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Declining budgets and rapidly evolving technology place a high degree of stress on Naval aviation logistics support systems. Information dependent, these programs rely heavily on labor intensive processes to collect data, convert it to electronic format and transmit to the appropriate data base. Unfortunately, inadvertent errors continue to plague the Program Manager, Configuration Manager, Logistician, Fleet Operator and Maintainer. Likewise, accidental loss of important repair and operating history (Scheduled Removal Card) is causing unnecessary repair and pre-mature condemnation of Life-limited components. The use of Automatic Identification Technology to identify, collect, and transmit data to the data base, offers the potential to mitigate the effects of human induced error.

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CONFIGURATION MANAGEMENT

AND

AUTOMATIC IDENTIFICATION TECHNOLOGY

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ABSTRACT

Declining budgets and rapidly evolving technology place a high degree of stress on Naval aviation logistics support systems. Information dependent, these programs rely heavily on labor intensive processes to collect data, convert it to electronic format and transmit to the appropriate data base. Unfortunately, inadvertent errors continue to plague the Program Manager (PM), Configuration Manager, Logistician, Fleet Operator and Maintainer. Likewise, accidental loss of important repair and operating history (Scheduled Removal Card) is causing unnecessary repair and pre-mature condemnation of Life-limited components. The use of Automatic Identification Technology to identify, collect and transmit data to the database, offers the potential to mitigate the effects of human induced error.

INTRODUCTION

This paper is based on "state of the art" Touch Memory (TM) applications being developed by the Design, Interface and Logistics Support Department (also known and referred to hereafter as the Integrated Logistics Support Competency, ILSC) located at the Naval Air Warfare Center Aircraft Division (NAWCAD), Patuxent River, Maryland. The ILSC designed an aircraft configuration and material management (repairable assets) system, for the Naval Air Systems Command (NAVAIRSYSCOM) Executive Helicopter Transport (EHT) program. When conceived two years ago, database validity was assured by Bar Code Technology. Recently, the EHT Program requested a system up-grade, adding Smart Point and Touch Button Memory devices to replace the original Bar Code data collection and transmission system.

BACKGROUND

The need to accurately identify material has always been with us. In the early days, product variety was limited and primitive forms of identification technology were effective. The arrival of the industrial revolution brought mass production and exponential growth in technology. The process of accurately identifying material and reporting data has been playing catch up ever since.

Naval aviation is a microcosm of the world's technological growth. Prior to World War II (WWII), aviation technology was rapidly changing. A variety of Naval aircraft were being developed and quickly pressed into service or discarded for higher performing models. In the post WWII era, micro-miniaturization, computers, the jet engine and other technological advances propelled the race into space and development of sophisticated weapons systems. In lock-step, Naval aviation became populated with complex, rapidly evolving, weapons systems with components that have high cost and long service life; and in many cases, identical "Form, Fit and Function." Today, Naval aviation continually introduces new repairable components, equipment and consumable

supplies into the inventory, while sustaining a growing population of older weapons systems that have extended service life. Logisticians and maintainers responded to these challenges with alacrity. In concert with rising demand, NAVAIRSYSCOM rapidly created engineering and logistics management procedures to support the introduction of new technology into the fleet. One pivotal program was the Naval Aviation Logistics Command Management Information System (NALCOMIS) which:

- Integrated the maintenance needs of the Organizational, Intermediate and Depot level activities, with the capabilities of the logistics pipeline.
- Feeds Aviation Material Maintenance Management (AV-3M) and logistics consumption data into the Naval Aviation Logistics Data Analysis (NALDA) System and the Technical Directive Status Accounting (TDSA) System.

The need to manage the configuration of complex weapons systems throughout their life-cycle, became a common requirement of the PM, Configuration Manager, Logistician Fleet Operator and Maintainer. NAWCAD Patuxent River is at the vortex of Naval aviation Configuration Management (CM) growth. On a daily basis, configuration managers and logistical personnel work with over 100 of the oldest and newest aircraft in the Naval inventory. This concentration of type, model and series aircraft, and exacting Research, Development Test and Evaluation (RDT&E) mission requirements, generate a constant stream of changing material support and engineering modifications. In response to customer needs and in-house engineering requirements, the Pax River Integrated Logistics Support Competency (ILSC) developed the Configuration Status Accounting System (CSAS). Working in a near real time environment, CSAS:

⇒ Is compliant with Navy Configuration Management Information System (CMIS) data requirements.

