It's a Bird, it's a Plane…No, it's an *Allegory* of a Life Cycle Support System

Centralizing Loran Technical and Logistical Support Systems

International Loran Association, 2005 Santa Barbara, California

Lieutenant Commander James R. Betz
Mr. John Elliott

Illustrated by Mr. John Elliott

U. S. Coast Guard Loran Support Unit

ABSTRACT

Following the monumental efforts that completed recapitalization of the Loran-C radio-navigation system in the Continental United States and some aspects of the system in Alaska, it is time to put forth the same effort to modernize the support system. The new electronic equipment suites deserve the very best technical support system possible. To do this properly, it is imperative to manage those areas that comprise an effective cradle-to-grave support system. These areas can be placed into six categories: Configuration Management, Technical Information Management, Technical Assistance, Maintenance Management, Electronic Logistics Supply Management, and Engineering Development Management. These are the warriors of Loran's Lifecycle Support System. Each of these warriors has several weapons in their arsenal, that, when properly applied, can protect an electronic system from its inception in the drawing room, to its fielding, and eventually its removal when obsolescence is reached.

This discussion concentrates on the required weapons the six warriors must use to effectively manage electronic support. This paper will map out where Loran-C electronic equipment support is at now and where it needs to go to implement these initiatives.

INTRODUCTION

In 1998, the Federal Aviation Administration (FAA) sponsored the United States Coast Guard (USCG) Loran Support Unit (LSU) to recapitalize the U. S. Loran-C radio-navigation system. With funding from the FAA, LSU systematically began making improvements to the system. By the summer of 2005 a significant milestone was achieved, the entire continental U. S. (CONUS) Loran-C system was modernized.

The modernized system replaced obsolete electronics installed at 18 Loran transmitting stations, 24 Loran monitoring sites and two remote control stations. The operations room equipment systems were also replaced at the six Loran stations in Alaska. These stations will eventually receive new transmitter facilities and timing and frequency equipment in the near future.

The new equipment suites filled requirements to transmit precisely timed Loran pulses and provide improved local and remote control and monitoring. The tremendous potential of this system to improve operational performance is currently under research and development in several projects managed by LSU. These projects are captured under the umbrella topic *enhanced Loran*. The modernized Loran system also provides for additional possibilities in improving system support.

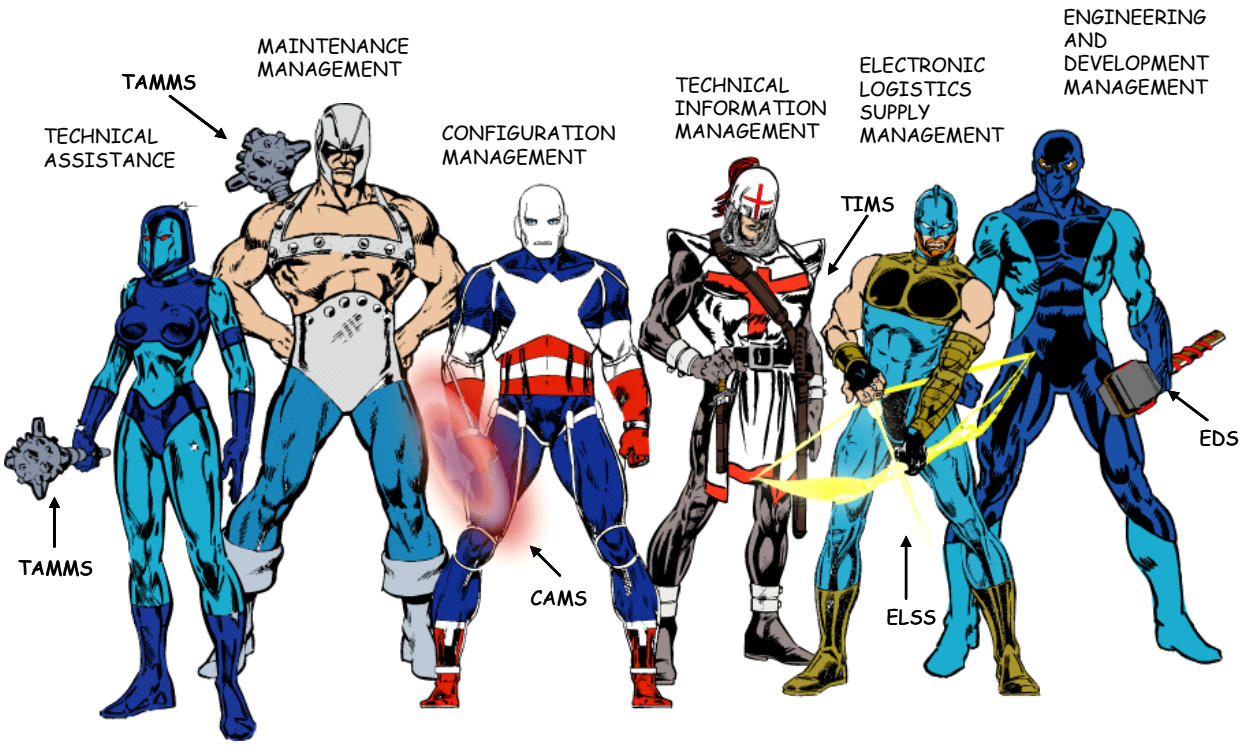
Effective support of equipment requires managing each step of that equipment's life cycle, from cradle to grave. Maximal management of the lifecycle support system is critical to the proper support of electronic equipment. This level of management is possible when each of the individual components that comprise the life cycle system is properly used. For the Loran-C system these components are: Configuration Management, Technical Information Management, Technical Assistance, Maintenance Management, Electronic Logistics Supply Management, and Engineering and Development Management. These are the warriors of Loran's Lifecycle Support System (LSS). Each of these warriors has several weapons in their arsenal, that, when properly applied, can protect an electronic system from its inception in the drawing room, to its fielding, and eventually its removal when obsolescence is reached.

As specialists, each of these warriors is responsible to protect the system in a specific area. However, as members of a team, each must also work in concert with its teammates to provide overall support. In other words, each must be singular to perform their particular function and simultaneously maintain some homogenous characteristics as to work together Outfitting each of these warriors requires the effective grouping and matching of available resources to cover the work requirements of each of these warriors. Warriors need weapons. The warriors of Loran LSS need the following five systems.

- Configuration Assets Management System (CAMS),
- Technical Information Management System (TIMS),
- Technical Assistance and Maintenance Management System (TAMMS),
- Electronic Logistics Supply System (ELSS), and
- Engineering, Research and Development System (EDS).

