The Goose Gazette

The newsletter of the *Wild Goose Association,*
the international **loran** radionavigation forum.

Volume 92-3 - News of the Summer, 1992

President's Message

Just a short note to the membership to highlight the past Convention and Technical Symposium and to set the stage for the coming years' meetings.

The 21st Annual meeting, in Birmingham, England was a great success! Technical sessions were excellent as usual, but with much increased European participation. As was expected, several papers dealt with the Loran-C coverage expected in Europe, and with the interference situation there.

The keynote address, by Jacques deDieu, Minister for Transport of the European Community, set a positive tone for the entire meeting. Mr. deDieu stressed the EC's support for Loran-C and indicated that this support extends to the development of receivers as well as transmitter chains.

Proceedings will be available from the WGA Operations Center as soon as printing is complete. A call to (614) 797-2081 (followed up by the usual check) will get a copy reserved for early mailing to you.

As expected, members took full advantage of the tours and special events at historic sites near Birmingham. The "medieval dinner" at Coombe Abbey was a bit messy, but much fun. We were honored with a Civic Dinner by the Lord Mayor of Birmingham and by his presentation of a beautiful glass vase engraved with the WGA logo.

I'll use this space to extend thanks to John and Marilyn Beukers for leading the 1992 convention and putting the details together in Birmingham. This is just one more of the long list of contributions by the Beukers to the WGA.

Upcoming WGA meetings and contact people:

1993 - Santa Barbara - John Illgen

1994 - New England - Bahar Uttam

For 1995, we have agreed in principle that this meeting will be held in Russia. At this time, we don't know whether St. Petersburg, Moscow or some other site will be chosen. WGA has asked for a proposal from Russian representatives, and Jim Alexander will help us evaluate their response.

Welcome to your Association's twenty-first year!

Bob Lilley

Northern European Loran-C Agreement

On 6 August, 1992, representatives of Denmark, France, Germany, Ireland, the Netherlands, and Norway met in Oslo and ratified an agreement to extend and operate the northern European Loran-C system. The U. S. Coast Guard has funded the Loran system in Europe for the Department of Defense; host nations operate most of the transmitting stations. DOD has stated that its requirement for Loran-C will cease in 1994; this agreement verifies that Europe plans to use Loran-C as an integral part of their navigation system mix.

The Commonwealth of Independent States has been granted observer status, and plans to meet with France, Germany, and Norway to discuss joint operation in Europe with their Chayka navigation system. Tests in the northwest Pacific have shown that this is possible, and the Coast Guard plans to operate jointly with Chayka as the GRI 5980 chain. Russian engineers have made minor modifications to the Chayka signal to allow it to be used by Loran-C receivers.

Iceland has decided to use GPS as its only navigation system. This removes the link with Canadian Loran-C. Other nations are unwilling to depend on a single system, over which they have no control. Great Britain has decided to continue using the Decca land-based system, but will reap the benefits of extended Loran-C coverage. There is a possiblity that Iceland and Great Britain will join the agreement at a later time.

Navigators have learned through bitter experience that total dependence on any one system is folly. This agreement ensures that European navigators will share the same advantage that we are starting to enjoy in the United States: two independent, accurate, full - time navigation systems.

The Goose Gazette is an official publication of The Wild Goose Association (WGA). The Gazette is published quarterly, with cutoff dates of 1 March for the Winter issue, 1 June for the Spring issue, 1 September for the Summer issue and 1 December for the Fall issue.

