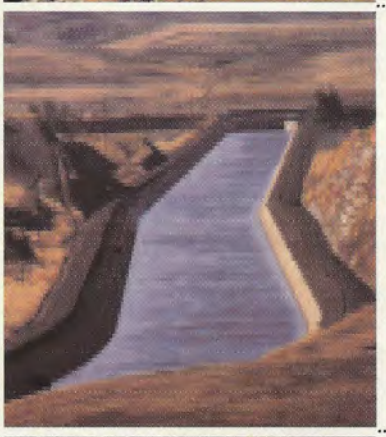

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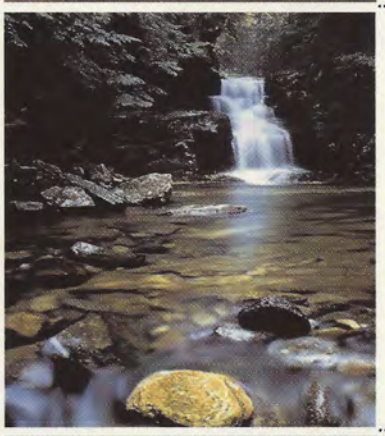

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RTT Integra and its sister company, Nortech GSI, combine years of experience with air quality and water quality monitoring systems. Whether your need is for regional ambient air quality control or for lake and river pollution monitoring, RTT Integra is ideally positioned to meet your requirements.

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Continued from page 22.

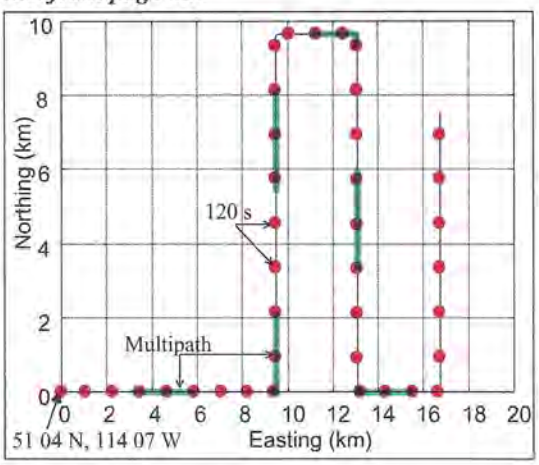

Figure 8: *Ship Test Trajectory*

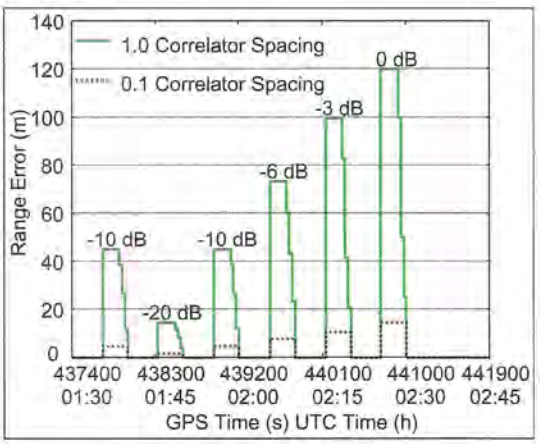

Figure 9: *Multipath Range Error added to SV#8*

Results

Each receiver was subjected to the same multipath environment. The data was analyzed in the following ways:

1) Post-Processed DGPS Position – Without Reliability Checking
2) Post-Processed DGPS Position – With Least Squares Reliability Checking
3) Post-Processed DGPS Position – With Kalman Filtering Reliability Checking

The University of Calgary's C^{3}NAVG^{2TM} post processing software package was used for the analysis. In order to assess the relative improvement between least squares and Kalman filtering, the isotropic mask angle was varied from 5° to 25° in 5° increments. The least squares reliability algorithm checked if the normalized residuals for a given epoch were less than 3.3 [N(0,1), α = 9.9%]. While the Kalman Filtering reliability algorithm checked if the normalized innovations were less than 3.3 [N(0,1), α = 99.9%]. If they were, that epoch was considered free from blunders, and the position was plotted as a blue dot. If at least one residual / innovation failed, subset testing was performed to isolate the blunder. Positions and residuals / innovations were computed for all possible observation subsets with one satellite removed. The residuals / innovation from each subset were tested as described previously, with one of the following results:

1) Only one subset passed, therefore the blunder was found and excluded, and the position was plotted as a green dot.
2) Multiple subsets passed, or all of the subsets failed, therefore the blunder could not be positively identified, and the subset whose position had the minimum sum squared residuals / innovations was plotted as a red circle.
3) Subset testing could not be performed due to insufficient redundancy, thus the position was plotted as a red circle.

All of the results from each receiver will not be presented in the time domain; only the 20° isotropic mask case will be presented, followed by a summary of the overall detection and isolation results.

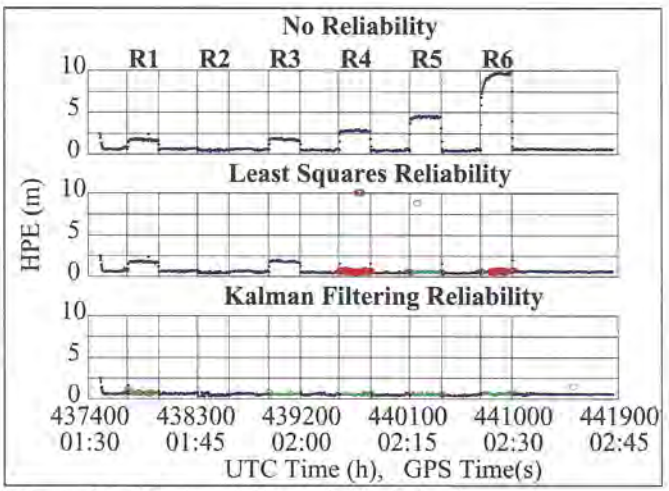

Figure 10: *Receiver "A" – 20° Mask Angle*

The horizontal position error (HPE) results for receiver "A" with a 20° isotropic mask angle for the three positioning methods is shown in Figure 10, the six multipath periods are labeled "R1" to "R6". Even without a reliability algorithm the HPE only exceeds 5 m during the last multipath ramp. Once the least squares reliability algorithm is applied the multipath errors are detected during the last three multipath ramps, however, the blunder can only be isolated during the 5th ramp. The Kalman filter detects and isolates the blunder in five of the six multipath ramps. Although multipath was added to SV #8 during the second ramp (R2) the receiver's correlator mitigated its effect, with a resulting position error of < 1 m. Thus the combination of a high performance correlator and a Kalman filter successfully mitigated the induced multipath.

The blunder detection and isolation performance of least squares (LS) and Kalman filtering (KF) for receiver "A" during the six multipath ramps is presented in Figure 11. The Kalman filter increases the detection and isolation probabilities by approximately 30% for receiver "A". Why are the detection and isolation probabilities not 100%? The answer lies in the receiver's correlator: it essentially eliminated the multipath from the second ramp and mitigated it during the other ramps. The Kalman filter algorithm detected the blunder in the other five ramps, thus its detection rate is essentially 100%. The least squares algorithm didn't detect the blunder during the first and third ramps, however, this is not a significant failure since the HPE was still < 2 m for these ramps.

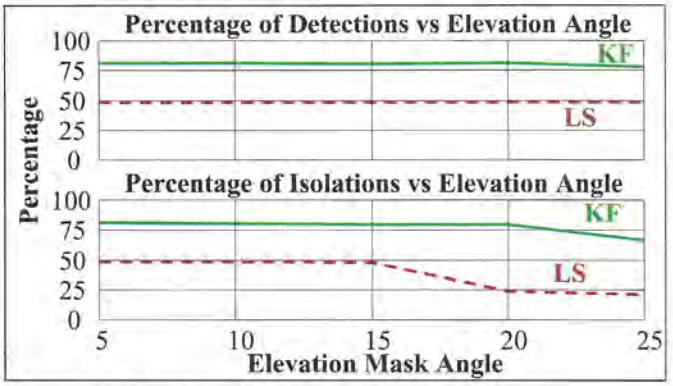

Figure 11: *Receiver "A" – Detections & Isolations*

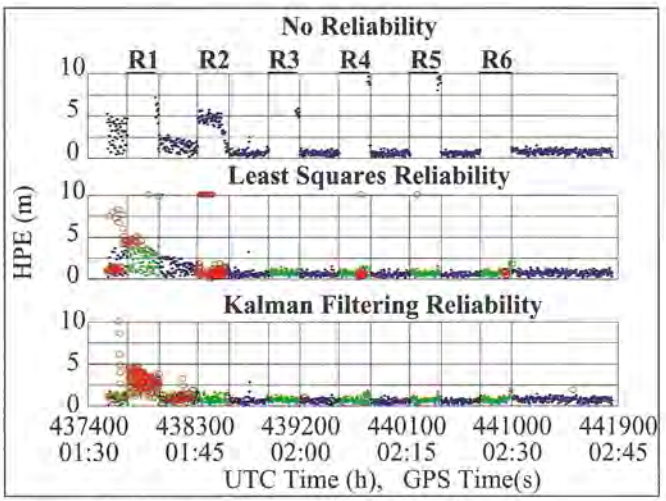

Figure 12: *Receiver "B" – 20° Mask Angle*

The results for receiver "B" with a 20° isotropic mask angle for the three positioning methods is shown in Figure 12. There are several major differences between the results for receiver "A" and "B". Since receiver "B" uses a wide correlator, the multipath causes relatively large HPE (> 10 m), as shown by the first sub-plot of Figure 12. Once the least squares reliability algorithm is added, the blunders are almost always detected and isolated. The Kalman filter further improves the isolation during the second, fourth, and sixth multipath ramps. Least squares has several large outliers in the second through fifth ramps, which are cleaned up by the Kalman Filter. Overall, the Kalman filter improves the reliability performance under these masking conditions.

The results for the other masking conditions are presented in Figure 13. The Kalman filter increases the percentage of detentions and isolations for all five isotropic mask angles. However, the results are most significant during the higher masking conditions. Under these conditions the redundancy is reduced, thus the dynamic constraints greatly improve the reliability of the position.