Armed with these weapons each of the warriors serves as a mighty defender of its unique section of lifecycle support. While each warrior is a perfect match to one of these weapons, in reality, each warrior can use any of the five weapons. This allegory of weapons and warriors to systems support is shown in Figure 1 and depicts the six warriors of the Loran-C LSS with their normal weapon of choice.

Figure 1: The Warriors and Weapons of the Loran-C Lifecycle Support System



Managed together effectively, these weapons and warriors can deliver a robust centralized systems life cycle support program. A centralized structure will significantly reduce personnel requirements and total cost of ownership while ensuring cradle to grave electronic equipment support that maximizes strategic and critical electronic systems operations and delivers substantial return on technology investment. This discussion concentrates on the six warriors of electronic support and their five weapons (CAMS, TIMS, TAMMS, ELSS, and EDS). This paper will map out the state of Loran-C electronic equipment support and where it needs to go to implement these initiatives.

WHO ARE THE WARRIORS NOW and DO THEY HAVE THE RIGHT WEAPONS?

LSU provides the bulk of the support as the Coast Guard's Systems Management and Engineering Facility (SMEF) and Coast Guard Center of Excellence (COE) for the Loran-C radio-navigation system. In many organizations, the warriors and weapons of successful electronic equipment support are maintained in a centralized environment. Increasingly, portions are operated at separate locations or contracted out to specialized companies who may provide superior expertise or continuity.

Currently, the Loran system's support structure is maintained at several locations using a smattering of techniques that grouped together, support the system. These various entities are:

- Loran Support Unit (LSU) Wildwood, NJ, Coast Guard (CG) COE,
- Loran Station Technical and Administrative Personnel,
- CG Electronic Technicians assigned to Electronic Support Detachments (ESD) near Primary Chain Monitor Sites (PCMS),
- Federal Aviation Administration Technicians assigned near PCMS.
- Electronics Logistics Center (ELC) Baltimore, MD, and
- U.S. Coast Guard Academy, New London, CT.

LSU shoulders a large portion of this effort as the CG's SMEF. LSU handles all manner of technical assistance, maintenance of technical documentation, and conducts research and development. Loran station personnel are the first line of preventive and corrective maintenance. Various ESDs and several FAA offices are first line maintenance on some of the PCMS sites. ELC provides logistical support in sparing of parts and maintaining some of the technical documentation. The CG Academy and several other notable research universities provide innovation and research and development programs.

All of these groups are heroes to the Loran community; however, the warriors and weapons they are using to execute these efforts are outdated and inefficient.

WHY ARE WE WHERE WE ARE?…or, CAN WE BLAME IT ON THE KRYPTONITE!?

LSU's attempt to achieve excellent technical support has been stymied recently by the incredible demands of the Loran Recapitalization Program (LRP). LRP siphoned off most of LSU's resources to complete modernization of 13 Solid-State Transmitter (SSX) Loran stations and building five new SSX transmitting facilities over the past two years. This rapid technical development and deployment impacted technical support and the ability to provide for an effective life cycle support program. It sapped the resources out of the LSU support staff much as *kryptonite* saps the strength from Superman.

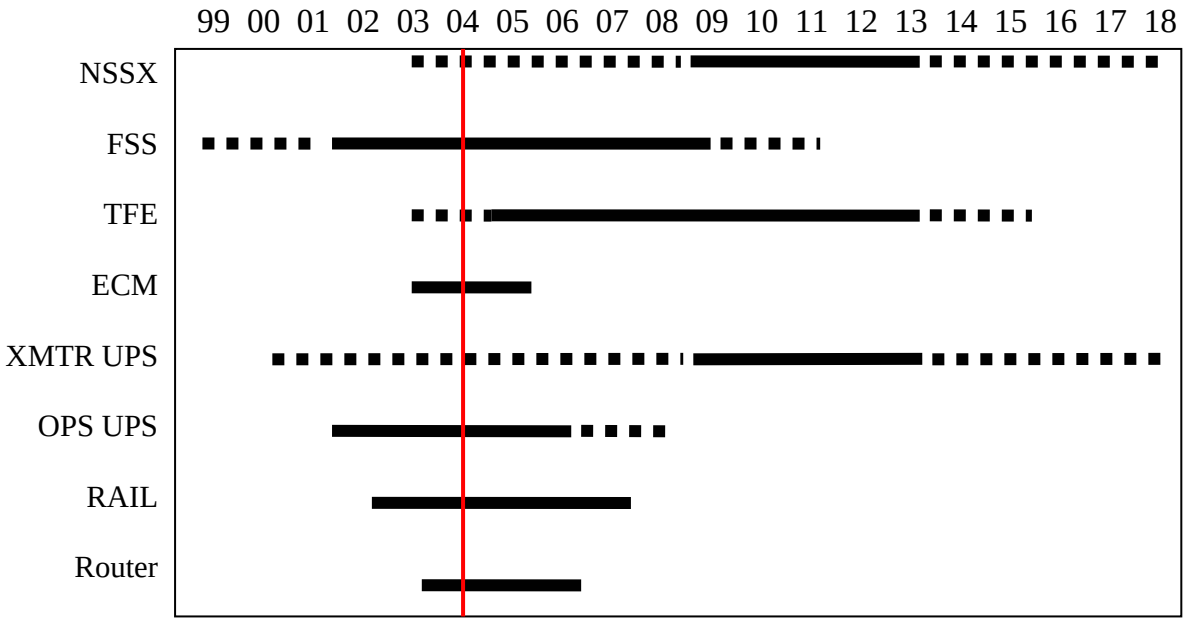
LSU concentrated most of its efforts to engineering, research and development, standardizing configurations, and installing new systems. This caused several unfortunate situations to occur that affected mostly logistical support (the weapon ELSS) and technical information (the weapon TIMS in both the documentation and training arenas). Many of our systems were fielded using contractor warranty support that did not address the complete life-cycle of the system.

This data is shown in Figure 2. All systems were purchased under contract with a warranty that would begin when the system was installed. The dotted line to the left of the solid black line represent those warranty start times as the individual systems were installed. The solid black line represents the time period when all of that particular system is covered under warranty. The dotted line to the right of the solid black line indicates the warranty end times as the individual system warranties expire.

Additionally, the substantial technical training required for these complex systems was insufficient. Other matters, such as technical information or technical support structure, were

developed after the new systems were installed, or not provided with the initial purchase of the contractor provided systems. This led to LSU performing some of the technical support features really well and others as best as possible with the situation at hand.