Address correspondence for the WGA to the new Operations Office:
Dr. Robert W. Lilley
Wild Goose Association
150 S. Plains Road
The Plains, Ohio 45780
(614) 797-2081 voice and Fax

Dr. Lilley also may be reached at:
Ohio University
Avionics Engineering Center
Athens, Ohio 45701
(614) 593-1514
Fax: (614) 593-1604

The WGA encourages readers to submit material for publication. Send information directly to the Editor:
Capt. Bill Brogdon
506 W. Washington Ave
Kinston, NC 28501
(919) 527-9349

Printer:
Messenger Publication Service
Athens, Ohio 45701

The association's permanent address is:
The Wild Goose Association
P. O. Box 556
Bedford, Massachusetts 01730
(516) 862-7500

Board of Directors

WGA Charter

"The Wild Goose Association is formed to provide an organization for individuals who have a common interest in Loran and who wish to foster and preserve the art of Loran, to promote the exchange of ideas and information in the field of Loran, to recognize the advances and contributions to Loran, to document the history of Loran, and to commemorate fittingly the memory of fellow Wild Geese."

Dr. Johanssen Retires; Roland New Megapulse President

Dr. Paul R. Johanessen, founder of Megapulse, Inc. of Bedford, Massacheutts, retired from the position of President on 1 October, 1992. He remains Chairman of the Board and Vice President of Research and Development.

Captain William F. Roland, USCG (retired) succeeds Dr. Johannessen as President. Billwas involved in design, development, and installation of Loran-C systems during his 30-year Coast Guard Career. Since retirement, he has been Sales Manager for International Sales of Power Plant Systems.

Megapulse is the only designer and manufacturer of solid state Loran-C transmitters. The new president expects continued growth due to international acceptance of Loran-C and from expanded product lines and services.

When You Publish

We would like to let each other know when WGA members publish articles and papers, either in scientific journals, society meetings, or the popular press. If you will send the details and a copy of the article to the association's operations office. We will try to keep track of them and announce significant ones in the Gazette. Ed.

New FAA Aircraft Receiver Approvals:

Arnav FMS 5000, Loran/GPS: IFR TSO C60b and C115a

Bendix/King KLN-88: expanded IFR approval in Canada and Alaska

II Morrow Apollo navigation management system, Loran/GPS: Multiple SCT approval, day and night VFR

Trimble GPS/Loran receivers: TSO C60b and C115a

Federal Radionavigation Plan Update

The Department of Transportation Research and Special Projects Administration is revising the Federal Radionavigation Plan, and expects to publish the new FRP late this year or early in '93. There are several items of interest to WGA members:

DRAFT new definition of Predictable Accuracy: "The accuracy of a radionavigation system's position solution with respect to the charted solution. Both the position solution and the chart must be based on the same geodetic datum. (Note: Appendix B discusses chart reference systems and the risks inherent in using charts in conjunction with radionaviagtion systems.)"

DRAFT new definition of Relative Accuracy: "The accuracy with which a user can measure position relative to that of another user on the same navigation system at the same time."

DRAFT new policy: Loran-C will remain part of the radionavigation system at least until 2015.

All of these statements are in draft form. Some have not received Agency approval, much less Department or coordinated approval. The Predictable Accuracy draft statement stems from issues raised by WGA members and the public. We also have reports of two Navy ships going aground by relying on GPS alone rather than backing up GPS by visual or radar fixes. However, rather than changing the predictable accuracy distances, DOD apparently has decided to change the definition. It is unclear how the cautionary sentence fits into the definition; in many parts of the world it is impossible to meet. It also is unclear how much if any of the error budget is due to charting inaccuracies, and how much is due to datum transformation errors.

The new FRP definition of relative accuracy is considerably different from the previous definition. With GPS Selective Availability apparently near the 100 meter level, we often saw three different positions from three different make receivers at the same spot. Usually the differences were 0.01-0.03 minutes of latitude or longitude. These differences aren't constant; successive fix plots follow trails which bear no simple relationship to one another.

It is not unusual to see different makes of Loran-C receivers aboard the same boat differ by 0.1-0.2 microseconds, but the differences are nearly constant. Relative accuracy for Loran-C, however, should remove the seasonal and diurnal effects, and be better than repeatable accuracy. The FRP shows both to be 20-90 meters.

