HeloTrack™; Implementing the US Navy's Newest Rotary Wing Dynamic Component Structural Life Tracking System for Their H-60 Fleet

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Abstract

Tracking dynamic components is crucial to component life assessment through accurate and timely configuration management tools and serves as a cornerstone for any Condition Based Maintenance Program. The United States Navy (USN) recognizes the importance of enhanced rotorcraft health assessment capability by focusing on serialization and tracking of fatigue life-limited flight critical components [1]. The United States Naval Air Systems Command (NAVAIR) and the USN H-60 Program Office (PMA-299) are in the process of implementing HeloTrack™ which is poised to serve as the foundational tracking system for naval aviation. Personnel from Technical Data Analysis, Inc. (TDA), an innovative and forward thinking engineering and software development consulting firm who developed HeloTrack™ are working closely with PMA-299 and NAVAIR offices to swiftly implement the future dynamic component tracking system by April 2016. To date the system is up and running at two USN H-60 demonstration squadrons. This paper will detail the fleet training TDA has performed with the fleet users, the feedback received from them and how it was incorporated back into the program. Additionally the process of integrating HeloTrack™ into legacy naval databases and the lessons learned that TDA will utilize when it goes forward with rolling out HeloTrack™ to the entire USN H-60 fleet will also be discussed in the presentation.

Introduction

HeloTrack™ is playing a key role in the US Navy's objectives for rotary wing structural life tracking. This paper will provide the reader with many of the essential elements to enable the United States Navy to start moving closer to the objectives set out in Department of Defense (DoD) directives for effective Condition Based Maintenance (CBM) and Unique Identification (UID) Programs. The underlying point of this paper is to emphasize that precise configuration management (CM) of tracked flight critical components is the "*Achilles heal*" to successful CBM and is in fact, the cornerstone to achieve the US Navy's objectives. To aid in the rollout of HeloTrack™ it was imperative that the H-60 Program Office (PMA-299) systematically approach the goal of rotary wing structural life tracking by identifying ways in which their existing legacy systems address configuration management information and build upon those

systems to further reduce man-hours to capture the data and accurately track and maintain the data. Maintaining accurate electronic history data within the Configuration Management Information System (CMIS) of day-to-day changes occurring with operational aircraft is a challenge for any database given the volume of missions flown and maintenance actions performed. One of the principal reasons for developing HeloTrack was to transition the fleet from paper tracking component history cards recorded manually per the Naval Aviation Maintenance Program (NAMP) [2] and instead provide an electronic means to capture these configuration changes. The H-60 Program Office and other NAVAIR rotary wing program offices found this future process of electronically capturing data a necessity to enhance the current biannual audits and contractor staff that augment the CMIS staff with keeping an accurate record of the configuration of each aircraft utilizing their Dynamic Component Tracking (DYCOMTRAK) database. It is important to state that the CMIS Repository is not the only component information database used in naval aviation. All U.S. Navy and Marine Corps helicopters, AV-8B's and V-22s are currently directed by their respective Periodic Maintenance Information Cards (PMICs) to send part/card information also to DYCOMTRAK. DYCOMTRAK is similar in responsibility to the CMIS Repository, but DYCOMTRAK is not responsible for maintaining information for all Marine Corps and Navy type/model/series (T/M/S) aircraft; the NAMP gives that responsibility to the CMIS Repository [1]. While at the squadron level, daily activities are captured and stored within their locally replicated Naval Aviation Logistics Command Management Information System – Optimized Organizational Maintenance Activity (NALCOMIS/OOMA) server and periodically that same data is "pushed" to upper tiers within NALCOMIS/OOMA. The squadron's server and paper aircraft logbook for each BUNO which is used to track their dynamic components are generally considered to be accurate validated by periodic internal audits as well as audits performed by outside contractors and responsible wing personnel. The real challenge however was that the mid-tier and upper tier data elements of NALCOMIS-OOMA accessible by reliability analysts, fleet support teams (FSTs) or other contract support entities did not in some cases reflect what was being held locally at the squadron. With external resources not able to directly access the squadron's locally held server, the mid and upper tiers of NALCOMIS/OOMA information is reliant on the information being pushed upward by timely submission of the hard copy records by the squadrons.