Figure 2: Warranty Map (Date begins 1999 and ends 2018)



With all CONUS Loran upgraded, it is past time to examine the system's support structure requirements. The availability minimum for the Loran system is 99.9%, with a system availability target of 99.99%. In other words, the system requirement is for the transmitter to be on air and in tolerance twenty three hours, fifty seven minutes, and thirty seven seconds per day. The goal is set even higher at twenty three hours, fifty nine minutes and just over fifty one seconds, or less than nine seconds of bad time per 24 hours of operation. There is not much margin for error. Still, sometimes equipment breaks or malfunctions. When these situations occur, and given the lofty requirement of availability, the technician must be able to return equipment to normal operations and return problem equipment to operational status quickly. This is where LSU's LSS comes into play, by providing that technician with the necessary tools. These tools include:

- Configuration management system that provides techniques for standardization and control and offers technical support and resolves system problems.
- Technical information program that efficiently provides information to enhance effective troubleshooting and repair equipment breakdowns or malfunctions.
- Logistics program that provides adequate spare parts and tracks inventory.
- Preventive and corrective maintenance program that logs these efforts.
- Engineering and research and development program that provides solutions to user requirements with a well organized LSS.

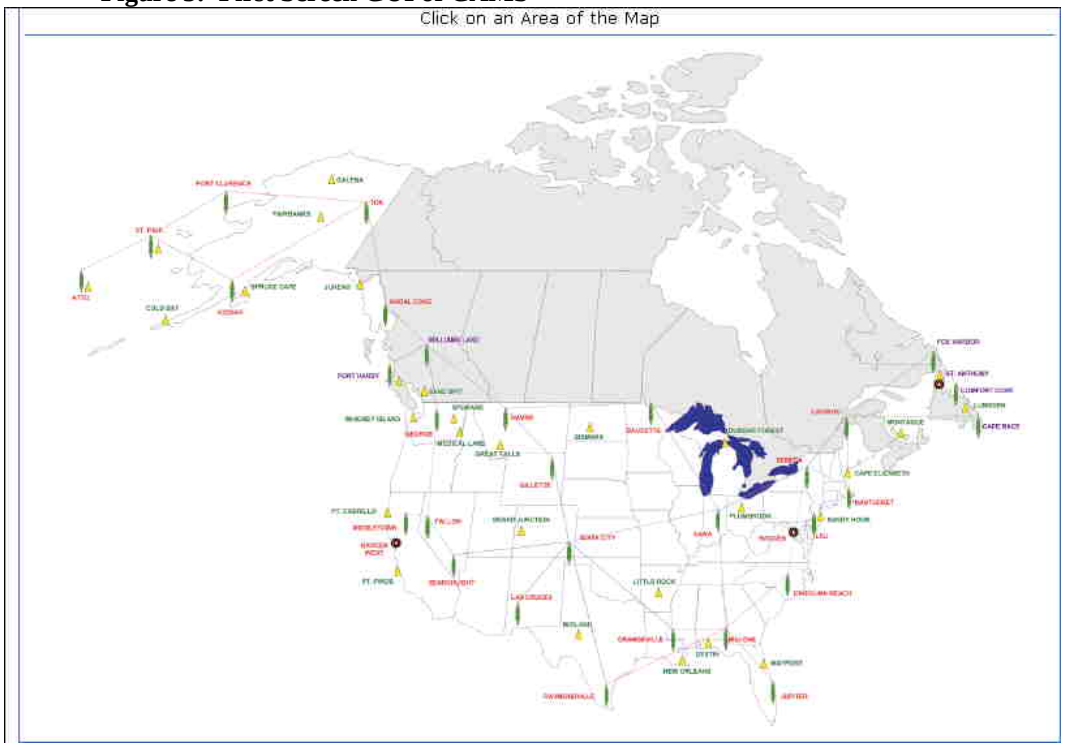
Today's Configuration Standardization, Control, & Technical Help Desk

LSU currently provides Configuration Management by maintaining Master Configuration Baseline Equipment (MCBE) suites for all installed systems. Field units are modeled after the MCBE suites located at LSU. LSU has five MCBEs:

- Legacy SSX Transmitter Equipment Suite
- New SSSX Transmitter Equipment Suite
- Tube-Type Transmitter (TTX) Equipment Suite
- New Loran Consolidation Control System (LCCS) Equipment Suite
- Primary Chain Monitor System (PCMS) Equipment Suite

Recently, LSU released a tool to better assist users of the Loran-C radio-navigation system to maintain configuration control, as well as access technical documentation. This system is offered over the Coast Guard network and is aptly named Configuration Assets Management System (CAMS). The program's user interface shows a map of the North American continent (Figure 3) with icons representing Loran transmitting stations, control stations and monitor sites. By clicking or pressing on the icon, the user is taken to that particular platform. The user can navigate to view pictures of the installed equipment suites, get access to technical documentation, or put in a request for technical help. LSU also maintains Configuration Status Accounts of each station. These are paper records that list the systems and each configuration item installed at each unit. The electronic format is much easier to maintain and enhances technical documentation control and distribution.

Figure 3: First Screen GUI of CAMS



Technical help is delivered through a published hotline phone number. The phone is manned during the regular workday, Monday through Friday 0800-1600 eastern time zone, by LSU's Configuration Management Branch staff. An LSU duty technician answers after hours and on the weekends. For non-emergencies, personnel can receive technical help via email. Personnel can email a description of their problem or question to lsusmef@uscg.mil, and receive an answer either through an email response or an LSU person will contact them via landline.

Several problems have been encountered with the technical help desk. Often, the person answering the phone does not have the level of expertise required to provide proper assistance. The call most often times is farmed out to a technical expert for that particular problem or system. Another problem with this model is the first level technician may not even have the capability to determine who the second level response should be directed to. This causes two problems. It delays resolution and causes field level technicians to direct dial known "experts" at their personal desk or oftentimes even at home. The "expert" assists the caller and the problem is resolved, but the "expert" does not follow through the next business day and capture the problem in the trouble report database. Yes, the problem was solved, but no data exists.

The information from Technical Help Desk calls is entered into a database as Trouble Tickets, System Trouble Reports (STRs), or System Improvement Reports (SIRs). They are then assigned to responsible personnel at LSU and monitored until they are resolved. The system used at this time is sufficient, but not efficient. The single biggest problem with the current system is its lack of automation. There is no mechanism in place that automatically tracks from entry to resolution. Each entry that is made is done manually. There is no automatic notification capability to avoid problems slipping into the proverbial crack. There is no ability to track trends and perform failure analysis to link Trouble Tickets with STRs or to observe whether SIRs eliminated or caused Trouble Tickets or STRs.