Figure 14 shows the 95% HPE for each receiver during the multipath ramps for each of the positioning methods (no reliability "NR", least squares reliability "LS", and Kalman filter reliability "KF"). Receiver "A" with no reliability is always less than 10 m, however, once the least squares reliability algorithm is added the worst case 95% HPE is < 2.5 m. Kalman filtering improves this even more, with a worst case 95% HPE of < 1.7 m. Receiver has

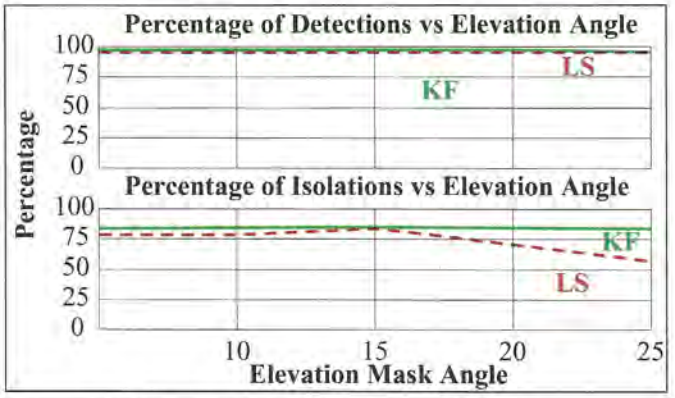

Figure 13: *Receiver "B" – Detections & Isolations*

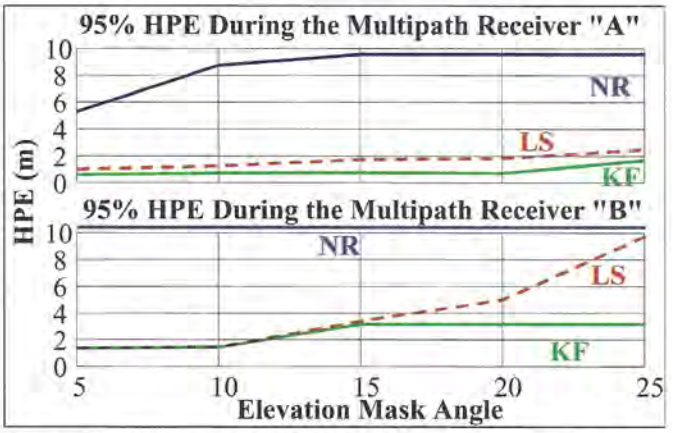

Figure 14: *HPE Results for Both Receivers "B" with no reliability*

a 95% HPE during the multipath ramps of > 20 m. At the low elevation mask angles, least squares and Kalman filtering perform almost identically, with the 95% HPE < 2 m for both cases. However, as the mask angle increases the Kalman filter consistently out-performs least squares.

Conclusions

Augmenting DGPS with dynamic constraints through the use of a Kalman filter greatly improved the availability and reliability of the navigation solution. While the most dramatic improvements are obtained during extreme masking conditions, the filter consistently outperforms standard least squares regardless of the mask angle.

The hydrographic survey software simulations demonstrated that adding a Kalman filter was equivalent to adding an additional satellite navigation system to standard least squares. However, the analysis assumed that the blunder did not bias the filter prior to detection. If the blunder was allowed to bias the filter, it would affect the reliability. The degree to which it would affect the reliability would be dependent on the specific blunder characteristics.

The analysis of the two user receivers using the GPS signal simulator showed that a Kalman filter can improve the reliability of both high and low end receivers. The filter improved the detection and isolation probabilities for both of the receivers, as well as the overall horizontal position error.

Future work will involve characterizing typical marine blunders and their impact on the availability and reliability of marine navigation.

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Dr. Gérard Lachapelle is Professor and Head of the Department of Geomatics Engineering, where he is responsible for teaching and research related to positioning, navigation, and hydrography. He has been involved with GPS developments and applications since 1980.

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- Almost 90% of those who died in boating incidents were not wearing a lifejacket or PFD.
- If you make it past the first moments when things go wrong, you can still die from the effects of hypothermia,even in July. A PFD can help keep you warmer, floating and visible while waiting for assistance.
- Even a small amount of alcohol magnifies the urge to gasp and disorients the person in the water. Don't drink and boat, even if you are just a passenger.
- Most victims never thought they'd be in the water. Be ready when it happens to you. Wear your PFD.

THE COOK-REES MEMORIAL FUND
For Water Search And Safety

Lighthouse puzzler

By
Beth Weller

	Sponsor	Navigator	Hydrographer	Admiral	Australia	Canada	Scotland	U.S.A.	Electronic charts	GPS	Multibeam	Transducers
Berry												
Gilles												
McFarlane												
Kieninger												
Electronic charts												
GPS												
Multibeam												
Transducers												
Australia												
Canada												
Scotland												
U.S.A.												

Lighthouse Puzzler # 21

Four CHA members from around the world are in Toronto for the 2002 Canadian Hydrographic Conference. Chatting at the conference Tradeshow with Mr. Berry, who is one of the Conference Sponsors, can you deduce which person is particularly interested in the electronic chart demonstrations?

1. Mr. Gilles is not from overseas; he is interested in the new line of GPS equipment.
2. Mr. Kieninger, from Scotland, is not the Multibeam enthusiast, nor is the hydrographer.
3. The retired Admiral is not from Australia; the one from Canada is navigator on a freighter.
4. The one from the USA is interested in the new multipurpose transducers.

Solution to Puzzler #20

The Greek slave galley was not off Halifax or Montreal (clue 4) or Tobermory [the treasure galleon was there] so it must have been off Vancouver, which means *Griffen*, not at Montreal (3), was at Halifax and the Avro Arrow was found off Montreal.

The slave galley was west of Montreal and not found with RDF (4) so must have been found by Loran-C at Vancouver. The GPS was not at Halifax (2) nor was the RDF (1) or the Loran-C so aerial photos must have been used there. Which means Wilcox, with his GPS, not Biggar (3), was at Montreal. So the RDF was with Biggar.

As there are no other double vacancies in the four rows, the treasure galleon off Tobermory must have been found by Biggar.

SOUNDINGS ...

We promised to publish comments received following our short article under the heading of "SOUNDINGS" in edition 60 of LIGHTHOUSE. You may recall the article was related to "What is Bottom".

Following are several comments we received. (A detailed list of references has been supplied and is available on our website: http://biachss.bur.dfo.ca/dfo/chs/cha/)

"I am responding to your column "SOUNDINGS" in edition 60 of Lighthouse (Fall/Winter 2001) which arrived 3 January 2002.

Preamble

I am amazed as well as disappointed that you are not aware of the developments that have taken place during the last 30 years regarding the determination of depths in areas with fluid mud and silt. Admittedly most of these developments took place in Europe. However the paper "Definition of the Seabed in Navigation Routes through Mud Areas" was presented in Canada as early as May 1979 at the 1st International Hydrographic Technical Conference held in Ottawa (details of this paper and other relevant publications are listed at the end of my letter). The reason for my amazement and disappointment is that I always admired the CHS for taking the lead in research and development and in implementing new technologies (and I was proud to be part of that organisation) so I expected it to stay abreast of developments elsewhere. If there is a lack of awareness amongst Canadian hydrographers I think it would have been caused by their unwillingness to become members of the Hydrographic Society and/or a lack of access to suitable journals (the latter was certainly the case when I was in the CHS).

The Establishment of Nautical Depth

After leaving the CHS in 1978 I worked at the Maritime Research Institute Netherlands in Rotterdam and in 1981/82 became quite involved in research on navigable depth as an expert witness in a court case. The depth that is really available for ship traffic then began to be called "Nautical Depth". It is defined as the depth measured from the water surface to the point where the water density reaches a specified value. In the Rotterdam Waterway for instance Nautical Depth is the depth at which the density reaches 1.2 tm^{-3}. If part of the ship's hull were to move through "muddy water" with a density greater than 1.2 tm^{-3} it was assumed the manoeuvrability of the ship would be affected too much for safe navigation. Density is unfortunately not the only criterion that determines the effect it has on ship behaviour. Therefore it cannot be assumed that what is acceptable for Rotterdam is acceptable elsewhere. The shear strength of the material, be it mud, sawdust or any other soft material and whether it is in suspension or more or less consolidated, as well as the presence or absence of gas in it also significantly influences the manoeuvring characteristics of a vessel.

The Influence of Nautical Depth on Ship Admission Policy

Around 1981 it was determined in tank tests at the Netherlands Ship Model Basin as well as with a real VLCC entering the Rotterdam Waterway that, provided the density was no more than 1.2 tm^{-3}, the vessel could proceed safely and behaved like any other vessel subjected to very shallow water conditions. Note that the ship's keel in these circumstances is in muddy water with a density of less than 1.2 tm^{-3} due to the minimum Under Keel Clearance (UKC) the Rotterdam Port Authority requires. At that time it was not known how much more and in what way manoeuvrability would be affected if the ship's keel is immersed below the Nautical Depth density of 1.2 tm^{-3}.

The Rotterdam Port Authority provided the pilots of all vessels that could be constrained by these conditions with up-to-date chartlets. These showed density contours together with the soundings. On the basis of these chartlets the pilot could then determine whether the ship could proceed. This was possible whenever the depth on the chartlet was less than the required depth and its associated density was less than 1.2 tm^{-3}. The method may well have changed, as it is now 20 years since this approach was first used. Since that time newer methods have been devised in determining density and more research has been carried out on the behaviour of floating mud and its influence on ship behaviour. For instance the Oceano Report (see list of literature) describes a French density meter introduced in 1986, which was an improvement on earlier models. Furthermore the information may well be shown differently or perhaps only nautical depth is shown now that the pilots are experienced in making use of it. There must be pilots currently employed that have never piloted vessels before the implementation of Nautical Depth. These pilots would feel completely at home navigating ships through areas that more than 20 years ago would have been considered too shallow and would first have been dredged to the design depth of the channel.

The Influence of Density on Depth Measurement

My own research, based on fieldwork carried out by others as well as personal experience, showed that an ordinary lead will always indicate the greatest depth. An electric hand lead shows less depth than an ordinary lead, while an echo sounder with a 210 kHz transducer indicates the least depth. The variation in measured depth between these three methods depends also on the degree of consolidation of the silt. What was most significant however was that in the tests done, the echo sounder (a Krupp Atlas) always indicated a depth where the density was 1.06 tm^{-3}, while the electric hand lead indicated a depth where the density was around 1.3 tm^{-3}. This was so regardless of the degree of consolidation of the silt. From this it can be seen that a standard lead will not detect the presence of mud until the density is well in excess of 1.3 tm^{-3}.

If the riverbed has been disturbed, either by a sudden influx of silt / mud or a ship with very little UKC moved through it, the density profile will be distorted. Any depths measured right after this event would be significantly shallower than those measured a few days or weeks later.

It was also discovered that 30 kHz transducers were much less consistent than the 210 kHz transducer in showing an echo at a constant density level. However it always showed the "seabed" at a depth where the density exceeded 1.2 tm^{-3}. In other words it could not be trusted to provide correct depth information in areas with silt or soft mud.

A striking example of this was experienced in Stony Lake on the Trent-Severn Survey in 1968. The Kelvin Hughes 26A echo sounders then in use by the CHS employed a frequency of about 30 kHz. For a number of days in the main body of the lake the greatest depths obtained were in the order of 90 feet halfway between shores. One day however one of the hydrographers, who had not been out in that area before, for some reason had cranked up the gain control. When his sounding roll was scaled we suddenly noticed a faint bottom appearing at less than half the depths obtained previously. Not only that, it was flat and at a fairly constant depth right across, whereas the previously measured depths plunged right down the moment the launch started its sounding line (it was common to touch a rock with the bow and measure 60 feet on the sounder). Upon investigation this faint bottom turned out to be soft mud and the whole area had to be sounded again. Ironically this happened a year after the Rotterdam Port Authority had already carried out its tests with the various frequencies and lead line leading to the results I quoted above. If only we had been informed then !