The repeatable accuracy definition is unchanged, but two philosophical approaches have developed. One group holds that repeatable accuracy only applies when there is something nearly constant to measure, like Loran-C TD's. The other group feels, just as strongly, that regardless of the character of the measurements and calculations, successive positions displayed by the receiver at a fixed location produce a plot which represents the system's repeatability. This can apply to natural as well as man-made systems. Does anyone have any data on any of these subjects? Opinions?

LORAN-C and the FRP

The Coast Guard has proposed **strong support** for Loran-C in its draft FRP policy statement, to alleviate "growing concern among Loran-C users that their time-tested navigation system will be eliminated in the near future. ... The Coast Guard continues to fully support, improve, and expand Loran-C facilities in the continental U. S. and Alaska. ... Due to the very large size of the Loran-C user community, continued reliance on Loran by foreign governments, and new non-navigaitonal applications, Loran-C is expected to be around at least until 2015."

New Loran-C Chart Information

The U. S. Coast and Geodetic Survey is adding Loran-C lines of position to nautical charts to meet user requests in the Pacific Northwest, and to reflect usable baselines from the South Central Chain, 9610, in the Gulf of Mexico. The following charts should be available near the end of the year:

Chart 18421, 1:80,000; Straits of Juan de Fuca and the Straits of Georgia. Shows Loran-C coverage in Puget Sound, GRI 5990, Y and Z. Chart 18465 Loran-C lattices do not match 18421 correctly, and will be adjusted at next printing.

Charts 11301 to 11344. All of these 1:80,000 scale charts, for the area from Brownsville, TX to western Louisiana, will have 9610 TD's added, along with the existing 7980 TD's.

11301 Southern Part of Laguna Madre
11304 Northern Part of Laguna Madre
11307 Aransas Pass to Baffin Bay
11313 Matagorda Lt. to Aransas Pass
11316 Matagorda Bay & approaches
11321 San Luis Pass to Matagorda Bay
11323 Approaches to Galveston Bay
11332 Sabine Bank
11341 Calcasieu Pass to Sabine Pass
11344 Rollover Bayou to Calcasieu Pass

NOAA added the 9610 TD's to these charts based on excellent crossing angles and gradients, but needs additional information concerning usability and signal strength in the areas which they cover. Anyone having information on the usability of these rates please notify Mr. Jeff Stuart, NOS, at 301 443-8157.

ACCURACY MEASURES

Changing FRP definitions of accuracy will make it more difficult than usual to compare research, especially work done at various times. We propose that ION take the lead in defining statistical measures of accuracy, to avoid many of today's apples-oranges comparisons.

GPS Selective Availability

The Wild Goose Association and its interest in Loran navigation is affected by decisions affecting GPS, and we will attempt to keep our members informed concerning decisions affecting that navigation system. In response to a recent letter from WGA member Henry Marx, The Assistant Secretary of Defense for Command, Control, and Communications, Duane P. Andrews, has given a clarification of Selective Availability policy :

"Your letter...notes that civil accuracy, created through implementation of Selective Availability (SA), is insufficient for precision aircraft approaches and requires that the U. S. Coast Guard employ countermeasures such as differential GPS (D- GPS). Neither of those assumptions is correct. GPS was not designed as a precision approach aid for aircraft. The civil accuracy is sufficient for en route and non-precision approaches. Augmentations such as D-GPS are being developed to satisfy requirements for precision beyond what is directly available from the system. They are decidedly not being developed solely to correct for DOD implementation of SA. Removal of SA would result in a civil accuracy of 20-30 meters, a marked improvement for unauthorized military use but still not precise enough to meet the civil needs which are driving D-GPS. D-GPS is being developed by the Coast Guard and investigated by the Federal Aviation Administration and land users to meet precise dynamic navigation needs in the range of 10 meters or less.

"Our long-standing and widely publicized policy on separation of military and civil GPS accuracies is increasingly valid in today's security environment, even with the dissolution of the Soviet Union. The notion that war is unlikely, given the current worldwide political climate, is highly debatable. Other combatants and potential adversaries, including terrorists, are fully capable of directly exploiting the precise GPS signals should SA be removed. GPS was designed to provide continuous, worldwide positioning as a force enhancement tool for the DOD. Its precise signal creates a very valuable military benefit for anyone who can receive it, and we strongly believe that removal of SA would dramatically increase its worldwide use for military and other hostile purposes."