The system needs and deserves a better tool to manage technical help requests to resolution and to capture all data.

Technical Information Management

Technical documentation and related technical information such as Trouble Tickets and STRs are managed in a loose manner. There is no management tool in place to categorize and track the varied types of publications, software bundles, letters and instructions that LSU is required to publish and maintain. The system is not setup in any management process or tool outside of using a collage of electronic files, hard copy files, and software bundles tracked through several homegrown spreadsheets and a unit database.

Although technical information in manuals and installation or operational guides has mostly been converted to the PDF electronic format and posted to the CAMS web site, there is no consistent use of style sheets for all types of documentation. Additionally, Configuration Status Accounts are still maintained in hard copy form and are laborious to update. Control and management of all documentation is difficult without a centralized tool.

The system needs and deserves a better tool to manage technical information.

Maintenance Management

Technicians at the Loran stations perform the maintenance management. Currently, the maintenance is recorded in electronic format, but maintained at the local level. The CG implemented a Groom program run by LSU. This centralized some of the maintenance performance data, but the data was captured in a report format and not into a Maintenance Management database. Also, grooms are not scheduled in a way that allows this program to complete all preventive maintenance at a Loran station or PCMS site. LSU dispatches a team of Loran technicians to visit each Loran station annually and each PCMS site biennially. The idea is to groom the equipment to maximize the performance. The groom program does not have a tool to capture preventive and corrective maintenance data into a database.

The maintenance system in place now is fractured and does not give the SMEF or Logistics command a total view of maintenance performed and its effects on the total system. A better tool is required to track and manage maintenance.

Logistics

Two logistics support programs exist for the Loran program. The first program has been in place for quite some time and supports the legacy Loran equipment. Legacy Loran equipment may be defined as any equipment installed pre-modernization. This legacy support program uses traditional methods of CG electronics support by sparing parts at the Supply Center in Baltimore, Maryland. ELC Baltimore is responsible for life cycle oversight of these electronic systems.

The second logistics program supports those systems installed through the LRP modernization effort. This support system has relied on purchasing COTS items, using cold sparing at the Loran station and warranty replacement by the manufacturer.

These systems are shown in Table 1 and do not have cradle-to-grave life cycle support programs.

Table 1: Support Plan for LRP Systems

System	Warranty Timeframe	Sparing Philosophy
Accufix 7500	10 Year	Cold Spare on Shelf/Add'l Parts Contractor Provided
Timing and Frequency Equipment	10 Year	Cold Spare on Shelf/Add'l Parts Contractor Provided
Frequency Standard Set	10 Year	Installed Spare/Add'l FSS Provided by Contractor
Remote Automated Integrated Loran (RAIL)	5 Year	Cold Spare on Shelf/Add'l Parts Contractor Provided
Operations Room UPS	5 Year	None
Transmitter Room UPS	5 Year	None
Equipment Control Monitor	5 Year	Cold Spare on Shelf/Add'l Parts Contractor Provided
Routers	3 Year	Cold Spare on Shelf/Add'l Parts Contractor Provided

The major problem facing logistical systems support personnel is the lack of a cradle-to-grave business support plan for each of the installed systems. It has not been determined what will happen after each of these systems' warranties expires. This is an unacceptable plan and must be fixed.

Engineering, Research and Development

Engineering and all manners of research and development (R&D) occurs at LSU. The CG Academy provides assistance in this area and LSU works with a number of universities on various R&D projects. As initiatives are brought to the attention of LSU, they are studied by a Technical Architecture Group (TAG) chaired by LSU's Commanding Officer. TAG discusses customer requests for system improvements, system trouble reports, technology refresh requirements, and those projects induced from R&D efforts.

Any ideas that are floated up to the TAG and studied are either made into a project for implementation, or, if deemed appropriate, some seed money may be put in place to perform some R&D or complete a feasibility study. After studies are completed, TAG decides if the project is possible and if it can be funded. If it passes this litmus test, then it becomes a project for fielding at the LSU.

WHERE DO WE GO FROM HERE? or...A MEANS OF GETTING AWAY FROM THE KRYPTONITE!!

With modernization of the Loran-C system in CONUS, it is the perfect time to examine methods to improve systems support through leveraging the advanced technology recently installed through LRP. Many of the functions that are required to actively and efficiently provide technical and logistical support can be automated and centralized. As a starting point, those areas already performed at LSU will be maximized, specifically:

- Configuration Management and Documentation,
- Technical Support,
- Maintenance Management, and
- Engineering, Research and Development

This improvement can be accomplished by executing and delivering the five weapons (CAMS, TIMS, TAMMS, ELSS, and EDS) to the six warriors (Configuration Management, Technical Information Management, Technical Assistance, Maintenance Management, Electronic Logistics Supply Management, and Engineering Development Management) that make up a successful life cycle support program for Loran-C radio-navigation systems. This new and robust delivery of these important and very complex issues are once again depicted as an allegory of super heroes as shown in Figure 4.

Figure 4: The Robust Loran Life Cycle Support System Warriors with Weapons

The burning question, how?