Developments after 1983

Since my move to Australia in 1983 I began to lose touch with the further technological developments. However I am sure this concept of nautical depth and its use by port authorities must be reasonably widespread. For instance I gave a paper on this topic at a symposium held at the Australian Maritime College in 1985 and received many inquiries from pilots and harbourmasters for several years after that. A number of papers have been produced over the years although I am not sure in what journals or at what symposia and when. If you wish to find out more I suggest you consult the (mostly quite old) publications listed below (there are many more but unfortunately they are in Dutch). Newer articles should be looked for in maritime oriented journals and PIANC proceedings. I have scanned the Hydrographic Journals from 1979 onwards and included in my list any relevant articles.

Summary

Summarising the answers to your questions: Yes, for the past twenty years we have been able to measure the density and the height of the mud / silt layer and we have known how dense the muddy water may become, before it unduly affects the ship's manoeuvring behaviour.

I take this opportunity to wish you and all my former colleagues a healthy and prosperous 2002 and a safe field season for those not yet retired.

Best Regards,
George H. Goldsteen
Lecturer in Hydrography (retired)
Lecturer in Navigation (not quite retired)"

Another note received via e-mail:

"Earl Brown certainly hasn't lost it when he posed the above question in the Fall/Winter 2001 edition of Lighthouse page 14. This is by no means a new problem and I believe that there was a paper presented on the subject at a hydrographic conference in the late 70's. From memory the paper dealt with experiences at Europort, a large port on the Rhine estuary in the Netherlands, where the water contained a significant amount of suspended sediment. Conventional echosounders were unable to resolve the issue of where bottom was. As a result samples of the water and sediment mix were retrieved from various depths and bottom was defined at the point when the density exceeded a certain value.

Regards,
John Brigden CLS, President
Brigden Survey Consulting Inc."

Editor's Comment:

We appreciate the comments and our thanks go out to George Goldsteen and John Brigden. George's comments are, as expected, very detailed and well thought out.

It is also of interest that both George and John make reference to a paper presented over 20 years ago. How have those responsible for charting responded to this concern raised two decades ago?

According to the *Guinness Book of World Records:*
Presently, 10% of all land area is covered with glaciers. If all this land ice melted, sea levels would rise around 70 metres (230ft) worldwide.

Friends of Hydrography

By: S. van Dyck

At a retirement party in 1998 a few of us got together to decry the potential loss of much of the history of the Canadian Hydrographic Service (CHS). To prevent this loss we decided to set up a volunteer organization with the following aims:

Harold Comeau

The Volunteer Group must, above all. provide a beneficial and satisfying experience to all participants and to the CHS. It must not be a 'social club' but must provide useful work to the benefit of the hydrographic community, now and in the future.

Projects can be those of a historical nature, current issues or even those with a futuristic leaning. The work is being done to provide accurate background information to publications such as Lighthouse, the news media, historical researchers, schools, etc.

Specific examples include:

- Document the history of hydrographic personnel.
- Document the history of hydrographic ships and other platforms.
- Document the history of charts and surveys.
- Catalogue relevant holdings in the CHS library.
- Enhance the display of museum pieces held by the CHS.
- Provide floating displays of selected historical subjects for Headquarters and Regional offices. These displays would be changed on a routine basis and would serve to acquaint present staff with their hydrographic roots.

The Volunteer Group will not undertake projects or tasks that are associated with any aspect of the production of paper or electronic charts.

The Friends of Hydrography are but a small group at this time. The work is progressing slowly but steadily. Emphasis at this time is on the website (as listed below). Some of the other goals have yet to be addressed. The site now has a goodly number of personnel listed. Most of these are thanks to David Gray, who has been assembling them for a number of years and has made his records available to us. The list of articles in the International Hydrographic Review is up to date. The history of CHS training is almost complete. Work is progressing on the history of ships. Many other items are being tackled. Among them a brief outline of Final Field Reports, relating to survey projects.

What makes people volunteer? There is no one easy answer. At present all volunteers are retired CHS personnel. Everyone is working on a subject of their choosing and at times of their choosing. All have similar interests. Some show up one day a week, others just join for individual projects. Everyone is welcome to contribute.

As we do not have the resources to make everything bilingual, we are publishing items in the language in which they are submitted.

If you have not yet visited our website to see what has been accomplished to date, please do so at your convenience.

If you do not find yourself in the listing of personnel, please send in a portrait of yourself , using the file on "Joe Example" as a guide. Contribute as much as you can from wherever you are, or join our happy little group.

You can contact us:
by email : canfoh@hotmail.com
or by phone: 613-995-5249, Sheila Acheson
Sheila is our CHS contact and will forward all messages to us.

www.canfoh.org

Charts for the Blind and Visually Impaired?

By: Glenn Macdonald, Canadian Hydrographic Service

"What is now proved was once only imagin'd."
William Blake

When working with geographic information everyday, it's easy to fall into the habit of supposing that your own understanding of space and how it's ordered is pretty much the same as everyone else's. You forget that many people have no idea what a datum or a projection is, they don't know the difference between a map and a chart, and couldn't tell you in which direction the St. Lawrence River flows. When I began working with the Canadian Hydrographic Service and told people that I make charts of the Great Lakes and the Arctic, I was surprised to hear people respond, "Haven't we already mapped those areas?"

The need to answer "No" has, over the years, drawn me to think about change in cartographic methods and geographic perceptions. Which is why the idea of mapping for the blind and visually impaired struck me with such force when I first encountered it at the 1999 International Cartographic Association Conference. There is nothing that quite so challenges one's understanding of space and how it's ordered.as the prospect of processing and presenting geographic information without the use of vision.

Unquestionably, one of the great enterprises in cartographic and human history has been the mapping of the Earth its shorelines and remote interiors. From the years leading up to Columbus' great adventure in 1492, humanity has asked complex and ever-more wildly speculative questions of its environment. In turn, we've been rewarded with an increasingly dazzling awareness of just where it is we've found ourselves. The endeavor has culminated in the images of the planet that began arriving from technologies in space in the 1960's. It may be the awesome sense of comprehensiveness inspired by all this that gives rise to the "already mapped" misapprehension. It's important to remember, however, that the seed of all such knowledge has been not so much in new technologies as in new ideas and new questions. Before the Discovery, always the Imagination…

> *During the fifteenth century, a link between visual perception and knowing gained formal expression, as did visual techniques to represent and guide development of this new form of knowledge. The rediscovery of Ptolemy influenced fifteenth-century perception through an increasing imposition and interjection of the grid onto representations of the world, and between people and their world. Renaissance linear perspective systematically organizes space visually ... Perspective encourages the visualization, and then construction, of relational mental mapping, a causal process that sequentially shifts one's point-of-view from here to there, a progressive movement from the extant position of the body towards the vanishing point at the horizon of Discovery. The Discovery is an event, and cartography maps it well, both in advance and after the fact. Perspective pre-conditions the imagination and the curious outlook of those individuals who will perform the legwork in making Discovery happen. (Ken Hillis, The Power of Disembodied Imagination: Perspective's Role in Cartography, Cartographica, Vol. 34, No.3, Autumn '94, p. 2)*

It's taken me some time to recognize that the question, "Haven't we already mapped those areas?" betrays not so much a lack of knowledge about technological developments (GPS, multibeam sounders etc.). Rather, it indicates a fundamental misunderstanding about two aspects of the way in which the Earth and human awareness interact over time. The question implies first that Geographic Information is a timeless and absolute thing, independent of human enquiry, and second, that our knowledge of the world derives from a sound and steady progression from ignorance to enlightenment. In reality, knowledge isn't so static or immutable. Geographic information changes in concert with technologies of measurement, transportation, and representation. In effect, the world changes in response to the questions we ask of it.

How, then, might our world respond when we ask it questions for which there are no visual answers? A world in which…

> *It has long been understood that culture has an impact on visual perception. But it is increasingly understood today that since the seventeenth century we live in a visual culture, and one wherein knowledge is seen as in the first instance deriving from vision, and from the ability of the individual scientist to stand outside of the situation being studied. (Michael Curry, Space and Place in Geographic Decision Making, UCLA)*

The thought of developing mapping solutions for the blind and visually impaired becomes all the more interesting when our cultural bias for visually-based knowledge is considered in conjunction with current thinking from the field of human psychology and cognition.

> *...lack of visual experience may result in a total lack of spatial understanding (the 'deficiency' theory); it may result in spatial abilities which are similar to, but necessarily less efficient than, those of sighted people (the 'inefficiency' theory); or it may result in abilities which are qualitatively different from, but functionally equivalent to, those of sighted people (the 'difference' theory). (Simon Ungar, Cognitive Mapping without Visual Experience, London Guildhall University)*

If the third of these options (the 'difference' theory) should prove to be the reality (and many psychologists are beginning to think this way), then there is a "qualitatively different … but functionally equivalent" mode of spatial cognition available to us. Essentially, cartography for the blind offers not only the possibility of bringing the blind into a geography heretofore accessible only to the sighted, but offers the potential of opening to the sighted a facet of geography never before imagined.

Have we already mapped those areas? No, we've barely even begun.

Glenn Macdonald has worked with the Canadian Hydrographic Service, Central and Artcic Region for the past 7 years as both a cartographer and field hydrographer.

