AN AFFORDABLE SOLUTION TO HEAVY LIFT

by James C. Garman, Sikorsky Aircraft Corporation

In service with the United States Marine Corps since 1981, the CH-53E Super Stallion has proven itself as a versatile, rugged, and extremely reliable aircraft in supporting amphibious assault missions. The aircraft was designed primarily for heavy cargo and equipment lift operations, troop transport, and combat logistics support. The Super Stallion has demonstrated the capability of superbly performing other missions as well. Examples are combat resupply, non-combatant evacuation operations (NEO), combat search and rescue (CSAR), and tactical recovery of aircraft and personnel (TRAP). The aircraft has also been utilized for forward arming and refueling point (FARP) support, medical evacuation (MEDEVAC), and support of national interests during natural disasters.

A strategy and transition plan that includes the use of the CH-53E Super Stallion through 2025 is included within the Marine Corps Aviation Implementation Plan. The CH-53E fleet is, however, aging. The aircraft has been in service for more than 20 years. The average fleet aircraft is reaching approximately 3,500 hours, with some of the older aircraft having significantly more hours and nearing their service life limit. The original H-53E design had a manufacturing initial design specification of 6,000 flight hours for the aircraft. A Service Life Assessment Program (SLAP) was recently conducted to determine the actual fatigue life limit of the airframe. The results of the SLAP identified the major airframe components that will limit the fatigue life of the overall airframe. The shortest fatigue life was assigned to the pylon transition lug area at 6,120 hours. There are also some limiting components in the main transmission mounting support area at 6,560 hours. Based on these limits the first CH-53E aircraft will be retired in the coming months. When reviewing the fleet and projecting when individual aircraft will reach estimated fatigue lifetime limits based on the forecasted utilization rate, beginning in 2001, significantly larger numbers of aircraft will retire each year. This clearly delineates the need and the requirement for the initiation of the CH-53E Service Life Extension Program (SLEP) in order to meet the Marine Corps Aviation Implementation Plan.

Looking beyond the service life extension needs for the aircraft, a comprehensive modernization of the CH-53E is also essential to effectively meet the Marine Corps' heavy lift and the Marine Air-Ground Task Force (MAGTF) war fighting requirements out to 2025. Cost effective product improvements can be incorporated into the CH-53E aircraft during its service life extension program. These product improvements will support shipboard-based expeditionary logistics and Operational Maneuver from the Sea/Ship to Objective Maneuver (OMFTS/STOM) for the Marine Corps well into the 21st century. Working jointly with the Marine Corps Headquarters Aviation Requirements Branch (APW-51) and the Naval Air Systems Command program office (PMA-261), objectives have been defined for the SLEP of the CH-53E. The objectives focused on addressing the following items:

- Operations and Support (O&S) cost reductions
- Increased range, payload capability and survivability
- Commonality, where possible, with other USMC assault support platforms

- Improved digital connectivity and interoperability on the battlefield

In conjunction with extending the service life of the aircraft, the Marine Corps would like to reduce the operational costs of the aircraft. As the aircraft have aged, the Operation and Support costs have continued to increase. The Marine Corps is also interested in achieving more commonality within the Assault Support Aircraft (UH-1Y, AH-1Z and V-22). Commonality can provide benefits with respect to aviation logistics, fewer types of parts to stock, and a simplified training base with more personnel trained on fewer systems. Commonality can also help reduce the procurement costs by increasing the numbers of systems or components that are purchased in the various buys. After reviewing the aircraft system, two areas of opportunity for commonality have been identified: the propulsion system and the cockpit avionics.

To meet the emerging MAGTF requirements for OMFTS/STOM and in order to reach out over 200 nm with large payloads, increased lift and increased range are necessary enhancements. To successfully operate on future battlefields, improvements in survivability, along with upgrades in digital connectivity and interoperability, are all needed.

When reviewing the preliminary requirements, the CH-53E SLEP was specifically designed to focus on each of the defined objectives by using an approach comprised of seven pillars. These were chosen to address each of the objectives while at the same time establishing an effective, affordable, and executable program.

1. Common Propulsion System
2. Improved Main Rotor Blade
3. Improved Cargo Handling System
4. Elastomeric Rotor Head
5. Aircraft Avionics and Electrical Systems Upgrade
6. Structural Life Extension and Expanded Gross Weight Capability
7. Survivability Upgrade

In order to increase range and payload capability for a wider range of ambient conditions, a replacement engine for the existing T64-GE-416 engine is required. The Rolls-Royce V-22 AE1107C engine is a possible candidate for a common engine package that would provide a significant increase in power available over a broader range of ambient conditions. The aircraft transmission and drive train would be used to their full capability providing a significant increase in payload capability. For high altitude/hot temperature conditions, the aircraft would no longer be power limited. The engine would have virtually the same dimensions as the T64-GE-416 and would fit into the current engine compartment space. The engine would also bring improved reliability with longer intervals between inspections, which will help improve and reduce the O&S costs.