This re-affirmation of DOD's long-standing policy leaves users to cope with S/A as best they can. During the past year, monitoring has revealed that S/A has varied from off to quite high: position variations of 300-400 yards. Users have observed 1) Positions appear to be stable, then move. 2) Two receivers often show different positions at the same time. 3) The average position, based on large numbers of fixes, varies from day to day. 4) Position match with charts is occasionally poor.

XIIIth IALA Conference

The Secretary General of the International Association of Lighthouse Authorities (IALA) has announced the XIIIth IALA Conference, "MOVING INTO THE 21st CENTURY". The conference is being hosted by the U. S. Coast Guard and will focus on the technical aspects of aids to navigation and issues concerning lighthouse authorities as we prepare to move into the 21st century. Each accepted paper will be presented by the principal author at the Hilton Hawaiian Village in Honolulu, Hawaii, 19 February to 2 March, 1994. (yes, '94)

International Association of Lighthouse Authorities
20ter, rue Schnapper
78100 Saint Germain en Laye
France
Fax +33 1 34 51 82 05

Loran-C can Reduce GPS S/A Errors

The biggest source of errors in GPS is selective availability, or S/A. (With S/A on, accuracy is specified within 100 m, 95% of the time, and 300 m, 99% of the time.) Loran-C, while having larger bias errors than GPS, has smaller noise errors than GPS with S/A. Ms.Soo Y. Brasch, Avionics Engineering Center, Ohio University, has shown that Loran-C can be used to reduce the S/A errors of GPS in real time. Her paper is included in the proceedings of the Birmingham meeting.

ION NATIONAL TECHNICAL MEETING

The Institute of Navigation has announced its meeting at the Park Fifty-Five Hotel in San Francisco, CA., 20-22 January, 1993. Dr. M. Elizabeth Cannon is the program chairman. The theme of this meeting, "Evolution Through Integration of Current and Emerging Systems," should be of great interest to WGA members.

Dr. M. Elizabeth Cannon
Dept of Geomatics Engineering
The University of Calgary
2500 University Drive NW
Alberta T3H 1Z2, Canada
Fax (403) 284-1980.

ECDIS 93 CONFERENCE

The second annual conference dedicated to the subject of Electronic Chart Display and Information Systems is scheduled for 8-9 March 1993 at the Marriott Inner Harbor Hotel in Baltimore, Md. The ECDIS '93 Conference & Expostion will inform the industry about recent advances in technology, standards, regulations, and the future of ECDIS. For more information on ECDIS '93 contact:

ECDIS '93
P. O. Box 265
Buckeystown, MD 21717
phone/fax (301) 874-2668

WGA -- 1992 Awards

The Wild Goose Association presented the following awards in Birmingham:

1992 Medal of Merit
Norman Matthews
as Secretary General, International Association of Lighthouse Authorities (IALA), for his dedicated efforts in fostering and coordinating Loran-C radionavigation policies of IALA member states throughout the world.

1992 President's Award
Andreas Stenseth
as Chariman of the Northwest Europe Loran-C Policy Group. Under his leadership Loran-C has been adopted for the European coastal waterways.

1992 President's Award
Kjell Erenstad
as Secretary of the Northwest Europe Loran-C Policy Group. His thorough and hard work in support of member interests contributed to the adoption of Loran-C for the European coastal waterways.