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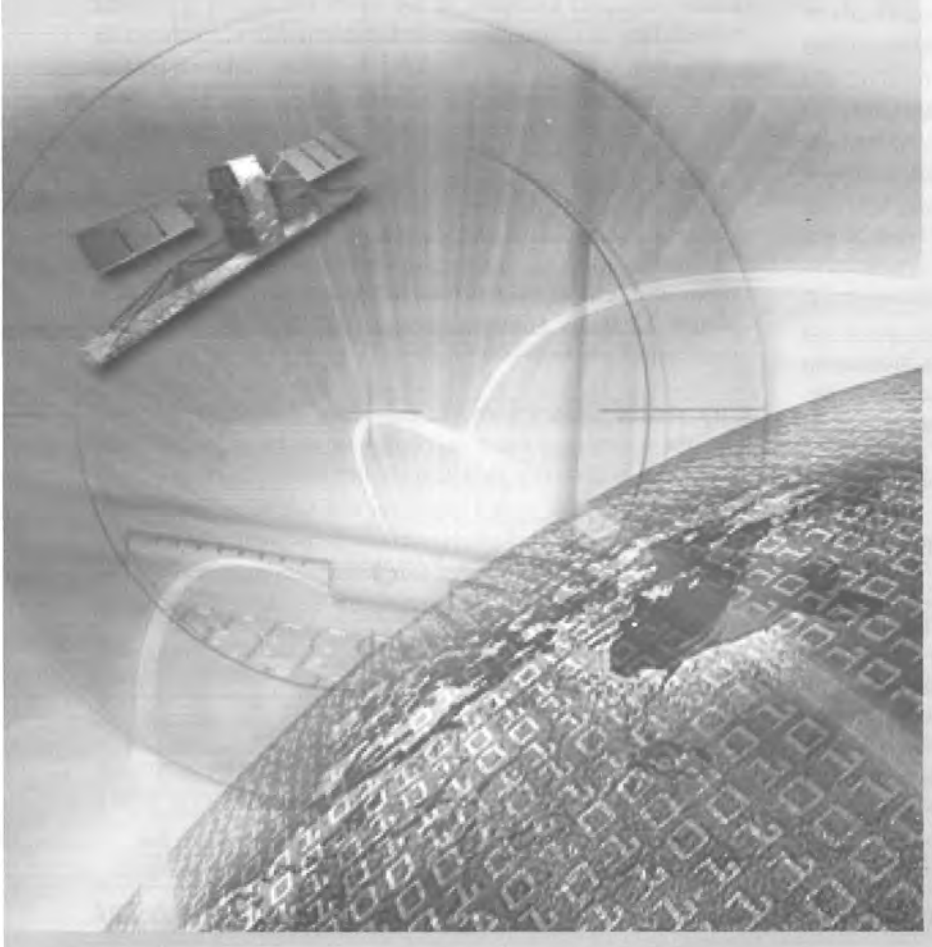

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CHA l'ACH

The Canadian Hydrographic Association (CHA) is a non-profit, scientific and technical group of more than 500 members with the objectives of:

- advancing the development of hydrography, marine cartography and associated activities in Canada;
- furthering the knowledge and professional development of its members;
- enhancing and demonstrating the public need for hydrography;
- assisting in the development of hydrographic sciences in developing countries.

It is the only national hydrographic organization in Canada. It embraces the disciplines of:

- hydrographic surveying;
- marine cartography;
- marine geodesy;
- offshore exploration;
- tidal and tidal current studies.

The Canadian Hydrographic Association is formally affiliated with the Canadian Institute of Geomatics. It is informally associated with The Hydrographic Society.

What the CHA Can Do For You:

- advance your knowledge of hydrography, cartography and associated disciplines, and keep you abreast of the latest development in these disciplines;
- enable you to develop and maintain contacts with others involved with hydrography, nationally and internationally.

These benefits are provided through the publication of *LIGHTHOUSE* (one of only three journals in the world devoted exclusively to hydrography) and through the sponsorship of seminars, colloquiums, training programs, national conferences, and Branch and National meetings.

LIGHTHOUSE

The journal of the Canadian Hydrographic Association, *LIGHTHOUSE*, is published twice yearly and distributed free to its members. Timely scientific, technical and non-technical papers and articles appear in the journal, with authors from national and international academia, industry and government. Present circulation of Lighthouse is approximately 900.

Membership

Membership is open to all those associated with the hydrographic community as well as those working in associated disciplines.

Branch & Regional Activities

The Canadian Hydrographic Association has five (5) branches located across Canada. National headquarters is located in Ottawa.

L'Association canadienne d'hydrographie (ACH) est un organisme sans but lucratif réunissant un groupe scientifique et technique de plus de 500 membres ayant des objectifs communs, comme:

- faire progresser le développement de l'hydrographie, de la cartographie marine et de leurs sphères d'activités au Canada
- permettre les échanges d'idées et le développement professionel de ses membres
- rehausser et démontrer l'importance de l'hydrographie auprès de public
- assister au développement des sciences de l'hydrographie dans les pays en voie de développement

Au Canada, l'Association est la seule organisation hydrographique qui embrasse les disciplines suivantes:

- levé hydrographique
- cartographie marine
- géodésie marine
- exploration extra-côtière
- étude des marées et courants

L'Association canadienne d'hydrographie est affiliée à l'Association canadienne des sciences géomatiques, et non-officiellement liée à The Hydrographic Society.

Ce qu'elle L'ACH peut faire pour vous:

- parfaire vos connaissances de l'hydrographie, de la cartographies et des disciplines connexes, tout en vous tenant au courant des nouvelles techniques et des derniers développements réalisés dans ces domaines;
- établir et maintenir des contacts avec ceux qui oeuvrent en hydrographie, au niveau national et international.

Ces avantages sont transmis par l'entremise de *LIGHTHOUSE* (une des trois revues au monde traitant exclusivement d'hydrographie) et par la tenue de séminaires, de colloques, de programmes de formation et d'assemblées régionales et nationales.

LIGHTHOUSE

La revue de l'Association canadienne d'hydrographie, *LIGHTHOUSE*, est publiée deux fois l'an et distribuée gratuitement aux membres. Des articles scientifiques, techniques et non techniques, provenant du milieu de l'industrie ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 900 copies.

Comment devenir membre

Le statut de membre est offert aux tout ceux oeuvrant ou ayant un intérêt dans des disciplines associées.

Sections et activités régionales

L'Association canadienne d'hydrographie possède cinq (5) sections à travers le Canada. L'administration central se trouve à Ottawa.

For further information write to / Pour plus d'information, s'addresser au:

National President/Président national
Canadian Hydrographic Association
1390 Promenade Prince of Wales Dr., Suite/Bureau 400
Ottawa, Ontario Canada K2C 3N6

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Sustaining membership allows companies closely linked with the hydrographic field to become more involved with the activities of the CHA and to maintain closer contact with users of their products. Through *LIGHTHOUSE* these Sustaining Members are also able to reach a world-wide hydrographic audience. The benefits of Sustaining Membership include:

a certificate suitable for framing / three copies of each issue of Lighthouse / copies of the local Branch newsletters, where available / an invitation to participate in CHA seminars / an annual listing in Lighthouse / an annual 250 word description in Lighthouse / discounted advertising rates in Lighthouse.

Annual dues for CHA Sustaining Membership are $150.00 (Canadian). Current Sustaining Members are listed below.

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Canadian Centre For Marine Communications
P.O. Box 8454, St. John's, NF A1B 3N9 Canada
contact: Bill Carter, Director, Information Marine,
Tel: (709) 579-4872 FAX: (709) 579-0495
E-mail bcarter@ccmc.nf.ca (affiliation - CHA Central Branch)

Garde côtière canadienne
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contact: Claude Duval Téléc: (418) 648-4236 (affiliation - ACH Section du Québec)

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contact: Claude Jean (affiliation - ACH Section du Québec)

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contact: Judith Knudsen, judith@knudsenengineering.com
Tel: (613) 267-1165 FAX: (337) 261-0192
(affiliation - CHA Central Branch)

Kongsberg Simrad Mesotech Ltd.
261 Brownlow Avenue
Dartmouth, NS, B3B 2B6 Canada FAX: (902) 468-2217
contact: John Gillis (affiliation - CHA Central Branch)

National Hydrographic Office
P.O. Box 75, 107 A Rajpur Road
Dehradun - 248 001, India
contact: Chief Hydrographer
Tel: +91 135-747365 FAX: +91 135-748373
(affiliation - CHA Central Branch)

McQuest Marine Sciences Ltd.
489 Enfield Road
Burlington, ON, Canada L7T 2X5
contact: Ken McMillan
Tel: (905) 639-0931 FAX: (905) 639-0934
Website: www.mcquestmarine.com (affiliation - CHA Central Branch)

Octopus Marine Systems Ltd.
Suite 3 Business Centre, Castle Farm,
Deddington, Oxon, United Kingdom OX15 OTP
contact: Duncan Mallace, Tel:+44 1869 337570
duncan@octopusmarine.co (affiliation - CHA Central Branch)

RTT Integra Inc.
675, Pine Avenue,
Saint-Lambert, QC J4P 2P4
Tel: 1-877-INTGRA1 (468-4721) FAX: 450 465-1938
e-mail: salesrtt@rttintegra.com (affiliation - ACH Section du Québec)

Terra Remote Sensing Inc.
1962 Mills Road,
Sidney, BC, Canada V8L 3S1 Fax: (250) 656-4604
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Knudsen Engineering Limited

Knudsen Engineering Limited, a Canadian owned and operated company, manufactures the 320 series of high performance rugged single beam echosounders — used worldwide for hydrographic surveying, oceanographic research, dredge mining, and navigation applications.

The Knudsen 320 series of echosounders provide precision water depth measurement. The 320M Marine Echosounder, 320B Blackbox, the 320MP and 320BP Portable Splashproof Echosounders, and the new 320BR Deep Water Echosounder offer flexible software driven architecture that allows ready integration with modern marine industry survey tools including GPS, heave sensors, dataloggers and PCs. Unique product features of the Knudsen Engineering echosounders include a standard SCSI port and Windows interface, and field programmable software that allows system upgrade or re-configuration to new frequencies.

The Knudsen 320 series of echosounders is fast becoming known in academic and research communities around the world. All three North American accredited hydrographic survey training centres — the University of New Brunswick, the University of New Hampshire, and the University of Southern Mississippi — have chosen Knudsen echosounders for their hydrographic field training, as well as serious research tools for graduate level programs.

Knudsen Engineering Limited is proud that their equipment is the single beam echosounder of choice for the Canadian Hydrographic Service across Canada. Knudsen equipment is part of the navigation systems on board the twelve Canadian Maritime Coastal Defence Vessels.

Product information for the 320 series of echosounders is available at: www.knudsenengineering.com.
Contact: Judith Knudsen , VP Operations / Marketing
Tel: 613-267-1165 ext 105 FAX: 613-267-7085
judith@knudsenengineering.com

RESON Signs McQuest Marine Sciences in Canada

McQuest Marine Sciences Limited, a company specializing in marine geophysics and hydrography, has signed an agreement to become a qualified RESON representative and distributor in Canada, further underscoring RESON's commitment to the international marketplace.

Mr. Kenneth McMillan is President and Senior Project Scientist at McQuest Marine. He has more than 25 years of experience in the hydrographic marketplace, including many years as a marine geophysicist at the Canada Centre for Inland Waters.

RESON is a leading provider of sonar equipment and software that meet the most stringent requirements of today's advanced hydrographic, offshore exploration, marine surveillance, and military applications. RESON provides compelling value to its global customer base by offering complete sonar solutions that span the entire spectrum of data collection, compilation, and presentation. With corporate offices in Denmark and a presence in 25 countries worldwide, RESON has been advancing state-of-the-art underwater acoustic technology for more than 25 years.

RESON and McQuest Marine recognize that Canada is an evolving market for hydrographic applications for multibeam echosounders, single-beam echosounders, and related software.

For further information contact::
Mr. Ken McMillan
McQuest Marine Sciences Ltd.
Tel: +905-639-0931 Fax: +905-639-0934
Website: www.mcquestmarine.com or visit www.reson.com.