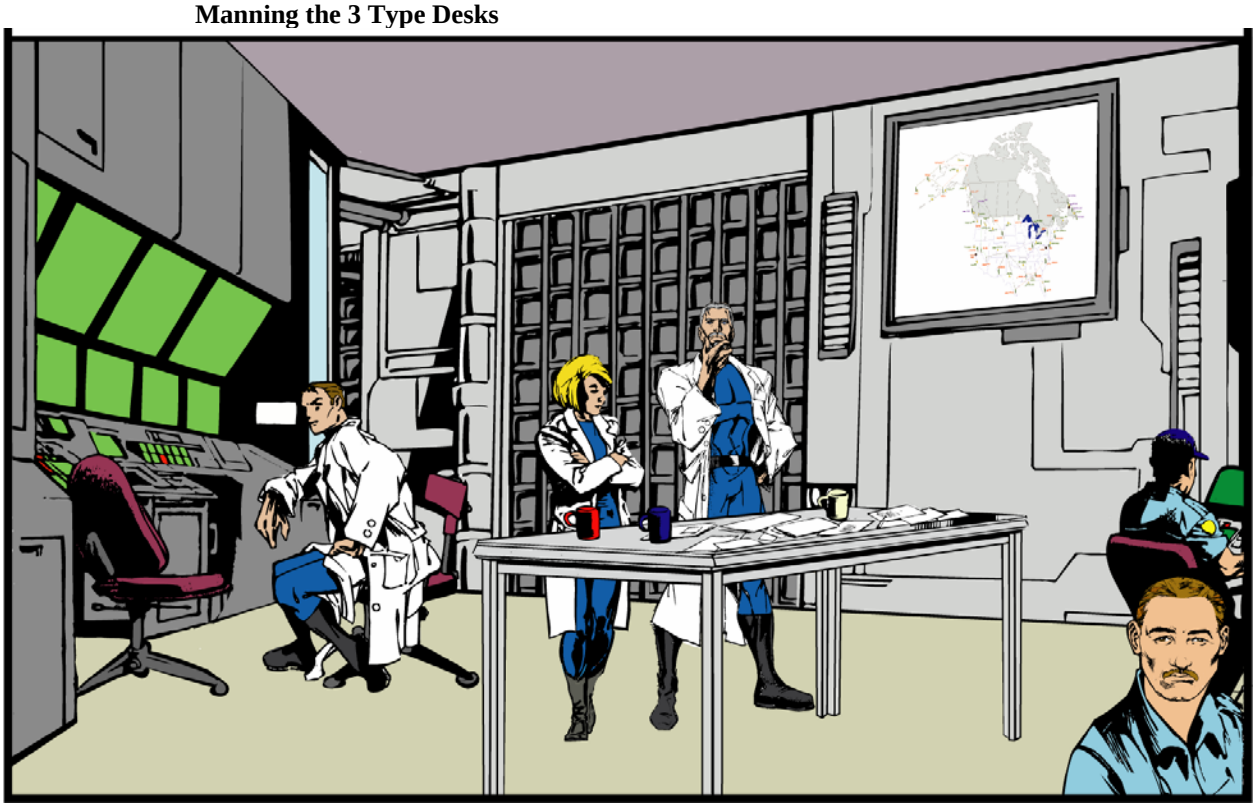
THE ANSWER: Call a Super Hero!!!, no, create a:

CENTRALIZED TECHNICAL HELP DESK AND MAINTENANCE MANAGEMENT SYSTEM

Loran's objective is to meet its system requirement, and its system goal, and in doing so deliver that which is most important to the end user, a reliable signal that is available all of the time. When equipment malfunctions, our technicians at the Loran stations require technical information, spare parts, and sometimes technical assistance. This program will provide the complete technical and maintenance support of the Loran-C Radionavigation system from one location. This location will house three type desks to coordinate all aspects of technical and help desk support. This modernized version is depicted in Figure 5 with our warriors and the very latest in technology that will fully implement a state of the art control center with:

- the type desk technical support help desk,
- the type desk IT management administration desk,
- and the type desk Maintenance Management System (MMS) with coordinator.

Figure 5: Depiction of a Centralized Technical Support System Complte with Super Heroes Manning the 3 Type Desks



These three type desks will work in conjunction to ensure that the Loran-C system is operating optimally and will forwardly identify problems that can be fixed prior to manifestation. Additionally, they will monitor the maintenance completed on the system and provide reports to attached or visiting technicians responsible for all levels and types of maintenance.

A Comprehensive Methodology and Outline of Loran Technical Support

The most streamlined centralized technical support function for our Loran system is structured in the three type desk areas: Technical Support Help Desk, IT Management and Maintenance Management System. A basic outline of the functions and areas of responsibilities for these systems follows.

- Technical Support Help Desk
  - Resolve all Trouble Calls
    - Enter Trouble Tickets into database
    - Monitor all active Trouble Tickets
    - Auto-notification system

- Technical Support Administration
  - Remote desktop control function
    - Real Time Equipment Control
    - Real time data retrieval
    - Historical data retrieval

- IT Management
  - System Administration Functions
    - Includes Tuning and Optimizing all computer-based systems
      - Loran Consolidated Control System (LCCS)
      - Remote Automated Integrated Control System (RAIL)
      - Timing and Frequency Equipment (TFE)
      - TCC
    - Remote Installation Server (RIS) Server
      - RAIL configuration files
      - LCCS configuration files
      - TFE configuration files
      - TCC configuration files
    - Provide and administer print server function

  - Network Administration
    - Network Monitor
    - TFTP Server

  - Database Administration
    - Includes Tuning and Optimizing all databases in use
      - LCCS Oracle database
      - LSU Access Database
      - Maintenance Management Database (not yet developed)
    - Provide remote monitoring (RMON)
      - Monitor backup and recovery of all databases
    - Provide data mining/queries (SQL) to all databases

- Maintenance Management System

  - Preventive Maintenance System (PMS)
    - Provide scheduling resource
    - Capture Maintenance completed into database
    - Historical data retrieval

  - Corrective Maintenance System
    - Capture Maintenance completed into database
    - Historical data retrieval

Technical Support Help Desk

The technical support help desk will provide over the wire help to on site technicians to solve problems, alleviate problems, and provide technical expertise. Also, if required, this process will activate the Emergency Response Flyaway Program (ERFP) to resolve those complicated or catastrophic problems requiring on site COE-type technical expertise. This technical support system will be broken into three layers.

- Layer 1 – This support will be over the wire and should provide technical help to solve 80% of the problems above the level of the onsite technician. The technical expert at the LSU help desk will be able to solve minor problems with test and maintenance procedures, documentation, computer and communications problems. They will walk the on site technician through all steps to repair equipment failures. If the problem is not solved at this level, then it is moved to the next layer.
- Layer 2 – This support will remain over the wire and should take care of all or most of the remaining 20% of those problems above the level of the on site technician. However, because of the complexity of the problem, the LSU will have to study the issue and will have to bump the problem up to an Integrated Problem Solving Team (IPST). The IPST and on site crew shall work on the problem 24x7 using all resources available to the LSU, including re-enactment on the baseline, to solve the problem. If the problem is not solved by the IPST, then a technical emergency is instituted and the problem is moved to the next layer.
- Layer 3 – This support is for those malingering problems that can not be solved by the local technical support group or those catastrophic failures that occur from time to time that are easily identified as above the resources of the on site technical support team. A Layer 3 Technical Support Request activates the LSU's ERFP process. This process builds a flyaway team that is immediately dispatched to the unit requiring support.

IT Management

The IT capability for the Loran-C system has grown dramatically over the past two years. A new frame relay high-speed data network incorporating Cisco router technology was installed. The command and control computer system was replaced with a new state-of-the-art Dell, Inc. server. The timing and frequency equipment was replaced with computer based and interfaced equipment suites. Finally, the transmitter controller was replaced with a computer-based system at the new solid state transmitting stations. This new transmitting station operations room has provided vast potential to change the way humans interface with the Loran station, both remotely and locally. Coupled with the installation of the new LCCS, it is time to examine how humans may use increased IT capacity to interface with Loran systems.