⇒ Identifies repairable components by type aircraft and bureau number (Buno).

⇒ Provides complete asset control and inventory by part number/serial number.

⇒ Identifies location of serialized components within a system and tracks change throughout their life.

⇒ Interfaces with the Naval Aviation Logistics Command Management Information System (NALCOMIS) and the Technical Directive Status Accounting (TDSA) System to monitor parts removal/installation and Technical Directive compliance by the Organizational and Intermediate maintenance activities.

⇒ Interfaces (prototype effort) with Bar Code Technology, allowing direct scanning of data from components and equipment into the database and the printing of CM labels.

THE PROBLEM

Naval aviation Configuration Management (CM) processes continue to be plagued by inaccurate data collection, erroneous reporting of identified material, and lost information. Collection of valid AV-3M data is the building block for most aviation logistics and maintenance programs. The integrity of AV-3M data affects combat readiness, maintenance and logistics issues and has important budgetary ramifications. The accumulation of accurate data includes:

- Correct identification of the component (usually at the aircraft).
- Successful conversion of information to electronic format (usually a manual effort).
- Accurate entry of data into the appropriate management information system.

These simple, yet essential, evolutions affect the integrity of most follow-on maintenance/material decisions. Analysis of AV-3M data feeds the CM effort, ultimately providing mission essential information to the Fleet Operator. In addition, AV-3M information is used as a primary tool in developing provisioning and/or re-procurement models to obtain spare parts and the analysis of actual usage data to re-compute the service life of dynamic (life- limited) components.

The manual conversion of printed information from identification plates (and stencil or sticker) to electronic data provides a fertile environment for human induced error. A collateral issue is the rapid growth of Life-limited Components, whose service life is measured by flight hours. These components are accompanied by a Scheduled Removal Card (SRC) to track appropriate measurement indices and ensure that the

service life is not exceeded. The inadvertent loss of hard copy repair and or operating history inhibits identification and tracking of usage and/or repair data on expensive life-limited components. This has important safety of flight ramifications and high budgetary impact. Obviously, the high pressure, high risk, and often inclement military operating environment is also a catalyst for errors. Frequent examples of human error include:

- Transposition of data.
- Misinterpretation of numbers or characters.
- Entry of incorrect data to Management Information Systems (MIS).
- Loss of records identifying latest configuration change or maintenance action.
- Loss of important operating history (Scheduled Removal Card).

Gaining control of human induced error associated with material identification, data collection, and lost SRC data offers Logisticians, Maintainers and the CM process substantial improvement. Resolution will:

- Contribute to Total Asset Visibility (TAV) at the retail level and help reduce Operating and Support (O&S) cost.
- Provide Configuration Managers with: correct life cycle component history and parts tracking; sound inventory management and responsive procurement of parts; and accurate Engineering Change Proposal (ECP) implementation by part number and or serial number.

IMPACT OF DATA ERRORS

Data accuracy affects the performance of the Fleet Operator and all supporting echelons and systems. This essential ingredient controls the validity of many future decisions and leads to either wise actions or expensive errors. Every day effects of inaccurate data or mis-identified material involve:

- Unit Commanders (and Planners) who rely on this information to know what capabilities are present within the Force. The lack of precise knowledge can have catastrophic effects on combat strategy and the ability to execute assigned missions.
- Inaccurate reporting of basic material identification numbers such as part number, Commercial and Government Entity (CAGE) code and National Stock Number. Invalid data has a direct and negative effect on the outcome of reliability analysis/study and could result in incorrect Engineering Change Proposals (ECP's) and Logistics Change Proposals (LCP's).
- Erroneous Configuration Tracking/Management which affects establishment of the initial baseline configuration and parameters to control future modification. Likewise, loading incorrect information corrupts files and can seriously impact safety issues and modifications based on CM data.
- Accurate reporting of asset management. Effective re-procurement and sparing are directly related to data accuracy and its impact on reliability analysis.
- Expending unnecessary time and money to correct errors.