RESON to offer on-water multibeam demonstrations

RESON, Inc. will be offering public on-water demonstrations of its SeaBat sonar systems and NaviSoft software at two Canadian venues in late May 2002.

The first demonstration will take place May 25 as part of the Canadian Hydrographic Association's (CHA) Coastal Multibeam Sonar Training Course in Burlington, Ontario. This six-day course is led by industry experts and provides comprehensive instruction on all aspects of multibeam sonars. The RESON demonstration will be open to all course participants. More information about the course is available at http://biachss.bur.dfo.ca/cha-mb2002/ or by contacting Paul Davies of the CHA Central Branch at 905-336-6448 or daviesp@lara.on.ca.

The second demonstrations will be part of RESON's exhibit at the Canadian Hydrographic Conference (CHC) to be held May 28-31 at the Westin Harbor Castle Hotel in Toronto, Canada. Multiple demonstrations will be provided each day during exhibit hours and will be available to all conference attendees. Anyone interested in participating can sign up at the RESON booth during the show or contact RESON in advance at sales@reson.com.

Both demonstrations will feature the SeaBat 8125, the world's highest-resolution profiling sonar. The 8125 features 240 real-time focused beams with a center beamwidth of 0.5 degrees. The SeaBat 8125 operates at a frequency of 455 kHz with an effective maximum range of 120 metres. Survey data acquisition and processing will be performed by RESON's NaviSoft Sweep software. NaviSoft Sweep is a complete package for performing multibeam hydrographic surveys, with modules for survey planning, data acquisition, data editing/cleaning, processing, and presentation.

C & C Technologies completes over 5,500 miles of AUV survey lines

C & C Technologies, Inc., a Lafayette, Louisiana-based survey company, announced an outstanding year of accomplishment for its HUGIN 3000 AUV. Since beginning commercial operations in January 2001 for BP, C & C has completed over 5,500 miles of AUV survey lines. The projects completed with the HUGIN AUV thus far have been site-hazard and preliminary pipeline surveys. Although the majority of the 2001 AUV surveys were completed for oil and gas companies with deepwater projects in the Gulf of Mexico, the HUGIN did perform several government site hazard surveys to study the environmental effects of deepwater drilling. To date, C & C is still the only company in the world to offer commercial deepwater AUV survey services.

Over the past year, this innovative survey tool has provided clients with exceptionally accurate data. The improved quality, coupled with the time and cost savings, has given C & C's clients new options that were never feasible with conventional deeptow methods. C & C Technologies employs over 160 employees and provides worldwide offshore and land surveying services.

For futher information contact::
Jay Northcutt
Tel: 337-261-0660
Email: info@cctechnol.com
Website: www.cctechnol.com

C & C Technologies Introduces C-Nav™ dGPS Service

C & C Technologies, Inc. announces that their new C-Nav™ Differential GPS (dGPS) service is now operational. C-Nav™ is a new concept in GPS positioning, where the accuracy at the mobile location is no longer a function of the distance from the reference station(s).

This application is a product of 10 years of research and development. NASA's Jet Propulsion Laboratory (JPL) has conducted the majority of this research in their pursuit to provide centimetre accuracy in space. This technology is now being used to provide sub-metre positioning around the world.

C-Nav™ uses a global network of reference sites strategically located around the world to simultaneously track and monitor the entire GPS constellation. Two independent and redundant Network Processing Hubs (NPH) are utilised to receive raw, dual-frequency GPS, code and phase GPS observable data from the reference sites to calculate orbit and clock corrections for each satellite in the GPS constellation. These corrections are packaged and up-linked to the INMARSAT communication satellites for global broadcast to all C-Nav™ users in real-time.

The C-Nav™ GPS receiver applies the received orbit and clock corrections plus the internally computed, dual-frequency, refraction corrected pseudo ranges to compute a 3D surface position.
For further information, contact:
Dan Galligan Email: dan@cctechnol.com or
Silvio Cuccurullo Email: silvio@cctechnol.com.

Deux Enseignants De L'École Nationale D'Enseignement Maritime et des Pêches de Nouadhibou en Mauritanie en Stage à L'I.M.Q.

Du 15 février au 8 mars dernier, deux enseignants de l'École nationale d'enseignement maritime et des pêches de Nouadhibou, en Mauritanie ont réalisé un stage de perfectionnement en mécanique électronique simulée à l'Institut maritime du Québec.

Durant leur stage, MM. Mohamed Lemine Ould Isselmou Ould Hamza et Brahim Ould Sidi Ould Maham ont pu vérifier leurs connaissances sur le démarrage complet d'un plan de propulsion d'un navire et sur la résolution de problèmes et les actions à prendre en cas de panne. Ils ont aussi été familiarisés avec les techniques d'optimisation d'un moteur de propulsion de navire.

Cette activité de formation à l'Institut maritime du Québec s'inscrivait dans le cadre de l'entente Projet formation en pêche en Mauritanie « Fort-Pêche », financé par l'A.C.D.I. et réalisé dans le cadre du Programme de partenariat des collèges communautaires de l'Association des collèges communautaires du Canada, en collaboration avec le Centre spécialisé des pêches de Grande-Rivière, au Québec.

Soulignons qu'en 2000-2001, l'Institut maritime du Québec a aussi accueilli en stage des enseignants et des dirigeants des écoles nationales maritimes du Sénégal et du Madagascar.

Source : Jean Lavigne, agent d'information
Tel : (418) 724-2822, poste 2024
Email : jlavigne@imq.qc.ca

The Hydrographic Society 2002 Bursary Award Scheme

Applications are now invited by The Hydrographic Society for its 2002 Bursary Award Scheme from qualified students attending, or wishing to attend, a recognised course on hydrographic surveying anywhere in the world including any accredited FIG-IHO Advisory Board on Standards of Competence.

Worth up to £2,000 per annum, the award is intended to help meet tuition fees for an accredited programme of study and is available for either the duration or remaining part of a course. It is open to any student of proven calibre and interest, irrespective of age, nationality or experience. To qualify for consideration, applicants must provide evidence of either a conditional or unconditional course offer from a recognised institution of their choice. Closing date for completed applications is 1 July, with the winner being announced next October.

The Hydrographic Society's annual bursary award scheme is administered under the auspices of its Education Fund, which has so far actively supported more than 30 students and 30 organisations worldwide. Previous award winners have included candidates from France, Indonesia and New Zealand.

Application forms for the 2002 award are available from:

The Hydrographic Society
University of East London
Longbridge Road, Dagenham
Essex RM8 2AS, UK
Tel: 020 8597 1946 Fax: 020 8590 9730
Email: hydrosoc@compuserve.com

Alternatively, they can be downloaded and completed via the Society's website: www.hydrographicsociety.org

RTT Integra Inc.

RTT Integra is a provider of system integration services and offers turnkey monitoring systems for all infrastructure and environmental projects locally, nationally and internationally. Our experienced team of engineers and technicians can assist in the project design stage, selection of instruments, mode of data transmission, installation, start-up, training and technical support. As a member of Roctest, RTT Integra can rely on more than 35 years of experience in the geotechnical, structural and environmental instrumentation fields. The combined resources of RTT Integra and Roctest offer a vast range of high quality products and services ensuring successful completion and operation of all projects.

QUICK, Capt. Lewis Dennis

QUICK, Capt. Lewis Dennis - 89, Yarmouth, passed away Tuesday, October 30, 2001, in the DVA Wing of Fishermen's Memorial Hospital, Lunenburg. Born 1912, in Devon, England, he was a son of the late William and Bessie Anne (Worth) Quick. He apprenticed, starting at the age of 14, sailing the seven seas. He received his masters' papers at the age of 22, later becoming a Master Mariner. He was Master of freighters in the Far East until the Second World War. He joined the Canadian Navy as Lieutenant-Commander and commanded Corvettes and Frigates doing the North Atlantic Run for six years. He held a career in the Canadian Hydrographic Service retiring in 1971. He was married for 55 years to the late Evelyn Fiendel (Bridgewater). He will be proudly remember by his sons, Tony, Hamilton, Ont.; Jim, Raynardton; grandchildren, Sabrina, Natalie, Philip, Ontario; Jacqueline, Dennis, Calgary.

Pacific Region

PLANS & PRIORITIES 2002/03

Client Liaison and Support

In addition to regular duties, the Hydrographic Systems Support Group (SSG) will transfer the multibeam systems from the *R.B. Young* to the *Vector* in Spring, and from the *Revisor* to the *Otter Bay* in Winter. Sonar Systems will test QTC algorithms for the Knudsen sounder, and seabed classification will be incorporated in hydrographic surveys. SSG will continue to act as a national centre of expertise for hydrographic and fisheries acoustics. In addition to normal duties, Sales and Distribution provides a monthly news bulletin for CHS Pacific dealers and provides website support. Ten dealer inspections and ten courtesy visits are performed annually. Oceans Support will be initiated with custom charts, and bathymetric displays will be developed upon demand. Field work may occur in support of Oceans activities. A new version of the Environmental Dataset will be produced.

Geomatics Engineering

Scanning of documents for archival, possible Print On Demmand (POD) actions and digital conversion will continue. Program Integrity II (PI2) money will be used to continue data conversion in support of Source Database loading and in support of other initiatives with the province, the Coast Guard (tsunami modeling), DND, NDI and our other partners or clients. Sourec Database loading and testing will continue (Phase I). Nationally, development of SDB Phases II and III is proceeding with the goal of an operational SDB by the end of the year.

Geomatics Engineering will produce the 2003 editions of the Tide and Current Tables (7 volumes) and respond to numerous requests for observed or predicted tide and current information. The Division will also be responsible for maintaining the national data set of verified tidal harmonic constants, as well as providing support for TCWL tools and the national tides web site. The position of Head, Tides, Currents and Water Levels will be staffed and all tidal activities including the Permanent Water Level network and tsunami response will come under the direction of this position.

Hydrographic Surveys Division

The *Revisor*/EM3000 will perform mainly Revisory Surveys in 2002. The surveys will be broken down into four main project areas: South Coast Revisory, North Coast Revisory, Shore-based & Lake Revisory, and Multibeam projects for external clients (Clio Channel – MEHS, San Juan and Gulf Islands – NRCAN, Lions Gate Bridge – DND, Trail Bay – BC Pilots).

Monitoring, maintenance and upgrades to the Permanent Water Level Network and Emergency Response (Tsunami) gauges will continue before QC of the data and submission to MEDS. In addition, LPTG rust-out migration to Sutron-based portables will continue. Tidal Section will also provide tidal support to the various field projects.

Nautical Publications

Charts currently in production include 2 Patches, 1 Reprint, 14 New Editions, and 3 New Charts. Plans for 2003/04 include 19 Reprints, 11 New Editions, 15 Reruns and 2 New Charts.