LSU should beef up its IT Management section to handle the additional requirements brought on by the infusion of the new computer based equipment and technology. This section's work would be separated into three main parts:

- NLCCS Database Administration
- NLCCS/RAIL Computer System Administration
- Network Administration

NLCCS Database Administration

NLCCS Database Administration will manage the Oracle database used with the new remote control equipment. All optimization and tuning of both the units installed at NAVCEN Alexandria, VA. and NAVCEN detachment Petaluma, CA will be performed at the LSU. A complete baseline is installed at the LSU and is fully functional and capable of taking control of any two Loran chains should the need arise. Additionally, through the use of the IT management systems, the IT crew would have access to all data stored on the server and can data mine for information that can help troubleshoot problems, spot trends, or verify operations.

Computer System Administration

The updated NLCCS and RAIL computer systems have made system administration much easier. The RAIL system has been migrated to Windows XP with a new system server that can be used to TFTP (Trivial File Transfer Protocol) computer configuration files onto remote computers. This server will also be used to TFTP router configuration files to remote router equipment. This standardization will improve system performance by reducing equipment swap out times. It releases the requirement for the on site technician to know how to setup a computer in the event that one would fail. All the technician will have to do is physically swap out the server; the system administrator will take care of the remainder of the work remotely.

The migration to Windows XP also allows usage of another valuable tool; the remote desktop log in. This will allow for an expert to remotely log onto the RAIL computer and take control of the Loran station from a secured remote location. System experts can then search through the RAIL computer and look at the actual real time data from TFE, TCC, and the transmitter. This will greatly enhance troubleshooting efforts by taking the guess work out of what an on site technician may be looking at. As a matter of fact, the remote administrator can log on prior to the on site technician's arrival and may be able to solve the problem and have a recommended (and hopefully correct!) solution for the technician **when he arrives.** The technician would then pick up his work order off the local printer that would give specific instructions on the corrective actions to take to fix the problem, perform the work, then report back to the Maintenance Coordinator Supervisor when he is finished.

Network Administration

Another enhancement to the system will be the administration of the network. This will be accomplished using a Remote Network Monitor (RMON) server. The RMON will allow real time health monitoring of the entire network and allow for the tuning and optimization of the network via configuration uploads, troubleshooting network connectivity problems, and provide optimized bandwidth taking into consideration metrics used in the system.

Maintenance Management System

A systematic and centralized solution to monitor preventive and corrective maintenance is required of the system and would lead to improved maintenance logging and accountability. Currently we rely on technicians at the site to perform CGPMS and make all of the necessary log entries that confirm the maintenance was completed. These technicians use a local reporting tool. By centralizing this function at the LSU, the technician can deliver the necessary entries over the wire to a centralized database. Our MMS coordinator will review all records as they are delivered to the database. Queries can be accomplished on certain data and trends can be recognized that may allow prevention of problems from occurring. The MMS coordinator will work with expert technical assistance teams at LSU to look for these trends. Additionally, this information will prepare our Groom Program to battle problems prior to their visiting a site. This will give a much greater return on our investment in visiting the station to optimize its performance. Finally, it will also prepare the system for unmanned stations.

If this function is centralized at LSU, it will give the Coast Guard much greater control and monitor over any other types of maintenance the Coast Guard may want to purchase, including contract maintenance. It is entirely possible, however, that once the system has been modernized all required maintenance and emergency repair work will be performed through LSU's Groom and Emergency Response Flyaway Programs.

Groom Program

The LSU Groom Program will visit each Loran station annually and each PCMS site biennially relying on the onsite technicians to provide supplementary assistance during the groom. On site technicians will continue to provide all other required maintenance. They will be required to log the information into a centrally controlled MMS that would track all work completed.

However, if on site support is removed from the station, then it would be necessary to groom each Loran station more often than once a year and each PCMS site annually instead of biennially. This would keep the Loran station preventive maintenance program intact while greatly reducing the personnel resources tied to the Loran system. Table 2 shows the six different platforms in the Loran maintenance system with the hours of annual PMS required to maintain the system. The last column yields the annual total PMS for the number of that specific platform. As would be expected, the TTX requires overwhelmingly higher amount of PMS than all other platforms.

What should be noticed is the very low maintenance requirement of the new SSX facilities. The majority of maintenance at all SSX stations is required on the half-cycle generator (HCG) cabinets. The newer stations have only 16 of these cabinets compared with a minimum of 32 at the legacy SSX stations. Additionally, the modernized operations rooms require very little on sight maintenance. Most of the maintenance required for these systems is administering computer-based systems and can be completed over the network.

Table 2: PMS Manhour Requirements for Loran Platforms

Platform	# of Platforms	Annual PMS	Total
TTX Dual/Single Rate	6	1700	10200
SSX Dual/Single Rate 32 HCG	6	500	3000
SSX Dual/Single Rate 56 HCG	7	720	5040
NSSX 16 HCG	4	50	200
NSSX 48 HCG	1	120	120
PCMS Site	24	180	4320
Totals	48	3270	**22880**

The CGPMS for Loran-C requires a top to bottom review. Particular attention will have to be paid to the value of doing each maintenance procedure and determination made as to whether the frequency of performing the procedure is accurate. Then, to implement an off site maintenance philosophy for Loran stations, the number of visits of maintenance personnel to each Loran station would have to mesh with the CGPMS frequency requirement.

To illustrate the feasibility of performing maintenance by visiting maintenance teams, data was put together from current CGPMS into Tables 2 and 3. Table 2 shows the total maintenance required per each type platform. The grand total of all required PMS in the Loran system shown in Table 2 is 22,880 hours. The value of 2080 in column two of Table 3 is based on one technician per 40 hour work week for 52 weeks a year. If the total required PMS of 22,880 is divided by 2080 that would yield 11 technicians required to complete the PMS for the Loran system. This does not take into account vacation time, sickness, or training requirements.

Table 3 shows the total manhours available for each station type. It shows the number of technicians assigned, the total available manhours to the unit, and the total available for all units of the same type. The total manhours available to perform all functions at all Loran stations annually is 185,120. This is a staggering number when compared to the 22,880 hours required to perform PMS.