HeloTrack™

HeloTrack™, Figure 1, is a proprietary comprehensive web application tool developed by Technical Data Analysis, Inc (TDA) that offers the user an opportunity to improve business processes with the principal objective being to improve maintenance performance across a broad range of benefits. TDA has extensive experience in rotorcraft and US Navy data management systems and currently is the prime contractor supporting the Structural Appraisal of Fatigue Effects (SAFE) program responsible for monitoring US Navy/US Marine Corps aircraft structural life limits. TDA is an integrator of technologies that specializes in providing engineering expertise and customized software solutions in the fields of aeronautical and mechanical engineering, statistical data analysis, web-based business transaction management and software development.

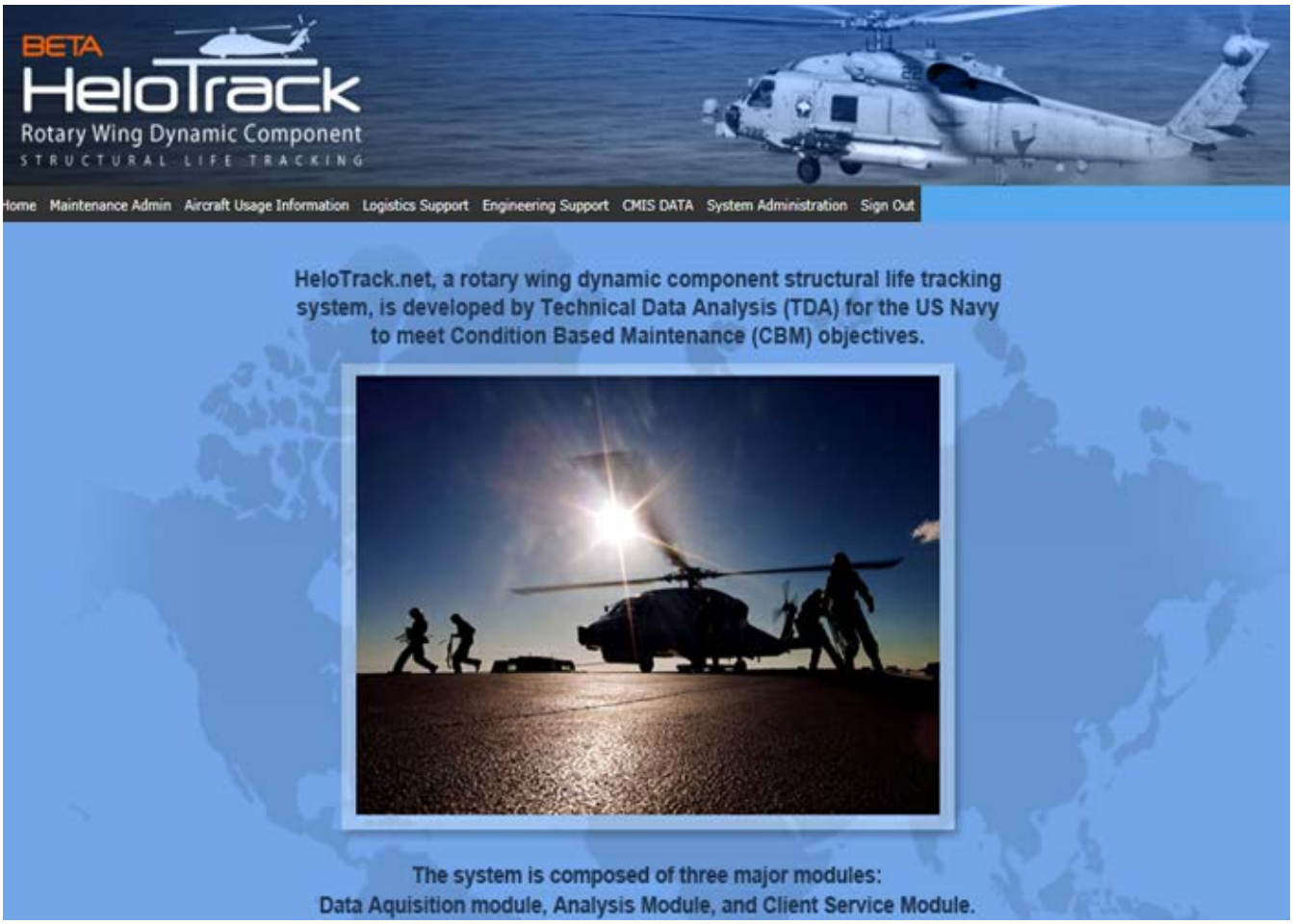

Figure 1: Home page HeloTrack™ Web Application

Envisioned in the development of this framework was an underlying goal to aid the USN in reducing total operating cost (TOC) while elevating its safety strategies through concise proactive management assessments via data mining, prognostics and trending, accurate scheduled maintenance actions as well as aiding in the development of potential requirements for future acquisitions to fulfil these goals. HeloTrack™ provides a framework for reliable data capture, streamlined data processing and dissemination through a one-stop web portal for all component tracking.