1992 Best Loran Paper Award
"Ionospheric Propogation & Loran-C Range--The Sky is the Limit"
David Last, Richard Farnsworth, and Mark Searle

1992 Best Student Paper Award
"Weighted Spectrum Analysis in Loran-C Receivers"
Andre Nieuwland

Outstanding Service Awards:
Elijah "Zeke" Jackson
as General Chairman, 1992 Convention

David C. Scull
as Chairman, 1992 Convention

David L. Olsen
as Co-Chairman, 1992 Convention

Robert L. Frank
as Awards Chairman, 1980-91

Robert W. Lilley
as Editor, The Goose Gazette, 1989-91

New Training Helicopter Avionics

The U. S. Army plans to install dual IFR electronics in 45 of the New Training Helicopters (NTH). Both the pilot and the student will have Loran-C receivers with a database, radiomagnetic indicators, and horizontal situation indicators. The database includes airports, navigational aids and other waypoints, and flight planning functions. The specifications call for the equipment to be certified to allow Loran-C approaches during actual IFR conditions.

Vessel Traffic Control

The House Subcommittee on Technology and Competitiveness, of the Committee on Science, Space, and Technology, has issued a report "Vessel Traffic Control," following hearings in New York and Long Beach. It advocates mandatory Differential GPS. Copies are available for $1.00.
GPO Stock no. 555-070-13002-1
Superintendent of Documents
Government Printing Office
Congressional Sales Office
Washington, DC 20402-9315

During testimony, Capt. Kenneth Graham of Jacobson Pilot Services, Long Beach, CA stated that more consideration should be given to use of Loran-C in vessel traffic control since it is presently available on all large vessels.

CDR Douglas Alsip, USCG, in response, testified that Loran is an offshore coastal navigation aid and its accuracy is about 500 meters. Although it is used now in all commercial shipping, it is not used in harbors. (Excerpted from Maritime Week.)

This is startling news to those of us who have been using Lorac-C in confined waters, during low visibility, and for finding small underwater objects, for decaces, taking advantage of its excellent repeatable accuracy.

Loran-C Regional Manager Moves

In July, the Coast Guard Atlantic Area Loran-C Regional Manager moved from Governors Island, N.Y., to Alexandria, Va. The Regional Manager, CDR C. K. Watanabe, is attached to Atlantic Area, but he and his staff operate at the Omega Navigation System Center (ONSCEN). His functions and responsibilities are unchanged. This is part of a Coast Guard project to centralize operational control of all radionavigation systems.

Commander (Atl)
USCG Atlantic Area
c/o USCG ONSCEN
7323 Telegraph Rd.
Alexandria, VA 22310-3998
(703) 866-3813; Fax (703) 866-3866

Corporate Members

WGA takes great pleasure in acknowledging the contributions of our corporate members.These organizations have contirbuted a great deal to the science of Loran navigation, and have supported the Wild Goose Association during Loran-C's long growth to a mature navigation system:

Bendix/King
Code Alarm, Inc.
U. S. DOT/RSPA/DRT-20
Federal Aviation Administration
Japan Assoc. for Aids to Navigation
JET Electronics & Technology
LSSRRI
Megapulse, Inc.
NAVCOM Systems, Inc.
Nat'l Ctr. for Atmospheric Research
NAVTECH Seminars, Inc.
Norwegian Defence Comm. Admin.
Ohio Universuty Avionics Center
Synetics Corporation
Telecom Solutions
Trimble Navigation Company
U. S. Coast Guard
U. S. Coast Guard Academy
Vaisala Oy
Volpe Nat'l Trans. Systems Center

Evaluating Loran-C Receiver Performance

By Bruce Hensel

This column may be of little interest to fellow Geese who have spent years designing, testing, or using receivers for the LORAN- C navigation system. However, there are many other association members who deal with other aspects of the LORAN-C system, such as the essential task of providing the signal in space, who may find some of the following thoughts of interest. More importantly, some WGA members are evaluating LORAN-C as a potential positioning system for a variety of product applications. For these members, an understanding of the issues discussed is essential.

I won't address many of the obvious considerations such as form, weight, and power consumption, that apply to the evaluation of any electronic product. Nor will I deal with the important issue of the user interface, given my limited experience in this area and the limited column space. (Perhaps another fellow Goose will be inspired to expand on this omission.) Finally, without a doubt, my biggest sin will be to ignore the almighty dollar, Eurodollar, or other applicable currency.