In summary, 68 paper chart products will be worked on in the coming fiscal year. This is a combination of regular chart production and extra work being completed with PI2 funds. Approximately 8 to 10 New Editions will need to be produced to incorporate the planned changes to the Vessel Traffic Services scheme in the Juan de Fuca Strait/Strait of Georgia area. Additionally, we are completing production on 16 ENC files this FY and will work on another 21 next FY. Depending on what is completed with PI2 projects, another 10 to 20 ENC files may also require updating.

Sailing Directions is preparing for the release of new SD booklets PAC 200, PAC 205 and PAC 206 early in the new fiscal year. The coming year will see production begin on the remainder of the volumes for the southern coast (Currently covered by BC Vol. 1).

Central and Arctic Region

Hydrographic Surveys in 2002

John Medendorp will be the Hydrographer-in-Charge of a survey on the eastern side of Georgian Bay again this year, operating from *CCGS Griffon*. She will carry five single-beam survey launches working nearby Byng Inlet, Georgian Bay, towards the north-end of chart 2243.

Bob Covey will be the Hydrographer-in-Charge of the Revisory Survey again this year, operating two single-beam launches. Their primary role is to investigate any queries and to collect data on new or changed features in order to update hydrographic charts, electronic charts (ENC's), and publications in production. They will be focusing on gathering updated information for Red Rock in Nipigon Bay, Lake Superior. There will be survey work for charts 1436 and 1437 to resolve discrepancies due to the recent change in the Single Agency Cooperative Charting (SACC) agreement between Canada and the United States. NOAA, Office of Coast Survey, has cancelled chart series 14761 to 14768 and 14999 (Lake of the Woods) meaning that there are now no similar charts published by Canada and the United States. Other survey work will involve areas around Rice Lake on chart 2022, Healey Falls Locks to/à Peterborough; chart 2203, Parry Sound to/à Byng Inlet; and chart 2204, Byng Inlet to/à Killarney.

John Medendorp will continue as Hydrographer-in-Charge of a survey in Lake Temiskaming this summer after the completion of the Georgian Bay Survey. It is anticipated that this survey will operate one multibeam launch and 2 or 3 single-beam launches.

Some history of the lake:

> The recorded history of the area goes back to the early 1600's when both English and French fur traders were active in the area. Fort Temiscamingue, on Lake Temiskaming, was established by the French in 1695. Missionaries and loggers were active on the lake as early as the 1830's, but the first permanent settlement was at the present town of Haileybury in 1885. Several townships were surveyed in 1887, and during the 1890's settlers, most from "Old Ontario", moved into the agriculture areas of the "Little Clay Belt" north of New Liskeard. Settlement was accelerated when the Temiskaming and Northern Ontario (T&NO, now known as Ontario Northland) Railway arrived at Lake Temiskaming in 1904, but the railway also brought with it the discovery of silver at Cobalt, resulting in a mining boom, which in subsequent years spread to Elk Lake (1906), Gowganada and Larder Lake (1907) and to Kirkland Lake in 1911.

- *excerpt courtesy of the Temiskaming Genealogy Group.*

Paola Travaglini will take charge of a variety of Multibeam surveys that will be operating this year in Hamilton Harbour, Tobermory and Lake Ontario.

Jon Biggar will be the Hydrographer-in-Charge of Arctic surveys this year. The *CCGS Nahidik* will continue work in the Beaufort Sea, running one multibeam launch and one single-beam launch in a joint CHS/Geological Survey of Canada program. Tim Janzen, aboard the *CCGS Des Grossiers*, will run one single-beam launch this summer. This work will aid communities around Nunavut for re-supplying communities near Hudson Strait and Fox Basin.

Ron Solvason, Manager of the Tides, Currents and Water Levels (TC&WL) section, will establish permanent gauging stations at Holman and Alert. Additionally, a reconnaissance survey for a possible gauge installation for Pond Inlet will be conducted.

Charting in 2002

Charting activities this year will continue to focus in four areas: New Charts; updating current editions of charts; new Electronic Charts (ENC's) resulting from paper charting activities; and a New Edition of Sailing Directions.

New charts near Parry Sound and Georgian Bay (2224 and 2242) will begin production this year.

There will be a variety of New Editions developed this year as well. Chart 2120, Niagara River to/a Long Point, and Chart 2245, Beaverstone Bay to/a Lonely Island and/et McGregor Bay. Two charts in the Trent-Severn extending from Peterborough to Bobcaygeon (2023 and 2024) will be worked on to incorporate new data. New Editions of Chart 2042, Welland Canal and Chart 2011, Belleville Harbour are also in the plans.

Additionally, 13 New Editions are planned for Lake Superior charts to bring them on-datum.

New charts to be available this year will be the suite of Lake-of-the-Woods charts which have been redesigned featuring back-to-back printing, waterproof paper and a new folded format. New Chart 5505, Belcher Islands to/à Cotter Island has just been released. New Chart 1431, Canal de Beauharnois – Lac Saint-Louis au/to Lac Saint- Francois, will be released this year. The Sailing Directions Office is working on an updated edition for the Ottawa River and Rideau Canal.

New Electronic Charts (ENC's) will be developed based upon the charting activities mentioned above.

The New Chart of Bathurst Inlet, 7793, is close to being completed. New Chart 5642, Whale Cove, is in CHS Ottawa for review. Other charts in the works are 5630 and 5631.

ISO9001:2000

As announced in the Fall / Winter 2001, edition 60 of Lighthouse, CHS has been successful in achieving registration to the ISO9001:2000 International Standard for Quality Management. The National Project Leader, Sean Hinds, and the Regional Quality Coordinator, Mike Johnston, received the Assistant Deputy Minister's Commendation Award in recognition of this great achievement.

Mentoring Program

CHS has developed a Mentoring Program. Mentoring is a supportive learning relationship between an individual (the mentor) who shares his or her knowledge, experience, and insights with another less-experienced person (the protégé) willing and ready to benefit from this exchange. The nature of this relationship varies with the personal styles of the partners. The program has met with great success within the region and is spearheaded by Norah Prince.

Atlantic Region

Hydrographic Surveys

CREED Program

In October and November 2001, multibeam surveys were conducted in the Bras d'Or Lakes with the *CCGS FREDERICK G. CREED* and the survey launch *Plover*. The work is part of CHS's continued support of a DFO Science initiative called SIMBOL (Science for Integrated Management of the Bras d'Or Lakes). SIMBOL is a multi-disciplined, scientific approach to enhancing knowledge of the Bras d'Or Lakes watershed to address stakeholder concerns identified at Bras d'Or Lakes Ecosystem Workshop held at the Canadian Coast Guard College in Westmount in October 1999. Now in its second year, SIMBOL has enabled historical data rescue, benthic habitat mapping, moorings to monitor winter processes, satellite data extraction, DFO and Environment Canada water quality monitoring, surveys of green crab distribution, and data collection using Compact Airborne Spectrographic Imager (CASI). Much of the work has been done in cooperation with the Eskasoni Fish and Wildlife Commission (EF&WC), a non-profit First Nations scientific group that has conducted several years of research on the ecosystem health of the Bras d'Or Lakes. Several memorandums of understanding have been signed between BIO and the EF&WC to enable cross training, information sharing, resource sharing, and personnel exchange.

CCGS FREDERICK G. CREED

The first three weeks of the survey were conducted with the *CREED*'s EM1000 system and included CHS personnel Paul Parks, Claudine Fraser and Jon Griffin, as well as Jason Pierro from the EF&WC. All the data collected was in East Bay with the homeport located in St. Peters. The last 2 weeks of the survey were conducted with the *Plover's* EM3000 system. The primary areas of data collection were in St. Peters Channel and the main shipping channel into Eskasoni. The CHS survey staff included Andrew Craft and Carmen Reid, with visits from Bruce MacGowan, Doug Frizzle and Mike Collins. There were also staff members from Helical Systems Ltd. and Quality Positioning Services (QPS) to conduct in-the-field training for several new software tools designed for multibeam data collection and processing.

The launch was outfitted with a new data collection system called QINSy (Quality Integrated Navigation System) which was assessed during the survey. The QINSy system offers several quality control tools during data collection, uses real-time kinematic positioning for on-the-fly tidal corrections, and logs the multibeam in .sds format. The other software modules that are currently being assessed were provided by Helical Systems, which enables the multibeam data to be contoured, suppressed, and converted into S-57 format using a batch file commands. In the coming months, a test site will be processed using the new tools and compared with S-57 output produced via the .ntx route. If successful, the QINSy/Helical software suite will enable the production of S-57 ENCs in the field.

MATTHEW Program

John Cunningham and Kirk MacDonald are completing the *CCGS MATTHEW*'s NotreDame Bay data quality checks. Glenn Rodger and Kirk MacDonald are completing the shoreline. The survey data should be completed by end of January at which time all field documents will be submitted. The colour proof of 4821 is due to be in Ottawa by mid May. Andre Roy reports that all his field documents have been submitted and that there is a new edition well underway for Red Bay. The new edition of the St. Anthony chart has also been started.

DND Route Survey is currently assisting the OMNI group in the processing of the NotreDame Bay data collected by the *CCGS MATTHEW*.

On-Datum Chart Project

The project bade farewell to Tom Rowsell in early December as he left for rockier pastures with his new position as NDI - CHS Liason. Steve Forbes has taken over the lead.

Steve Grant has been added to the list of prestigious team members as facilitator. The team is currently developing ISO procedures in the form of a project charter and these will be available soon. New equipment has been and is being purchased (better hardware, and new IRAS/B licenses).

Doug Regular has also joined the group with 17 orphan datum charts that require bilingualization. We thought it best to merge the projects to form 'Team OnDatum / Bilingualism'.

At the moment we are maximizing the number of charts we are putting through to the contractors and have 20 charts being worked on between Nautical Data International (NDI) of Newfoundland and Geonet (PEI). Mark McCracken has created some management tools in the Planning Database to help with the tracking of charts and modelling of priorities. Once the process has settled down, records will be uploaded into CHSDir. We expect to get 60 charts through the first phase of the project (put on-datum and add magnetics) before the end of the fiscal year. Phase 2 of the project will complete the updating of the safety data, symbology, notes, etc.

Tidal Section

Steve Grant was contracted by HQ to undertake a national review of the Tide Tables. Steve is looking at possible changes to the existing format and methodology to improve secondary port calculations. He is also testing for consistency with digital predictions and will be canvassing various user groups for product feedback.

Ocean Sciences Division has made great headway on developing a 5-constituent tidal model for the North West Atlantic. Interestingly, this model had predicted a "renegade" data set in Northern Labrador; subsequently the suspected error was independently verified through in-situ measurements. Future plans for this research include extension to a 10-constituent model and the inclusion of tidal current predictions. CHS is a primary partner for this work and expects significant benefits in increased spatial resolution of tides / currents prediction, as well as enhanced capacity for reduction of offshore multibeam surveys.