HeloTrack™ focuses on applying technology that holistically:

- Improves maintenance capabilities and business processes;
- Complements and enhances DoD-wide reliability analysis efforts;
- Involves the integration of support elements to enable enhanced maintenance-centric logistics system response; and
- When expanded to incorporate Health and Usage Monitoring (HUMs) data, it will facilitate accurate predictions of impending failures (based on condition data), resulting in dramatic savings and improved weapon system availability, ultimately benefiting the warfighter.

The USN recognized that when any component history is in question penalties have to be imposed when such data cannot be validated and this penalty could be significant resulting in some cases forcing retirement of a component before reaching its original design fatigue life.

The HeloTrack™ system was designed to eliminate many of the human errors associated with missing cards and incorrect data and preserving the parts history. By creating easy to use data entry forms on the HeloTrack™ website, point-of-entry data validation provides immediate feedback and error checking. This first line of quality control (QC) will prevent errors from populating the component history database. After completing a component transaction, an updated component tracking card can be printed in the proper Naval Aviation Maintenance Program (NAMP)-prescribed format and placed into the aircraft logbook. To move in a direction which would support NAVAIR 4.3.3.4 objectives for a sound Structural Appraisal of Fatigue Effects (SAFE) program for rotary wing assets, traditional paper hand written and updated forms like the Scheduled Removal Component, Assembly Service Record, and Equipment History Record (SRC, ASR, and EHR respectively) cards needed to be converted to a more manageable format. TDA devised an electronic record keeping system (eSRC, eASR, eEHR) coupled with point-of-entry data validation which enabled highly accurate transaction records to be interrogated instantaneously, world-wide by all stakeholders. The eSRC/eASR/eEHR system is intended to be an efficiency driver. The USN will benefit immensely from the adoption of this system by reducing costs through optimum asset life management and maintenance planning. This also satisfies the USN's end goal of tracking each aircraft and its components in near real-time, gathering complete component usage history and thereby accurately predicting the life of each component. As a cloud-based system, the eSRC/eASR/eEHR system is device independent, provides almost unlimited storage and has the capability to be interfaced with other USN data management systems. The eSRC/eASR/eEHR system is designed to provide growth capability to work with other USN data management systems and other aircraft platforms. To the mechanic and maintenance control personnel, HeloTrack™ will enable and have its impact immediately felt when components removed and replaced are electronically captured providing an immediate history of the component. Efficiencies gained at this critical junction of maintenance activities will allow more rapid turnaround of grounded assets and permit enhanced aircraft availability to fulfil the scheduled mission needs.

HeloTrack™ Development and Beta Implementation

The CBM$^+$ strategy found within DoD policy signed by the Deputy Under Secretary of Defense (Logistics and Materiel Readiness) directed that CBM$^+$ achieve a number of objectives including improved maintenance agility and responsiveness, increase operational availability, and reduced life cycle total ownership costs. Technical Data Analysis was contracted to aid PMA-299 with fulfilling many of the objectives of the CBM$^+$ strategy promulgated by the DoD and specifically, USN directives and policies that were implemented to align with these DoD policies. Adequate planning, securing an understanding of the requirements and insight to the root cause of any obstacles are essential to the success of implementing any complex program. Under the guidance and direction by stakeholders within NAVAIR that sponsored the Small Business Innovative Research project, N08-006 titled, "*Rotary Wing Dynamic Component Structural Life Tracking*," TDA set out through a number of funded and phased elements of the original SBIR to develop a comprehensive system to identify and to track specific parts over their life in the fleet and to determine the damage that accrues on these parts. The efforts by TDA were not however performed in a vacuum as engineers and software developers worked closely together with the NAVAIR Program Office personnel as well as meeting and soliciting feedback from the fleet end-users to spirally develop the intricate functionality within HeloTrack™.

Tackling the timely and accurate configuration management of the fleet was technologically and logistically one of the most challenging elements of this project. The USN acknowledged that accurate serialized component tracking is what will enable USN to take full advantage of individual usage monitoring in support of its CBM initiatives. For this reason HeloTrack™ was developed to be a cornerstone on the configuration management foundation to enhance safety, reduce TOC, automate many of the necessary logistical tasks with tracking parts, and thereby reduce workload and inherent human errors.