I'd like to focus on LORAN-C specific features and key performance metrics. Many receivers have fundamental architectural differences, such as single-chain vs. multi-chain design and the ability for master-independent operation. These architectural differences can affect position accuracy, robustness against LORAN-C transmitting system outages, and the ability to transit between the primary coverage areas of adjacent chains without loss of position.

It's beyond the scope of this article to attempt to quantify these effects; however, receiver manufacturers or independent sources such as academics or consultants should be able to help the potential user with such issues. Another architectural difference is the protection provided against continuous wave interference (CWI) sources. Some receivers rely on a series of notch filters preset at the factory for the operational area, while other designs incorporate automatic notch filters that adapt to the interfering environment. The latter approach has some advantages in that it readily adapts to changes in the real world (e.g., the unexpected Navy transmissions at 131.5 kHz in San Diego this year) and can adapt to highly localized interference sources, such as harmonics from a local switching power supply.

Finally, as our friends at Bangor and Delft have thoroughly documented, operation in areas with exceptionally harsh CWI environments, such as Europe, dramatically raises the importance of this issue.

Some performance metrics can be measured readily in real world testing. Acquisition and settling time are straightforward concepts whose importance depends on the application. The operating environment and particularly the frequency of conditions that would cause a receiver to lose phase tracking integrity also affect the importance of acquisition or reacquisition time.

Absolute accuracy is an important metric that is best measured in the real world. Further, it is important to measure this parameter at several points in the intended operational area, because accuracy will vary with proximity to the tracked LORAN-C stations, geometry of the tracked stations, and nature of the propagation paths from the transmitting stations. Receiver design significantly affects absolute accuracy. The most important factor is how accurately the manufacturer compensates for propagation delays (ASFs) over land propagation paths. Many manufacturers correct LORAN-C TDs for ASFs in their designs, while others model the world as seawater. The August 1990 edition of Avionics Review contains the results of side-by-side field tests of six airborne LORAN-C receivers that shows clear and significant differences in absolute accuracy.

The final key metric to consider for evaluating LORAN-C receiver performance is the integrity of cycle selection. As most readers are aware, cycle selection errors can result in position errors on the order of several miles or more. A receiver must have good immunity against two phenomena to provide proper cycle selection.

First, a conventional receiver must be able to detect skywave interference and properly track the groundwave. A good real world test for this is to operate the receiver at night in an area of moderate to marginal LORAN-C coverage. Problems will be much more apparent at night, as the skywave levels are significantly higher. Obviously, skywave immunity can also be tested on the bench with a suitable LORAN-C simulator.

The second phenomena is the CWI problem previously discussed. A good test of this for a land application is to operate the receiver close to power lines with known power line carriers (PLC). (The North American Electric Reliability Council maintains a database of such interferers.) PLCs represent a significant source of interference to LORAN-C in North America.

I've attempted to provide a basic list of criteria that should be understood in order to properly evaluate LORAN-C receivers. By no means is this list complete. Further, the complexity of the problem greatly increases when a potential user has to evaluate different navigation or positioning systems. I'll save some of those discussions for another article in this series.

CANADIAN HYDROGRAPHIC SERVICE USES LORAN-C FOR CURRENT MEASUREMENTS

The Canadian Hydrographic Service is using Langaranian drifting buoys and Loran-C to study the currents along the the west coast of British Columbia. Michael J. Woodward, Current Survey Officer, and William R. Crawford, Research Scientist, led this work.

The Langaranian method of current measurement measures the positions of floats which drift with the current, to determine their trajectories. The CHS study used this method rather the Eularian method of current meters in fixed positions, to make it easier to locate current eddies and jets. Current meters had revealed little about these phenomena, and were often destroyed by fishing trawlers or by storms.

