



NSF Grant #s DUE 0653277, 0653291

Sea and Air Overhaul



Matthew Babb City College Electrical Engineering matthew.babb@yahoo.com

Wahid Baha SDSU Electrical Engineering wab619@cox.net

Emmanuel Hernandez SDSU Mechanical Engineering e_hdez@yahoo.com

Jeri Perez SDSU Aerospace Engineering jeriperez@gmail.com

Introduction

Fleet Readiness Center (FRC) is composed of both civilian and military personnel who are able to provide assistance in the overhauling of aviation as well as ship engines. In order to provide top quality products for their clients, Fleet Readiness Center endeavors to remain as a "leader in innovative aviation maintenance solutions, committed to customer, workforce and community."

Methods

One characteristic of the U.S. Armed Forces is its heavy reliance on vehicles. Defense contractors must make sure that the vehicles they create conform to military guidelines. Meeting these standards increases product life, decreases repair costs, ensures proper functionality, and guarantees safety. Our projects involved the inspection of vehicles and their components, both air and sea, to determine if they followed such mandates.

A successful component which meets military mandates is the LM2500 gas turbine engine, a critical part of some naval vessels. At FRC a disassembly inspection report is created as it is dismantled. First, the high pressure turbine is taken apart and checked. Next, the compressor rear frame is disassembled and examined, followed



Inspecting the LM2500 requires disassembling it piece-by-piece.

by the compressor stator and rotor. All parts are cleaned and analyzed for cracks. Damaged parts are repaired or replaced based on the degree of damage. Once artisans repair the individual components, the rotor is trimmed and balanced to match the stator cases. After the engine is reassembled it undergoes the functional, performance, and penalty (if necessary) tests.

The DDG-1000 Zumwalt Class Destroyer will be the newest line of ship available to the Navy and is currently being built in an eastern shipyard. Just like traditional naval ships, the Zumwalt class of ships has to be aware of its acoustic environment during

deployment. For example an oncoming ship would blow its whistle 3 times to ask for right-of-way; then the Zumwalt ship would blow its whistle 2 times for an acknowledgement.

The sound reception systems of the ship are acoustical electronic navigational aids to enable the officer on the watch to hear external sound signals inside an enclosed bridge in order to perform its look-out function. Based on the unconventional shape of the ship, a sound reception system has been developed that retains the acoustic performance for the officer on the watch.



The DDG-1000 Zumwalt Class Destroyer and what it may look like when commissioned.

Just like naval vessels and their components, hardware problems that conflict with military guidelines can exist within planes. Fixing these problems costs time, labor, and finances. Fleet Readiness Center has developed a means to counteract this issue. Navair and Boeing documents are searched to compile a comprehensive database. Doing so helps to log all wiring problems, identify recurring issues, and to predict the location of future faults based on previous history.

A specific example of the hardware issues that may arise in planes can be seen in the C-2A Greyhound:

The C-2A Service Life Extension Program (SLEP) team, among others, is sent rapid reply request (3R) forms which require engineers' attention on various problems such as corrosion, fatigue cracking, stress-corrosion cracking, short edge distances, etc.

One of the most popular kinds of 3R forms are those requiring engineers' disposition on holes that are mainly located in the upper longeron area of the airplane. From there, engineers decide on what actions to apply on individual holes with respect to many aspects of the subject zone. All actions considered for the holes are directed to extend the life of the plane.

One of the main actions applied to holes is that of cold expansion. Cold expansion is a process by which a combination of tools is used to expand individual holes. The purpose of the process is to create a residual compressive annular zone around

the hole that will be used to counteract the induced tensile stresses at critical points of the hole, which eventually cause it to crack.



The upper longeron area is the main structural concern of the aircraft

Results

By focusing in on and correcting problems that may occur within the internal workings of air and sea vehicles, many benefits have arisen:

Regarding the LM2500, conclusion to the causes of failure can be determined as the engine is dismantled. This allows it to be repaired and tested. If the results of the test are within the standards it is then sent back to NAVSEA. If the tests show some discrepancy, depending on analysis, one must determine what could be causing the inconsistency. If the cause of the failure is not external but internal, then most likely the whole engine must be disassembled and rebuilt. Once it has been rebuilt again, it must undergo the penalty test.

Inclusion of the acoustic detection system within the DDG-1000 satisfies the mandate that requires a vessel to allow those onboard the ability to listen for other ships' horns and whistles. Accomplishing this feat permits the DDG-1000 to go to the next step of development and ensures that the DDG-1000 performs just like any other ship that utilizes lookouts to carry out the same task.

The inspection of NAVAIR and Boeing documents for logging errors and problems led to the development of the NAVAIR database. This helped to streamline the "I-Level" process, saving time, money, and man-hours.

Concerning the C-2A:

Fasteners with the right diameter size and grip length are installed into each post-cold expanded hole. Fasteners can be installed with a combination of washers and carefully engineered straps.



Wahid makes certain that the acoustic detection system meets naval standards.

As a result of the cold expansion process, each hole's fatigue life and stress resistance is improved, therefore ultimately extending the life of the C-2A greyhound to the updated required service date.

Conclusion

Through our time at our respective companies, we were able to attain first-hand exposure to the industry of engineering. We were able to witness the technical fashion as to how duties are carried out and with what technology. Experience in teamwork and networking was gained as our mentors and supervisors guided us through our tasks. We also developed a better sense of the responsibility the defense contractor has to its customers' needs.

Acknowledgements

We would like to thank:

- The National Science Foundation Grant #s DUE 0653277, 0653291
- From FRC: Don Deandrade, Andy Lima, Claudia Garcia, Steve Gustin, Carl Shelley, Jeff Pham, Gregory McCalester, Roger Long, and Rollie Legaspi
- Jay Layno, Brett Balazs, John Barnhart, and Roger Shih
- Angeline Yang for putting the entire program together in order for us to get this wonderful opportunity
- Anyone who was not mentioned but allowed us to partake in this enthralling experience, who helped us at our respective tasks, and made this internship a wonderful event where skills were acquired and friendships were made.