In the fall of 2013 it was determined by PMA-299 that the Demonstration Phase of HeloTrack would occur at two operational training squadrons (Helicopter Sea Combat Squadron 2 NAS Norfolk, VA and HSM-40 Mayport, FL) using a BETA version of HeloTrack™. By TDA receiving a data deposit or "dump" from the CMIS repository under the direction of PMA-299, TDA personnel along with Fleet Services personnel were able to review the archived data, utilize DYCOMTRAK's audits to valid and update the data based on coordinated and timely audits, and migrate this "validated" data into the HeloTrack™ database. This validation process enabled both of these squadrons to commence utilizing the BETA version of the HeloTrack™ system in April and June of 2014 respectively. To initiate the Demonstration Phase, each squadron was visited for one week with a team of personnel working together from the H-60 Program Office, In-Service Support Center (ISSC) Cherry Point, North Carolina, USA along with subject matter experts from TDA who conducted training with all the squadron and wing enlisted Aviation Maintenance Administrationman (AZs) rated petty officers, senior enlisted and maintenance officer personnel, and performed a final validation of the data before migrating the local data officially into the HeloTrack™ tables. At each squadron at the beginning of the week, an initial overview brief was provided to wing and squadron personnel to provide insight to the overall objectives of implementing the system. A HeloTrack™ introductory training course was executed and to support this training, printed user guide books and electronic copies of materials were generated and left with the squadron for future reference and/or for train-the-trainer scenarios. TDA also generated a Quick Reference User's Guide to coincide with many of the improvements and enhancements which had made their way into the HeloTrack™ system and solicited recommendations and ideas to assist future squadrons, wings and Level II Aircraft Intermediate Maintenance Detachments (AIMD) at the Fleet Resource Centers (FRCs) across the United States and overseas.

During this beta test and evaluation of the HeloTrack™ system which is still ongoing at these two squadrons, it was important to remember that while the HeloTrack™ component history was constructed from the CMIS data it wasn't complete and accurate until verifications occurred at the local squadron by the implementation team. The validation to the CMIS data by conducting audit checks, log book verifications and when necessary, on site physical verification of the components on each BUNO enabled the AZs to take full advantage of the new system and ensured only validated data was allowed to populate the new HeloTrack™ system. The beta system also enabled the squadron AZ's to begin using the many time saving features of the system to include automated T/M/S conversion calculations, search features, install and removals with automatic card updates, and utilizing the print function of HeloTrack™ to produce hard copy print outs of the appropriate tracking cards (ASR, SCR, and EHR) thus preserving existing NAMP requirements for hard copies to populate individual aircraft logbooks. The on-site training was necessary to ensure the AZs and maintenance personnel were comfortable with accessing HeloTrack™ and ensuring they were able to follow the necessary steps to take full advantage of the system. More importantly though, it was the time spent by the implementation team with the local squadron acquiring immediate feedback and in some cases being able to make changes to the HeloTrack™ system within

hours to achieve specific functionalities that the AZs were recommending to the team that was the greatest benefit to the beta demonstration process. Additionally, with each squadron visit, breakout meetings were scheduled and held with future stakeholders in the system (local Level II/AIMDs, depot, wing, and NALCOMIS OOMA administrators) to again gain a better fleet-wide perspective on the functions of the system, considerations for deployed squadrons, actions in the event of loss of connectivity, and depot/supply actions.

TDA captured all these recommendations in an issue and project tracking software called *Redmine* as shown in Figure 2 hosted on TDA's local server with each squadron visit and from feedback received in weekly meetings that were held. The team continues to maintain and operate the issue reporting and bug tracking tool. Based on comments and feedback from the demonstration squadrons and from the ongoing teleconferences and working group meetings, new tracker issues (bugs, support, and features) are generated that capture the AZ recommendations as well as functionality enhancements which meet customer requirements. TDA programmers and engineers continue to monitor the open items and resolve and close open issues based on priority and customer feedback. Through daily communication duplication has been avoided between common issues identified by multiple stakeholders.