Table 3: PMS Manhour Availability for Each Station Type

Station Type	Annual Hours/Person Based on 40 Hour Week	# Technical Personnel Assigned/ Unit	Available Manhours/ Unit	# of Station Types	Annual Available Hours/ Station Type
Isolated TTX	2080	6	12480	3	37440
Other TTX	2080	4	8320	3	24960
SSX	2080	3	6240	13	81120
NSSX	2080	4	8320	5	41600
Totals	2080	17	35360	24	**185120**

The manhours showcased here do not take into consideration facilities maintenance or other requirements such as corrective maintenance and administrative work. And when the subject of

corrective maintenance is raised, if the station is unmanned, what happens in times of equipment failure?

This is a fair question that deserves a fair answer from anyone advocating unmanning Loran stations. Built in equipment redundancy would, in many cases, allow for the signal to remain within its tolerances during equipment failure. At that point a repair team would dispatch to fix the sidelined equipment. What team would respond and from what location? The team in many instances would respond from LSU and several maintenance detachments that could be setup at NAVCENs Alexandria and Petaluma locations. Corrective Response Maintenance agreements could also be established at those ESDs or FAA centers that were located in close proximity to Loran stations. When the equipment malfunction is determined, the MMS coordinator would establish the responsible repair party and dispatch the team to fix the problem.

Unfortunately, many of the Loran stations are located in areas far away from any Coast Guard or government entities. Two cures exist for this problem.

1. Relax the signal availability requirements.
2. Move away from Master-Slave signal transmission dependency for the user and adopt a time of transmission independent system for the user.

Option 2 is the obvious choice, but will require a complete makeover of how we operate the system and how the user uses the system. We are moving into this territory as we look at the benefits of time-of-transmission control and all-in-view receivers. Until then, recall times could be relaxed where appropriate and satellite or detached maintenance groups strategically placed so as to respond in the required time. And this leads directly to the other question remaining, what to do when a catastrophic failure occurs?

Emergency Response Flyaway Program

Catastrophic failure would be met by LSU's emergency response flyway team. This team would be ready to flyaway 24 hours a day, 7 days a week. It may be prudent to have a detachment at Kodiak and perhaps Petaluma if unmanned stations are to be realized, but the best bet remains to step out of the box from an operational standpoint and move to a system that is transmission independent. Under these requirements, if a station went off air for a period of time, it would not be as critical as long as the coverage area contained enough Loran signals to meet signal requirements in the user area. Additional detachments and their exact placements would be driven by required response times and what TOTM control and equipment redundancies may allow.

COMPREHENSIVE CENTRALIZED TECHNICAL and LOGISTICAL SUPPORT

Is it essential to change our support structure? Yes. Today's landscape of technical support makes change essential and responsible. LSU could very well take on all responsibilities for maintenance, both preventive and corrective, and could perform these functions from a centralized location. The Groom Program and Emergency Response Flyaway Program would

augment the centralized technical support type desks maintained at LSU. They would provide the hands on periodically required at the Loran station. The detached units would extend the outreach of this technical support team. The teams would work together as a cohesive unit to keep the signal on air and in tolerance at all Loran stations at a significantly reduced cost.

LSU has built a solid reputation with our customers for outstanding systems and engineering support. We also realize that improvements must be made to support the newly installed systems at this same hallmark level. These improvements will be achieved through full implementation of the lifecycle support system and the centralization of support functions. The real challenge is to improve the level of support without increasing overall cost and, if possible, decreasing overall coast. This sort of challenge is not new to the Coast Guard. As an organization the Coast Guard has always found a way to do more with less.

The greatest ongoing cost in running the Loran system is personnel. Reducing the personnel cost of the Loran system would lighten the financial requirements and make Loran a system worth keeping. Full implementation of the lifecycle support system and the centralization of support functions would be the first steps towards reducing personnel cost in that these steps could lead to the eventual unmanning of the Lorsta. It would at its least provide the most efficient means of operating and performing the mission of the LSU.

The Coast Guard and the Loran-C community have always been faithful stewards of the taxpayers' dollars. The technology is now in place to make unmanned stations feasible. Unmanning the stations would be win/win/win situation for the Coast Guard and the federal taxpayer in that support of the Loran system continue at its same high level, personnel would be made available for operational or afloat billets, and all at an actual cost savings. Of course, this is not purely a technical issue, but also a highly politicized one. A less expensive Loran system that delivers increased functionality with no additional downtime is a more attractive alternative to the resource laden system currently in place. It may, in fact, be the only alternative.

The support LSU provides to its customers will not be compromised. LSU's skilled systems support engineers and technicians will continue to develop and deliver a comprehensive range of support services that ensure the quality of our fielded systems. It will continue to partner with ELC to provide top notch logistics on the total system and equipment life cycle, acting as single points of contact on all technical and logistics matters. For this centralized scheme to work, LSU will rely heavily on our team members, NAVCEN and ELC Baltimore. Ultimately, however, the buck will stop at LSU Systems Support Division. The components of the proposed Systems Support Division are as follows:

Figure 6: Configuration Management with CAMS

Figure 7: Tech Assist with Tech Assist/Maintenance Management System

- 24-7 Help Desk Support
  The Help Desk Support team will provide customers with a system designed to (1) identify and solve user problems remotely, (2) dispatch an ERFP Team to quickly arrive on site and fix the problem, if necessary.

Figure 8: Maintenance Management with Tech Assist/Maintenance Management System

- Maintenance Management Systems
  Preventive and corrective maintenance coordinated from a central location is at the center point of our ability to move into the future of a Loran system that does not require technicians attached at each station. All maintenance would be captured into a centralized database and effectively controlled by technical experts using groom teams and emergency response programs.

We are poised to implement a centralized MMS using the Fleet Logistics System (FLS). This system has a comprehensive maintenance module that will standardize preventive and corrective maintenance procedures and reporting. It will also allow Work List generation across all assets from a centralized entity and total maintenance records visibility.

- Technical Publications and Training
  LSU's highly skilled System Support Teams are working diligently with our Engineering Staff to provide high-quality Technical Documentation and Training services. By partnering with our customers from system concept through the complete life cycle of our systems, we maximize the usefulness of the systems and the technology investment. We have provided a centralized management system for technical information. The TIMS that we are currently using can be accessed by users through our CAMS website at http://cgweb.uscg.mil/g-s/lsu/CM.htm .