Although we believe it is high, in most instances, the financial impact of human induced error is difficult to track. Fortunately, some perspective can be found by analyzing the effect of lost SRC data on unnecessary repair actions and/or premature condemnation of material (retirement before service life expectancy is reached). Over the past five fiscal quarters, the Naval Aviation Maintenance Office (NAMO), Aeronautical Time Cycle Management (ATCM) team, has processed 4,666 requests for reconstruction of SRC data. Good work by the NAMO ATCM team resulted in 2,995 positive responses, thereby avoiding an estimated $69.5 million in unnecessary repair or condemnation costs. Conversely, 1,671 requests for information could not be filled, resulting in a potential $31.7 million charge to the Navy for maintenance or loss of service life that may not have been necessary (if adequate records had been available).

AUTOMATIC IDENTIFICATION TECHNOLOGY

AIT comprises an array of techniques that electronically collect, store, and/or transmit data for accurate identification of material and personnel. It is a rapidly evolving field mirroring the high and low ends of technology prevalent today. Examples include:

- Bar Code
- Biometrics
- Magnetic Strip
- Optical Character Recognition
- Voice Recognition
- Radio Frequency (RF) Identification
- RF-Data Communication
- Smart Cards
- Touch Memory Devices

A variety of commercial TM interface devices provide a communication link between remote peripherals and the component. Touch Memory devices are advantageous for applications requiring accurate interchange of data, frequent updates or modifications and remote access to data. Industry applications include:

- Cargo tracking in the airline industry.
- Facility security and watch station management.
- U.S. Postal Service, date and time of mail collections from public mailboxes.
- Waste management including weight of trash, collection time and billing.
- Secure/permanent identification device (electronic tag) for valuables.
- Portable medical records.
- Material tracking and shipping container inventories, etc.

In conjunction with the new EHT Program material management system, and in a continuing effort to improve the material identification capability of CSAS, the ILSC has continued to research the AIT field. Thus far, Smart Point and Touch Button Memory devices seem to offer the highest potential to improve the data collection, reporting and lost record problems confronting Naval aviation.

TOUCH BUTTON MEMORY

Touch Button Memory (TBM) data storage has been around more than 10 years. However, this type of AIT has recently enjoyed a series of facelifts. Always small in size, this Commercial-Off-The-Shelf (COTS) device is rapidly evolving into a very attractive alternative to the venerable Bar Code technology. Touch Memory devices are available as Electrically Programmable Read Only Memory (EPROM) or Electrically Erasable Programmable Read Only Memory (EEPROM) micro-chips, which can be manufactured in a wide variety of housings and configurations in order to suit customer requirements. Key features and inherent advantages over Bar Code technology include:

- small size (half the diameter of a dime)
- Data read, write and update capability.
- Data storage up to 2 Megabyte (rapidly expanding).
- Secure password protection system.
- Can serve as a stand-alone database.
- Stored data is ASCII (American Standard Code for Information Interchange) format.
- No internal power (battery) required.
- Long life data storage -- 100 years.

SMART POINT TOUCH MEMORY

The Smart Point was initially conceived to support the specialized identification needs of the Swiss watch industry. With two exceptions, this newest version of touch memory technology, enjoys all of the previously mentioned characteristics of the Touch Button. Differentiation centers on:

- Extremely small size. 20 of the smallest can fit on top of a dime.
- Memory storage capacity ranges from 75 to 600 characters (and is not likely to expand in the foreseeable future).

NAWCAD, PATUXENT RIVER INITIATIVES INVOLVING COMMERCIAL-OFF-THE-SHELF TECHNOLOGY.