Survey support continues with Glen King analyzing data from temporary tide gauges at La Scie, Nippers Harbour, Leading Tickle and Triton in Newfoundland. Two Sutron sensors showed signs of drifting, however there was sufficient redundant data to perform tidal reductions for the attendant hydrographic surveys. Fred Carmichael will be looking into the source of the problem. Three more stations remained to be analyzed.

Fred Carmichael and Charlie O'Reilly traveled to Belledune, NB to perform site maintenance and repair of a faulty wind sensor on behalf of the local Ports Canada harbour authority.

Glen has reviewed and edited tidal notations for approximately 30 charts as part of the PI2 On-Datum and bilingual charts initiatives.

The town of Dieppe has been reporting significant sewage problems due to the changing nature of water levels on the Pedicodiac River. A review of our chart and tidal files reveals that the knowledge of area water levels is almost 100 years old! Consequently, a tidal survey is being planned for the upcoming field season.

The Permanent Gauge Site at Nain installed in September is now operational. Telephone communication has been established, with good data return.

As part of two RCMP investigations, tidal staff provided advice, detailed tidal predictions, photographs, and on-site assistance regarding the fire at the Two Rivers wharf (Joggins) in which we lost a temporary tide gauge installation. Subsequently, we provided similar information concerning the fatal accident in which a car drove over a cliff in the same area on Christmas Eve. The RCMP was looking for insight into the timing of both events.

The PI2 funded GPS-on-Benchmark survey is in full swing with NRCAN. All Maritime sites would be completed by March 31, 2002.

PRAIRIE SCHOONER BRANCH

Of note to the geomatics profession in 2001, the groundbreaking occurred for a new research building for the University of Calgary Faculty of Engineering, in which there will be a new navigation laboratory and an antenna range on the rooftop. The Calgary Centre of Innovative Technologies will be completed in fall 2002 and will significantly enhance the positioning and navigation capability of the Department of Geomatics Engineering.

The individual members continued to pursue their careers in 2001.

Glen Belbeck continued with Shell Canada as a member of the Geophysical Operations team. He provided geomatic advice to internal Shell clients, concentrating on marine navigation and other frontier issues. In October, Glen added the position of Seismic Broker to his tasks, which involved managing the sale and purchase of geophysical data for Shell Canada. He also sits on several CAPP committees dealing with O&G industry issues.

Andrew Brebner is alive, well and emerging from his 13th winter in Yellowknife, NWT with his wife, 4 children, 3 dogs and 2 cats. Having been with the Federal Government for the last 6 years, Andrew is currently working with Legal Surveys Division (LSD) of NRCAN as Head of Cadastral Services, North. April 1, 2001 saw the review of oil and gas surveys in the Northwest Territories and Nunavut under the Canada Oil and Gas Land Regulations transferred from Ottawa to the Cadastral Services Unit, LSD office in Yellowknife.

John Brigden worked as a Nav QC in the Gulf of Mexico for pipeline route and wellsite investigations using AUV and high resolution survey vessels; and offshore Nova Scotia and Newfoundland for several 3D seismic programs conducted by multi-streamer, multi-source vessels.

Bruce Calderbank spent the winter on the North West Shelf Australia, and the spring offshore Nova Scotia as a Nav QC for marine 3D seismic surveys. This was followed by further Nav QC work for a couple of Ocean Bottom Cable seismic surveys off the east coast of Scotland in the fall. While in Houston to give a paper at the local Hydrographic Society of America chapter, Bruce was contracted to provide consulting services to the Canyon Express pipeline installation.

Elizabeth Cannon was involved in the assessment of the benefits of the emerging European Galileo satellite navigation system to Canada. This work, sponsored by the Canadian Space Agency, was a collaborative effort between the University of Calgary, the federal government and Canadian industry. The work resulted in a final report that was presented in May to the European Commission in Brussels.

Fred Cheng continued with UMA as the Geomatics Manager. He was appointed to the Board of Examiners for the Alberta Land Surveyors' Association; the Board of Directors for the Alberta Geomatics Group; and the Advisory Committee for the Geomatics Engineering Technology of the Lethbridge Community College.

Mike Chorney continued with Shell Canada working out of Halifax on a rotational basis as the offshore Onondaga well logistics co-ordinator, which provided all sorts of new learning opportunities and challenges.

Alex Hittel continued expanding All-Can Engineering & Surveys, with work in Northern Alberta and elsewhere.

Gerard Lachapplle was awarded a Canada Research Chair and an iCORE Chair in Wireless Location. He was also the Program Chair for GPS01 in Salt Lake City held between 11 and 14 September, which was particularly challenging in view of the September 11 tragedy.

Paul Sawyer provided construction management services to clients in British Columbia, West Virginia and Texas. Plans for 2002 include a newly signed contract to supervise the rebuild of a ship loader in Chile.

David Thomson continued expanding the renamed Challenger Geomatics, with work in Northern Alberta and elsewhere.

Wendy Watson of Point Inc was involved with development release of 5 GPS-based products for surveying and mapping.

Frank Wisker continued as the marketing representative for Ashtech.

PACIFIC BRANCH

2001

CHA Pacific membership was 53 regular members, 2 life members, 1 retired member, and 1 corporate member (down 3 members from last year). There were two seminars in 2001: one luncheon by Bill Crawford at Glen Meadows and one by Terra Surveys at IOS (including pizza and pop). Social events included a bowling evening, and a curling bonspiel (a joint venture with G.A.C. - the BC geological association). Attendance from CHA was minimal, and the events were not regarded as being highly successful. The plaque for the Wille J. Stewart, which was installed last year, came loose and had to be re-installed. Maintenance of this plaque will be an ongoing expense for CHA.

2002

Election of Officers – all by acclamation
Vice-President - Dave Gartley; Secretary/Treasurer - Sherman Oraas, Executive - Craig Lessels, Allan Thorn, Past Vice-President - James Wilcox.
Al Smickersgill and Brian Schofield were thanked for their efforts over the past years.

The Hydrographic Society

- serves the interests of the world hydrographic surveying community
- promotes knowledge and expertise at symposia, seminars and workshops
- supports improved standards in education and training through Education Funds and Award Schemes
- publishes both the prestigious quarterly Hydrographic Journal and other specialist literature
- provides vital worldwide links between Corporate and Individual Members – and employers and employees
- offers a wide range of additional information and services at www.hydrographicsociety.org

The 13th International Conference & Exhibition of The Hydrographic Society

HYDRO 2002

in association with Deutsche Hydrographische Gesellschaft

8–10 October 2002
Kiel, Germany

www.hydro2002.org

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W: www.hydrographicsociety.org

Dave G. is trying to renew interest in the branch with a summer BBQ and more seminars/socials for 2002. The first luncheon is planned for April. CHA has traditionally given stickers annually to paid-up members, however, CHA National no longer supplies them. CHA Pacific membership wants to continue this. Bruce Johnson volunteered to produce the stickers using common PC software, and Brian Watt volunteered to assist with the graphics. The CHA Pacific website needs to be updated and, with the assistance of a student volunteer, the branch is making a solid attempt to make the necessary improvements.

CENTRAL BRANCH

The CHA Central Branch executive is organized into five distinct Committees, each tasked with maintaining certain functions of the Branch. They are: Communications and Publicity; Membership; Admiralty Launch Surveyor; Education and Development and Social Events. Here's what's been going on since we last reported in Lighthouse 60.

Seminars

Last fall, Andrew Leyzack gave a photo-presentation of the 2001 Western Arctic survey in the Beaufort Sea, a joint CHS/Geological Survey of Canada program.

We held our last general meeting of 2001 at Thirty-Bench Winery, in the Niagara wine Region of southern Ontario, where host Franz Zeritsch presented the flavours of their fine vintage wines and a tour of the facility.

Three general meetings have been held this spring with seminars given by retired Regional Director, Earl Brown who spoke of CHS surveys in the British Virgin Islands; Central Region hydrographer Daniel Brousseau, who gave a presentation on Remote Sensing Applications in hydrography; and by present CHS Regional Director, Dennis St. Jacques on the International Federation of Surveyors (FIG).

AGM

The 12th Annual General Meeting and Dinner of the CHA, Central Branch was held December 6, 2001 at the Mimico Cruising Club, Etobicoke. The new Central Branch executive was announced with a new VP, Tim Janzen, at the helm, Secretary - Earl Brown; Treasurer - J. "Sam" Weller; Executive Members - Fred Oliff, Brian Power, Scott Youngblut, Jim Weedon, Past Vice-President - Andrew Leyzack.

The guest speaker was Michael Peake, who is Editor of Che-Mun, the journal of Canadian Wilderness Canoeing and Governor of the Hide-Away Canoe Club. Special thanks to our speaker, to our sponsors, and to the Mimico Cruising Club for making this fine annual event a great success.

Member News

Branch members Carol Robinson and Jim Weedon have recently joined CHS Central and Arctic Region as full-time employees. Congratulations to Carol and Jim. George Fenn, recently on assignment as the Manager of Product Maintenance, has accepted a one-year assignment with Corporate Services, Real Property Management in Burlington.

H2O

On February 23, 2002, Central Branch hosted their 31st Annual H2O Bonspiel. Once again, the spiel was held at the Grimsby Curling Club. 64 curlers participated in the bonspiel and all reports indicate that everyone had a fine time. The winning rink of the "A" event was lead by Rick Kirluk from Fisheries and Oceans', Habitat Management and his crew: Andy Thompson, Brent Valere and Elaina Gendron. Bringing home the trophy in the "B" event was skip, Brian Power and his crew Austin Rodgers, Jason Power and Scott Youngblut. The ice was excellent, the food was superb, the drinks were cold and the comradery was great.

Ab Rogers (left) with Bradley Zelenyt.

You are never too young or too old to curl: Bradley Zelenyt was celebrating his ninth birthday on Saturday by curling with Ab Rogers, who has seen eight decades come and go. Ab Rogers, a CHA member and long-retired Hydrgrapher of the CHS, still curls regularly.

2002 Coastal Multibeam Sonar Training Course

Under the direction of Paul Davies, the 2002 Coastal Multibeam Training Course is about to get underway. The course will be held May 22 through 27 at the Travelodge Hotel in downtown Burlington, Ontario. This course, which will be given by Drs. John Hughes Clarke, Larry Mayer, Dave Wells and Christian deMoustier, continues what has become one of the best sources for multibeam sonar training worldwide. Although it will be mostly intensive classroom time, the six-day course will include an afternoon of on-the-water demonstrations from manufacturers such as Reson and Kongsberg Simrad.

For more information, check out http://chswww.bur.dfo.ca/cha-mb2002.

Rates Tarifs

POSITIONING / EMPLACEMENTS

The acceptance and positioning of advertising material is under the sole jurisdiction of the publisher.

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur.

DIGITAL REQUIREMENTS
EXIGENCES NUMÉRIQUES

Advertising material must be supplied by the closing dates as digital Tiff 600dpi files. Proofs should be furnished with all ads.