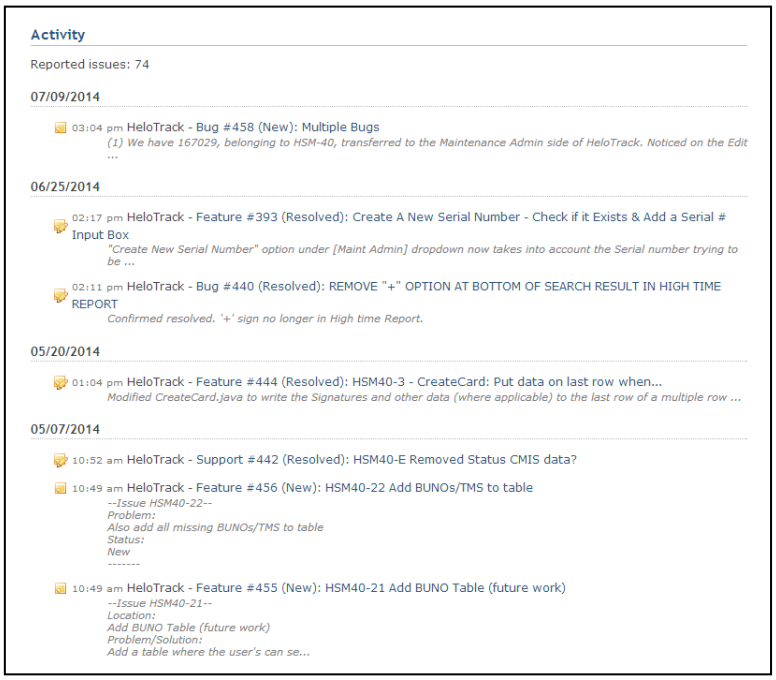

Figure 2: Redmine Issue Reporting & Tracking Tool

As users of HeloTrack™ encounter issues or think of recommendations, they are also able to submit these via the "Issue Tracker" application on the HeloTrack™ home screen (Figure 3). The application has been designed to send email traffic to a specific navy.mil address. The issues are monitored by FRC-East AIR-6.7.1.2 (ISSC Cherry Point, NC) and pertinent items are forwarded to TDA where the appropriate tickets are created in *Redmine*. They are also backed up via the TDA database ensuring no loss of user issues or concerns.

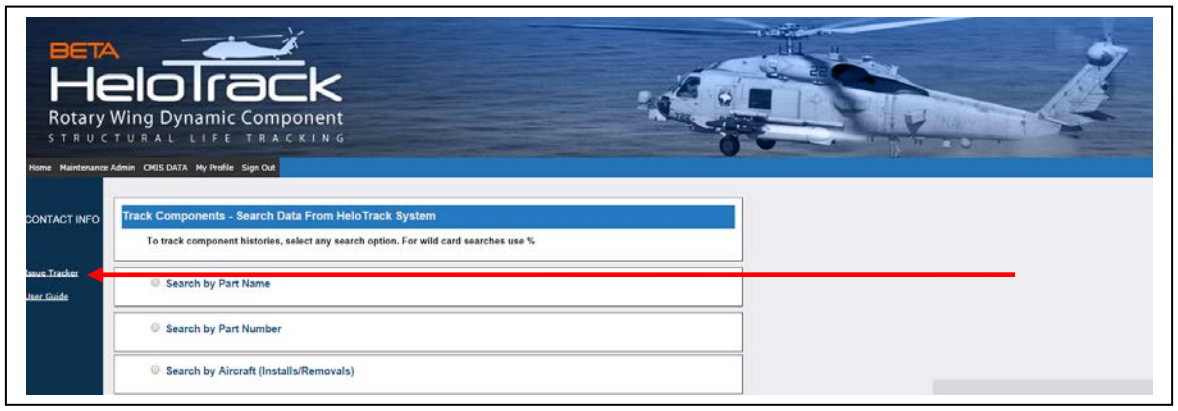

Figure 3: Issue Tracker within HeloTrack

At the completion the Demonstration Phase which will be expanded in the coming months to include Level II/AIMDs collocated at FRC-Southeast (Jacksonville, FL, USA) and FRC-Mid Atlantic, Norfolk, VA, USA), the USN will have tested and demonstrated a mature system capable of aircraft data collection, processing, and dissemination of results to all interested stakeholders in a streamlined way using the HeloTrack™ web application framework. At the conclusion of the Demonstration Phase, a system will have been demonstrated that can:

1. Accurately track the dynamic component configuration of rotorcraft in two fleet squadrons;
2. Compile all incoming data to provide necessary statistical and visual‐aid tools for decision making with appropriate data quality control, data monitoring and feedback procedures on a near real time basis;
3. Develop the integration plans for the capacity to deduce component loads from a combination of techniques including regime recognition algorithms and flight test loads;
4. Develop the integration plans for the capacity to perform fatigue lifing calculations with advanced dynamic component life calculation algorithms and various options within each method (safe‐life, strain‐life, flaw tolerant, and damage tolerant); and
5. Integrate the capacity for conducting data mining, prognostics and trending modules.