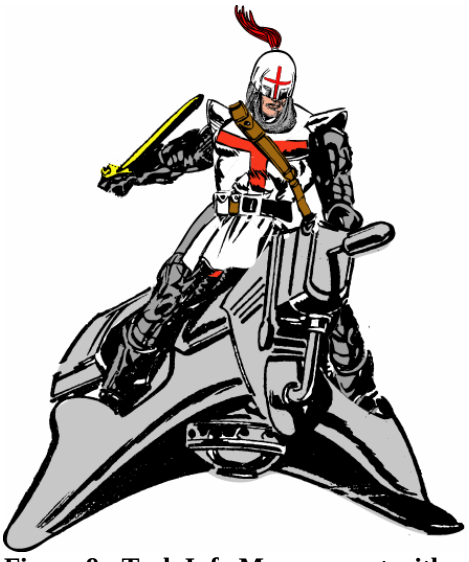


Figure 9: Tech Info Management with Tech Information Management System

Along with the MMS module, the FLS program also has a TIMS module that will allow Loran documentation to be gathered and managed centrally. All configuration items can be linked to their technical documentation, whether it is a User Manual or a schematic diagram. This information will be available at the click of a button like it is on CAMS.

Figure 10: Engineering & Development Management with Engineering Development System

- Hardware/Software Support
  LSU would continue to provide hardware and software engineering support from its on site engineering staff. Research and development would continue as a major initiative to provide our customers with the latest and greatest technology and to provide maximum use of the new technology we have recently installed. This would include those engineering initiatives currently underway now, such as the Loran Data Channel project.

- Logistics and Depot Support
  LSU, along with ELC Baltimore, is establishing Integrated Product Teams (IPTs) for all installed systems. The IPTs will address the full supply chain for each system and develop a life cycle plan to carry the systems from cradle to grave. The goal will be to minimize and manage logistics risks. The IPTs will look at product support tasks, including warranty analysis and depot planning ensure the system is optimally supported.

  FLS also contains a configuration and logistics module. Configurations will be viewable for all stakeholders of the Loran system. Configuration control will be centralized to LSU as SMEF. Configuration changes will be implemented through work orders on FLS to Loran technicians in the field or installation teams arriving to the station from ESD or LSU. Verification on all equipment installed will be validated by technicians performing maintenance on the configuration items.

Figure 11: Electronics Logistics Supply Management with Electronic Logistics Supply System

Supply side inventory is handled on CM Plus for now. Technicians dump their inventory each quarter to provide proof of their supply side stock. FLS also has an inventory module that will allow the inventory to be managed on FLS. It also will allow Total Asset Visibility as any customer in the Loran system will be able to access a part and gain information on its location.

CONCLUSION

With the implementation of CAMS, TIMS, TAMMS, ELSS, and EDS LSU will have the supporting structure of Loran's lifecycle support system in place. It will then be possible to manage all configuration, technical information, maintenance, electronic logistics supply, and engineering and development efficiently and effectively. Centralized technical assistance will be provided for any equipment in the Loran system throughout that equipment's lifecycle. All systems will be fully supported from cradle to grave. These systems allegorically presented in this paper together will provide centralized control and management.

CAMS, TIMS and TAMMS will centralize control and management of configuration, maintenance and logistics. Together they will reduce personnel requirements to perform the same mission. As maintenance is performed on the Configuration, the Configuration at each

station fulfills all CG property and inventory reporting requirements. Accountability is verified! Maintenance completion is logged and can be validated from any location over the web. When spare parts are required during corrective maintenance, they are logged into the maintenance module of the logistics tool and this tool will automatically subtract the count of the spare part from equipment inventory and, if required, automatically order another part. This maintains an up to the minute accurate inventory and satisfies all reporting requirements because that inventory's visibility will be constant from any location by any Coast Guard entity requiring inventory asset information.

ELSS and IPT management of all installed systems and future projects will partner the Loran system with the Coast Guard's Engineering Logistics Command. Representatives of these two commands have agreed through a signed memorandum to incorporate best business practices and partner with all Loran system stakeholders to systematically develop comprehensive life cycle support plans for all installed Loran systems. Additionally, these two commands will assemble structured and well represented IPTs for all future projects so that a feasible life cycle support plan may be implemented prior to any systems installation.

EDS will work in conjunction with the ELSS structure using guidance from Coast Guard policy on system design and implementation. Project Managers will Chair each IPT and along with the systems support and logistics teams, provide a system that fills customer requirements while delivering a product that is supported throughout the system's life cycle.

With the right weapons and warriors, LSU will conquer all lifecycle support issues and provide outstanding technical and logistical support for its customers.

Acknowledgements

Mr. Mitch Narins, of the Federal Aviation Administration, is sponsoring this work. The LRP Project is supported by many military and civilian personnel, too numerous to print here. Thanks to all of those who have contributed and believe in this work. Also, thanks to Dave Nevers for his expertise and patience in assisting the authors in the use of different computer applications used to put the presentation for this paper together. Finally, thanks to the members of LSU's Systems Support Division for all of their hard work and efforts to overcome the logistics and systems support obstacles brought on by the rapid implementation of new technology in the Loran system. Your dedication and commitment to duty has kept our heads above water.

About the Authors

Lieutenant Commander Jim Betz has served in numerous assignments in electronic systems and technical fields over his twenty-two years in the U.S. Coast Guard. For the past seven years he has been assigned at the Loran Support Unit working in the field of Loran and on the LRP Project. Jim has a Bachelor of Science degree in Electrical Engineering Technology and has used his education to perform duties as a Project Manager and Support Branch Chief at LSU. He is currently assigned as the Systems Support Division Chief at LSU and is responsible for technical and logistical support of the Loran-C radio-navigation system.

John Elliott is currently a GS illustrator (technical equipment) for the United States Coast Guard Loran Support Unit. His prior professional experience has run the gambit from highly technical to highly creative. He has served as a technical writer and illustrator at the USCG Electronics and Engineering Center's Computer Systems and Vessel Traffic Service System branches and as a technical editor for Computer Sciences Corporation under its contract with the Federal Aviation Administration. In this capacity, he worked hand-in-hand with software designers and engineers to create user-friendly machines and programs and produce well-written computer documentation. John has also worked as a free-lance game designer for TSR inc., working on that company's Marvel Super Heroes Role-playing Game. During his tenure he produced a series of six books for this product line covering such characters as Captain America, Spider-Man, the Incredible Hulk, and the X-Men.

References:

1. Betz, LT James R., Macaluso, John J., Teaney, Charles A. Hartzell, John E., "On Air With the New Solid State Transmitter," 33rd Annual International Loran Association Proceedings, 2003.
2. Conover, Zachariah S., Macaluso, John J., "Supporting the Enhanced Loran-C System," 33rd Annual International Loran Association Proceedings, 2003.

The views expressed herein are those of the authors and are not to be construed as official or reflecting the views of the U.S. Coast Guard or the U.S. Department of Homeland Security.