Single-page inserts will be charged at a full-page body rate. Material must be supplied by the client. Page size must conform to the single page insert trim size (below).

L'annonce publicitaire doit être fournie aux dates de tombée. Les épreuves devraient être fournies avec tous les suppléments.

Les insertions d'une page seront chargées au tarif d'une pleine page. Le matériel devra être fourni par le client.

PUBLICATION SIZE
DIMENSIONS DE LA PUBLICITÉ

Publication Trim Size/ Dimension de la revue:	**8.5"**	**x**	**11.0"**
Live Copy Area/ Encart libre:	**7.0"**	**x**	**10.0"**
Bleed Size/ Publicité à fond perdu:	**8.75"**	**x**	**11.5"**
Single Page Insert Trim Size/ Insertion d'une page:	**8.25"**	**x**	**10.75"**
Standard Ad Sizes/ Grandeurs standards des suppléments:			
Full Page/ Pleine page:	**7.0"**	**x**	**10.0"**
1/2 Page/ Demie-page:	**6.875"**	**x**	**4.75"**
or/ ou:	**3.375"**	**x**	**9.75"**

PRINTING / IMPRESSION

Offset screened at 133 lines per inch.
Internégatif tramé à 133 lignes au pouce.

CLOSING DATES / DATES DE TOMBÉE

LIGHTHOUSE is published twice yearly, in Spring and Fall. The closing dates are March 15th and September 15th respectively.

LIGHTHOUSE est publiée deux fois par année, au printemps et à l'automne. Les dates de tombée sont le 15 mars et le 15 septembre respectivement.

RATES / TARIFS

All rates are quoted in Canadian Funds. Sustaining Members receive a 10% discount.

Tous les tarifs sont en devises canadiennes. Les membres de soutien ont droit à un rabais de 10%.

	B & W/ N & B	Colour/Couleur Four/Quatre
Outside Back Cover *Couverture arrière*	NA/SO	$1,025
Inside Cover *Couverture intérieure*	NA/SO	$825
Body, Full Page *Pleine page*	$275	$675
Half Page *Demie-page*	$200	$475
Single-page Insert *Insertion d'une page*	$275	$675
Professional Card *Carte d'affaire*	$125	NA/SO

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Advertisers will be protected at their contract rates for the term of their contracts up to one year. Cancellations are not accepted after closing date.

Les tarifs sont assurés aux termes des contrats publicitaires jusqu'à concurrence d'un an. Les annulations ne sont pas acceptées après la date de tombée.

All advertising material should be directed to:
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HINTS TO AUTHORS

LIGHTHOUSE publishes material covering all aspects of hydrography. Authors submitting manuscripts should bear the following points in mind:

1. **Submit a hardcopy complete with graphics including tables, figures, graphs and photos.**
2. **Submit digital files, one with text only and a separate file for each graphic (tables, figures, photos, graphs) in its original form or in .tif format (600 DPI). Photos may be submitted separately to be scanned. These may be submitted via E-mail or on CD ROM to the Editor.**
3. **Papers should be in either English or French and will be published without translation.**
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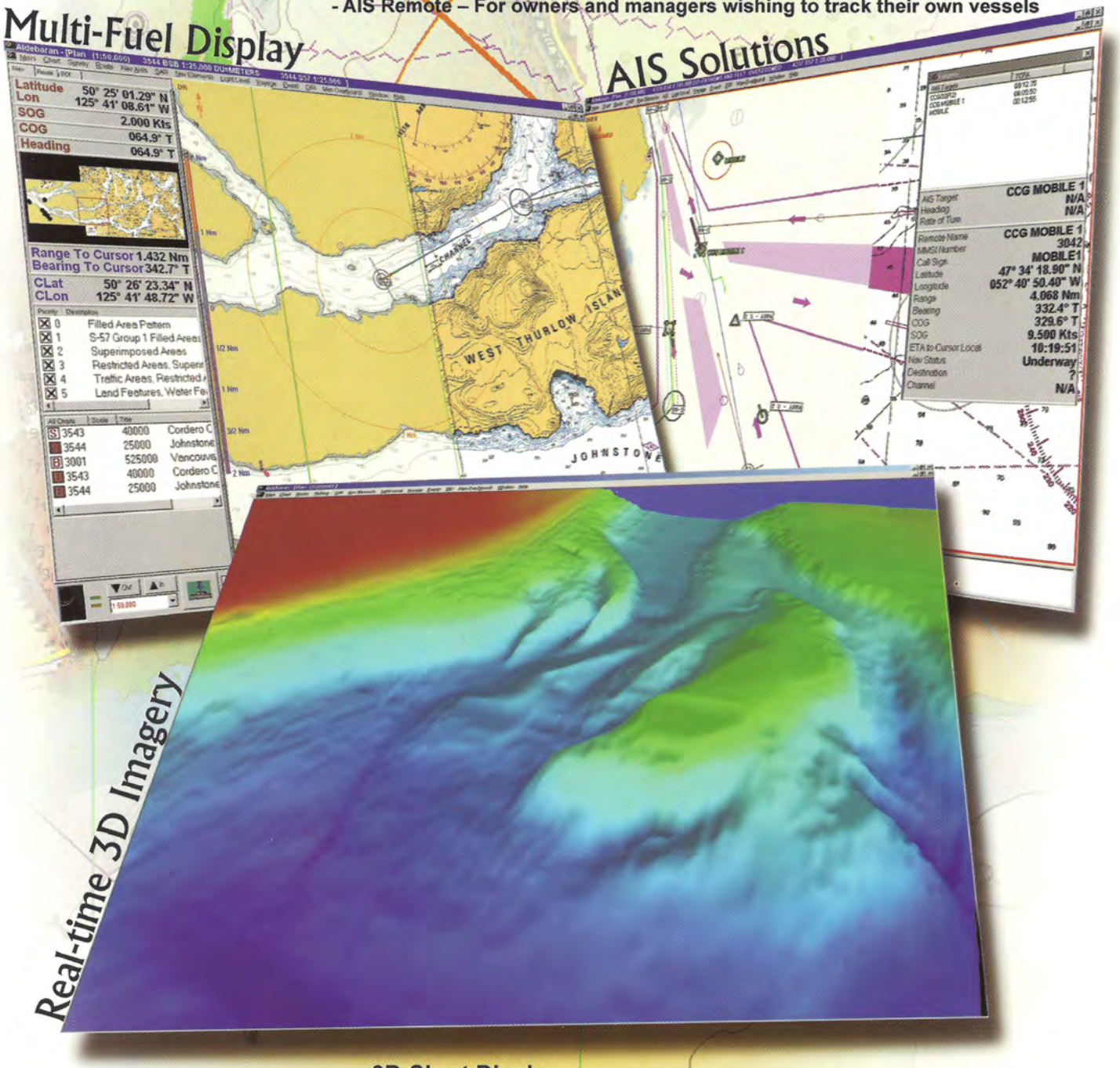

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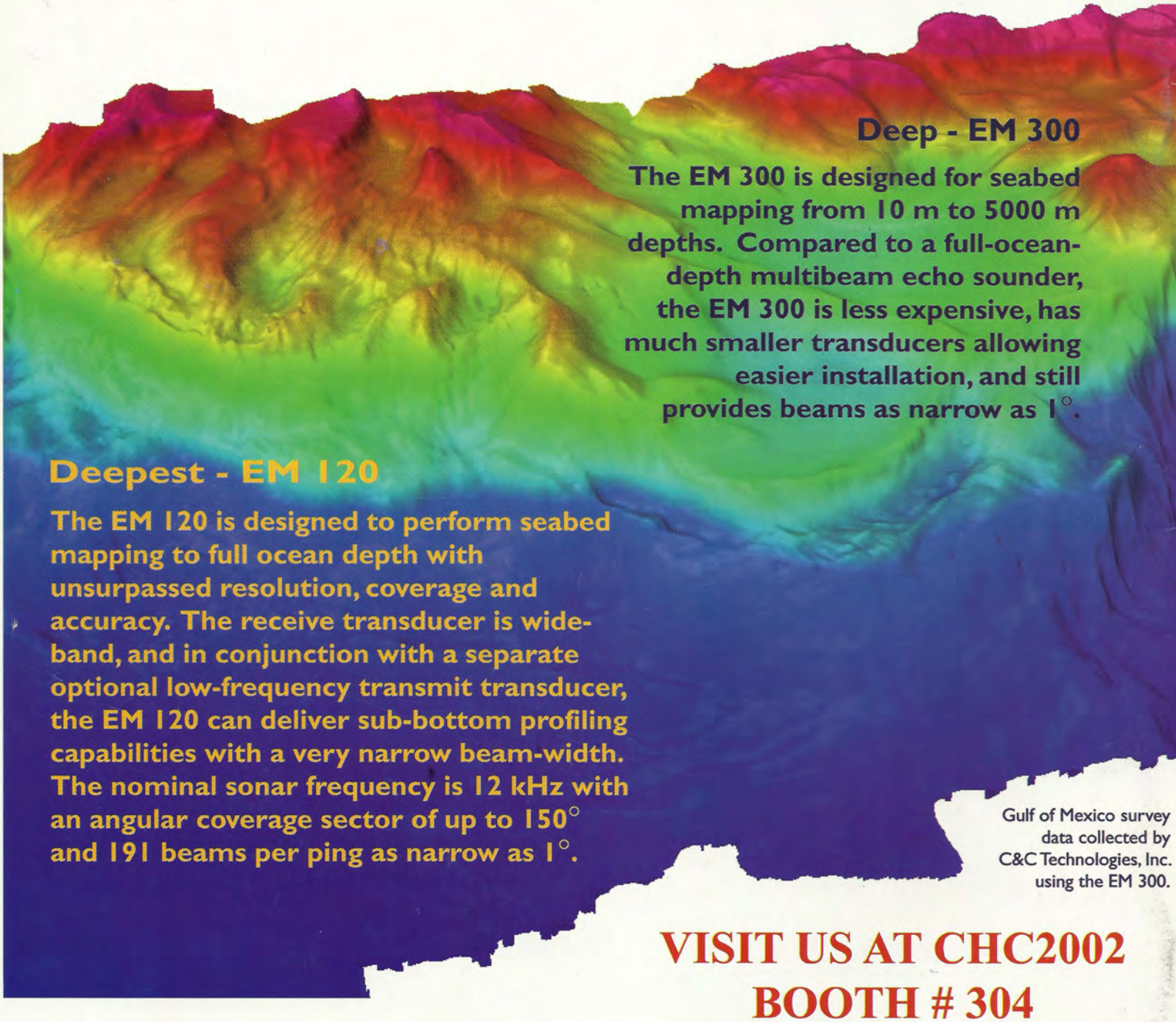

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Gulf of Mexico survey data collected by C&C Technologies, Inc. using the EM 300.

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