Planned HeloTrack™ Fleet-Wide Implementation

TDA and its engineering staff after an initial training and Demonstration Phase with the two squadrons (HSC-2 and HSM-40) and two regional Fleet Resource Centers (Jacksonville, FL and Norfolk, VA) will continue to monitor the HeloTrack™ website database and continue to make refinements and adjustments based on customer feedback as well as implementing additional adjustments to optimize the system for the US Navy. The goal is for these two training squadrons and FRCs to facilitate the transition from performing specific legacy activities of monitoring and tracking components on paper to a combination of utilizing HeloTrack™ and printing hard copies of the cards to comply with existing Navy regulations until such time that either policies are modified or updated to transition to a paperless system. Based upon the success of the Demonstration Phase and PMA-299 available resources, HeloTrack™ will enter into an Implementation Phase across a broader selection of H-60 squadrons as directed by PMA-299 and potentially into other naval aviation program offices. It is assumed the same or similar constraints placed on the demonstration squadrons will

remain in place during the broader implementation phase to the other H-60 squadrons. By drawing in other stakeholders from the wings, Fleet Resource Centers, deployed squadrons, and the depot facilities where more extensive component replacements occur, more understanding on the complexity of tracking components will be learned as the component moves through its various life cycle stages.

In addition to the planned tasks, TDA and NAVAIR's Aviation Readiness & Resource Analysis Department (AIR-6.8) are also in the early stages of integrating the component tracking module of HeloTrack™ into the Navy's Decision Knowledge Programming for Logistics Analysis and Technical Evaluation (DECKPLATE) system. This module has been coined the Aircraft Component Tracking System (ACTS) as the proxy reference to the original HeloTrack™ system. It is anticipated that ACTS will involve expansion of the original HeloTrack™ module to manage all aircraft platforms, both fixed and rotary wing, enterprise-wide. It should be noted that with each preceding phase, it will provide opportunities for refinements to be implemented into the ACTS/HeloTrack™ system.

Conclusions

The goal to test, certify, implement and conduct field trials of the HeloTrack™ system was successfully accomplished by the summer of 2014 as evidenced by the ongoing ability of the two demonstration squadrons (HSM-40 and HSC-2) to continue to utilize the system as the rest of the fleet prepares to be delivered the enhanced HeloTrack™ system. It's important to note and reference the maturing HeloTrack™ system as an "enhanced" system because as a result of providing a baseline system to the demonstration squadrons, these operators were able to provide immediate feedback with recommendations. This strategy of soliciting comments, criticism, and counsel from the end-users enabled the day-to-day functionality to perform their duties as Aviation Maintenance Administrationmen (AZs) to be built into the HeloTrack™ and future ACTS system.

Moving forward with fleet-wide implementation of HeloTrack™, TDA developed and presented a logical roll-out by regions in its Master Implementation Schedule. This schedule has been embraced and is providing the roadmap for the H-60 Program Office to implement the system to all H-60 units to include deploying squadrons. The methodology of leveraging an adept implementation team knowledgeable not only with the HeloTrack™ system but also with the current naval maintenance practices and responsibilities of the AZ rated personnel will invariably posture the H-60 Program Office for a successful fleet-wide implementation. In addition, TDA has also developed and provided automated quality control algorithms for the transactions within HeloTrack™, enhanced the CBM and stakeholders' toolkits with advanced data processing methods and is currently working to address the integration of HeloTrack™ in with existing legacy naval enterprise data management systems. The foundational steps of solidifying accurate electronic component record tracking has postured the US Navy's H-60 Program Office and other future beneficiaries of the ACTS system to begin to take full advantage of maturing HUMS technologies. These advancements coupled with TDA's innovative data fusion algorithms which have been built into the ACTS/HeloTrack™ system will soon be used by NAVAIR engineers [1] as a CBM tool to track individual component life based on HUMS reported usage.

References

1. Maley S., Plets S., and Phan N.; “US Navy Roadmap to Structural Health and Usage Monitoring – The Present and Future;” Presented at the American Helicopter Society 63rd Annual Forum; Virginia Beach, VA; May 2007.
2. COMNAVAIRFORINST 4790.2B, “Naval Aviation Maintenance Plan”, 15 MAY 2012.