The Integrated Logistics Support Competency is an innovator in the development of Configuration Management systems and their interface with Commercial-Off-The-Shelf (COTS) Automatic Identification Technology. Over the past two years, the ILSC has been working in partnership with the EHT Program to develop a configuration and material management system to track avionics equipment. Employing Bar Code technology, this system integrates the EHT Program CM with: the supply pipeline; the newly established Intermediate Maintenance Activity (IMA); the commercial depot (Sikorsky Aircraft Corp); the aircraft operator (HMX-1) and all relevant Naval aviation databases (CMIS, CSAS, NALCOMIS, NALDA, TDSA, etc.) Use of COTS technology enabled Pax River to speed design and implementation of software which interfaces with CSAS and NALCOMIS. Ground and flight tests of the Bar Code labels were conducted to ensure that positive identification of avionics equipment could be made, regardless of component location. Part number, serial number and CAGE code data is input through the local NALCOMIS terminal. This information allows the customer to track configuration changes and manage assets throughout the material cycle (receipt, storage, issue, consumption, maintenance and return to storage.) The EHT Program took delivery of this prototype system in May 1996.

While developing the EHT system, a variety of problems controlling and disseminating the stream of engineering/material changes were continually encountered. Adapting the Bar Code label to frequent material modifications/changes was labor intensive and repetitive. On the up side, Bar Code labels are inexpensive, easy to produce and fairly durable. Conversely, the data density to size ratio is poor (Bar Code labels with 1,000 bytes - 2 Megabytes of data are huge). Likewise, it is read only technology, necessitating construction and placement of a new label on the material whenever there is

a change in information. While working these issues, the ILSC began exploring the capabilities of Smart Point and advanced Touch Button Memory devices. EHT Program interest in new micro- chip AIT (Smart Point & Touch Button) parallels that of the ILSC.

Although the prototype system utilizing Bar Code has delivered improved CM and data accuracy, it does not appear to be the ultimate technological solution for the EHT Program. Lessons learned from this ongoing AIT program are being evaluated for incorporation in a forthcoming EHT Program upgrade to Touch Memory devices. Thus far, Touch Memory AIT appears applicable to:

- Tracking Life-limited Components and computation of Actual Life Usage data.
- Improved marking and identification of repairable assets including Ready For Issue, Non-Ready For Issue components, etc.
- Enhanced TD (Technical Directive) procedures.
- CM initiatives.
- TAV at the retail and unit deployment level.
- Surrogate or replacement for Scheduled Removal Card (SRC).

POTENTIAL SOLUTION

Recent ILSC Configuration Management and AIT experiences corroborate the often stated need to achieve life-cycle management of repairable components (including Life limited Dynamic components). Many activities have worked unceasingly toward this end, but success is proving to be elusive. At least one common barrier continues to defy even the most creative management programs. The inadvertent introduction of human error keeps affecting important data bases. To tackle this problem, Pax River AIT component management initiatives are narrowly focused on:

- Identifying material correctly the first time.
- Achieving accurate conversion of data to electronic format.

- Ensuring correct and real time entry into databases.
- Avoiding loss of important hard copy repair and operating history (SRC data) through use of TM devices.

Clearly, the best time to establish the baseline identity of material is when it is manufactured. More specifically, Naval aviation acquisition plans must be structured to require introduction of a foolproof form of identification by the Original Equipment Manufacturer; one that has a high probability of remaining with the component throughout its life-cycle. For components already in the inventory, the designated over-haul point (DOP) is the logical location to accurately establish material identity and affix the appropriate Touch Memory device. If necessary, this first time marking evolution could be expanded to include certain IMA's. Whether it be an initial identification effort, or a modification as a result of engineering change, 100% data integrity is the overarching requirement. Touch Memory devices being tested for the EHT Program currently carry the part number, CAGE code and serial number, and have room for up to 2 Megabytes of data (ie, an entire log book.) Once loaded correctly, data retention will last approximately 100 years.

One of the beauties of Touch Memory AIT is the relationship between the interface device (reader/writer) and the database to be accessed. Once the TM device has been read, the reader/writer converts the data into electronic format and will down load it into the designated database on demand. This effectively eliminates the need for manual conversion of printed material.

With 2 Megabytes of data storage common place, and substantially more on the horizon, current TM devices also have the ability to function as tiny stand alone databases. The potential impact of this technology on life-limited (dynamic) components is enormous. Existing TM devices have potential to incorporate an entire SRC record (less than 2 megabytes of data) and accompany the component throughout its life-cycle (both operational and repair.) Likewise, Touch Memory AIT could be integrated with the existing NAVAIRSYSCOM Structural Data Recording Set (SDRS) to offer a quick and accurate way to process actual life usage information on life-limited components.