The buoys store water temperature and Loran-C data at 30 minute intervals, storing data for 2,600 records. They transmit this data periodically to a ship. Using the drifting buoys in the Hecate Strait-Dixon Entrance area, CHS found that Loran-C positions taken every thirty minutes gave a speed uncertainty of 2 cm/sec (0.04 kt). They recorded all data to computer files, and can examine the progress of the buoys in an animated display program.

This has allowed them to gain a good understanding of currents in the area, particularly the "Rose Spit Eddy," long reported but not previously proven to exist. This eddy is important in holding young Dungeness crabs in the area long enough to mature before depositing them on the shore. Previously used satellite systems did not provide positions often enough or accurate enough to show smooth tracks of buoy positions. GPS promises to do both of these, and CHS plans to experiment with GPS receivers. However, antenna requirements in light of buoy motion and submergence favor Loran-C, according to one expert.

{Is this a typical Loran-C problem? It met all requirements, with low power consumption and a good antenna configuration, yet the experimenters want to go to GPS because_____. Just fill in the blanks, fellows.}

What is Repeatable Accuracy?

We all know that Loran-C has excellent repeatable accuracy, but different ones of us seem to have different ideas as to what it means, particularly with respect to other systems.

FRP definition: Repeatable -- The accuracy with which a user can return to a position having coordinates which have been measured previously with the same navigation system.

With Loran-C, Omega, Decca, VOR/DME, radiobeacons, and other earth-based systems, the idea of repeatability is relatively straightforward. A receiver showing a reading identical to an earlier reading is near the same position (or line of position). The errors come from signal variation and receiver measurement errors. With Loran-C, repeatable accuracy is obtained by returning to the same TD readings, ideally with the same receiver.

We could even apply the concept to a visual bearing: when a lighthouse bears 310 by magnetic compass, we are near a 310 line of bearing leading to the lighthouse. With the ship on the same heading, and the lighthouse again bearing 310 by compass, we are near the same LOP. Notice that we haven't considered variation or deviation, But have held the deviation constant by having the ship on the same heading. The angular error in reading the compass, or in taking a bearing while it is swinging, are the only errors. A different ship, or the same ship on a different heading, or returing 20 years later when variation has changed, introduce additional errors, some of them large, in the LOP.

But what about satellite navigation? The time of arrival data changes continiually, so there's nothing fixed to measure. But does that mean that GPS doesn't have repeatability? Suppose you take a receiver to a place where the latitude and longitude which it indicates are identical with the values it displayed last week, or last month? Isn't the distance to the original position a measure of repeatability?

Stated another way, does not a plot of receiver-indicated positions from a fixed location give a measure of repeatability?

Even celestial navigation positions have repeatability, in a sense. Returning to a position which gave identical altitudes from the same stars a week later would not only be extremely difficult, but it would not be the same place. However, a plot of successive celestial fixes would indicate the repeatability of the system: stars, almanac, sextant, navigator, calculations, and plotting.

Let's have some discussion of this concept, which seems to awake differences of opinion.

Bits & Pieces

-The Air Force Argus unmanned aerial vehicles being tested to provide real time battlefield intelligence use Loran-C for positioning.

-U.S. Marine Corps Search and Rescue helicopters at Cherry Point, locally known as "Pedro," often assist the Coast Guard on SAR missions. "Loran-C is essential to this mission," says a USMC Pedro pilot.

-The U. S. Navy unit at Fallon, NV uses twin hueys as SAR helicopters. One pilot, Lt. Kyle Kelley, said, "We live or die by our Loran. We feel that there is nothing that the Navy could give us that would do the job better."

-Boat U S reports, "Some Charts and GPS don't mix." They report finding discrepancies between GPS positions and chart positions up to a mile and a half in some parts of the world.

-Rural EMS helicopters often perform a vital, life-saving function in getting injured people to a hospital in the critical first hour after the accident. More and more of them are relying on Loran-C for for coordination with ground forces as well as for navigation. Portable Loran-C receivers are a key to this function.

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Wild Goose Association
P. O. Box 556
Bedford, Massachusetts 01730

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