TM devices appear to offer a high Return-On-Investment. Potentially, the Navy could save millions of dollars each year by avoiding unnecessary maintenance and or condemnation actions involving very expensive life-limited components. In addition, recalculation of component life limits using actual life usage data (vice predicted data) also gives evidence of a high flying hour pay-back program in the helicopter community and millions of dollars in savings.

CONCEPT

The ILSC is taking advantage of more than two years of experience demonstrating effective, affordable AIT. The two phase Touch Memory AIT development plan is designed to ensure quick improvement of EHT Program capabilities and the documentation of valuable experience. The following information outlines the ILSC plan of action and gives some indication of early success:

PHASE I

Conduct a comprehensive study to:

- Analyze compatibility of existing Touch Memory AIT hardware and software with Navy systems such as NALCOMIS, CSAS, CMIS, etc.
- Environmentally test TM devices for survivability in Navy operating environments.
- Mount TM devices with identification and configuration data on components in a way that ensures safety of flight and remote electronic data retrieval at the aircraft.
- Establish liaison with NAVAIRSYSCOM on development of an implementation plan to integrate TM into existing CM and Maintenance Program initiatives.
- Establish liaison with Naval Supply Systems Command (NAVSUPSYSCOM) to ensure initiatives are compatible with: repairable management programs such as the Advanced Traceability and Control (ATAC) Program; DoD Total Asset Visibility (TAV) Program; and the DoD Automatic Identification Technology Coordinating Group (AITCG).

- Ensure cost efficiency is maintained with periodic "go, no-go decision points."

PHASE II

When authorized, the ILSC will provide the government with documentation to acquire and implement a Touch Memory system on selected fleet weapons systems. Completion of this phase will allow the Navy's Configuration Management program to demonstrate accurate and near real time logistic data to a full spectrum of users.

INITIAL RESULTS

The availability of previously conducted commercial RDT&E, is an inherent advantage in the use of COTS Automatic Identification Technology. This baseline information has been incorporated into the recently completed ILSC test plan, allowing for some economies in testing and consolidation of developmental effort. Results of initial test are:

- Electromagnetic pulse assessment of the Smart Point and Touch Buttons was conducted in field strengths of 5.8, 26.7 and 55.0 kV/m with no loss of stored data
- Touch Buttons and Smart Points were bonded to a sheet of aluminum using a five minute epoxy found in Federal Stock. The shear specimen separated at 3,026 pounds and the tension specimen at 2,443. TM devices weighed 1/2 ounce or less.
- 100 failure-free flight hours on master helicopter blades for H-3, H-46 and H-53 aircraft.

CONCLUSION

The Design, Interface and Logistics Support Department at NAWCAD Patuxent River is moving quickly to exploit the potential of Automatic Identification Technology in the fight against inaccurate and lost data. The approach is two-fold and emphasizes

Customer Service. In that regard, most resources are directed at upgrading the configuration and material management system of the Executive Helicopter Transport Program with TM capability. In a parallel effort, scarce investment dollars are being used to expand and expedite the research necessary to apply Touch Memory AIT to fixed wing aircraft applications and the Navy repairable management program. Based on initial data and Fleet experience, the Design Interface and Logistics Support Department is confident that the Touch Memory devices will prove both robust and dependable. Likewise, TM devices appear adaptable to most (if not all) Naval aviation applications. Conversely, there are a few areas that require further development.

- Software protocols and modifications to existing databases such as NALCOMIS must be carefully undertaken.
- TM reader/writer and download hardware must be extensively hardened, made more environmentally resistant, and easier to use (ergonomically enhanced).
- TM hardware must also have software enhancements to allow multiple applications to be completed in sequence and to operate (download) more quickly.

In summary, the Pax River Touch Memory AIT initiative is less than nine months old, but already showing substantial evidence of a high return-on-investment. Excellent work has been done, but much more is needed before a topnotch Touch Memory Configuration and Material Management System can be recommended to NAVAIRSYSCOM.

ABOUT THE AUTHOR

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