The current pressurized titanium spar blade was designed in 1970 and is currently one of the top degraders when it comes to the operating costs of the aircraft. An improved main rotor blade utilizing current blade technology will provide increased payload capability while also addressing a major aircraft O&S cost driver. The approach would use an all composite blade design with a new technology airfoil and with a swept anhedral blade tip. This new blade will show significant increases in the figure of merit. The result will be a significant lift enhancement due to the improved blade efficiency, allowing more lift for a given power.

The combined performance benefit of the new engine and new blade will provide the Marine Corps the ability to carry very large loads (LAV sized loads of around 28,000 lb) out to combat radius distances of 200 nm. Smaller sized loads such as a dual HMWWV load (at 20,000 lb) can be carried out to combat radius distances of 280 nm providing the Marine Corps significantly more capability and the ability to meet their tactical objectives with OMFTS/STOM.

With the vastly increased payload capability provided by the new engines and new main rotor blades, the need for external carriage of over-sized cargo will be amplified. The current external cargo handling system has had some reliability issues and is a challenge to maintain. The objective of the new external cargo handling system design is to greatly improve the reliability, safety and maintainability of the system by simplifying the mechanical system and crew interface. The hooks, both single and dual point, which are complex and heavy, will be redesigned, resulting in lighter, more simplistic devices. Sensor information from each hook will be relayed to the Cargo Management System, a microprocessor-based smart monitoring system that monitors and evaluates the aircraft during the external load operation. The system will be integrated into the cockpit displays and provide the aircrew important information about the external load, the aircraft weight and CG status, power available and power required for the current ambient conditions. The improved external cargo handling system will be simpler and more reliable, designed to prevent inadvertent releases, thereby increasing the users' confidence while improving the overall safety of external lift operations, as well as lowering O&S costs.

The current rotor head is the number one maintenance degrader from an O&S standpoint. It requires multiple inspections and is difficult to maintain. An improved rotor head, based on the

designs and lessons learned from previous and existing programs such as the CH-53D and H-92 programs, would incorporate elastomeric bearings, a fail-safe hub structure, on-condition maintenance, improved dampers and electric blade fold. The elastomeric rotor head would eliminate the maintenance intensive hydraulic lines, reservoirs, and seals. The elastomeric bearings will also reduce the wear on the metallic surfaces. There would be an overall reduction in the number of parts in the rotor head along with a significant reduction in the number of required inspections. All these improvements would contribute to and result in significantly lower O&S costs associated with the rotorhead.

The entire aircraft avionics and electrical systems will be upgraded to meet current, and as much as practical, future command, control, communications and intelligence (C3I) requirements as well as reducing O&S costs. In addition, the cockpit will be upgraded and made common with another assault support platform (MV-22 or UH-1Y) with an objective of replacing the existing high maintenance displays and controls with integrated, common electronic architecture. Improvements will be made to the cockpit physical and functional efficiency adding digital connectivity and interoperability, increasing field of view by reducing the control and display clutter, reducing pilot workload, and decreasing supportability and maintainability requirements.

Airframe fatigue and structural life limits will be addressed in a structural life extension. The major components highlighted by the SLAP would be remanufactured, primarily the tail pylon, transition section, and the cabin area around the main transmission. This upgrade would also allow an increase of 5,000 lb to the maximum gross weight capability of the aircraft (external gross weight), thereby taking full advantage of the full capacity of the new engines and new blades. The result would be increased life airframe components, lower O&S and increased payload capability.

The CH-53E has been routinely operated in medium/low threat environments. Evolving combat scenarios will place the aircraft in higher threat environments and therefore expose it to higher level threat systems. The primary threats to rotary wing aircraft operating in the amphibious and land assault environments are infrared (IR) and radio frequency (RF) man-portable air defense systems (MANPADS) and small arms fire. Incorporation of survivability features into the aircraft that address the potential of the varying IR, RF and/or ballistic threats is necessary. Improvements in survivability can be achieved through incorporation of modern technology. IR/RF signature reduction, improvements in aircraft survivability equipment (ASE), and ballistic vulnerability improvements can all be combined to reduce the detectability of the aircraft and improve its survivability on the battlefield.

As the Marine Corps continues to pursue the doctrine of Operational Maneuver From the Sea (OMFTS) and Ship to Objective Maneuver (STOM), the need for flexibility in extended range missions and increased payload capability is evident. The aim is to get away from the traditional ship to shore movements that require subsequent operations ashore to maneuver to the objective. The Marine Corps desire to move directly in on the objective from the ship location off shore is achievable and affordable with existing technology. In today's reduced defense budgets, the United States military forces demand multi-mission capability, high performance, and versatility. With its large cabin volume, three-engine power, exceptional payload, speed and reliability, the enhanced SLEP CH-53E Super Stallion will provide that capability with inclusion of cost effective and affordable upgrades. The enhanced SLEP CH-53E will provide the US Marine Corps a high capacity asset for the next 25 years and demonstrates that there is an affordable solution to providing heavy lift capability for the service.

About the Author:

Jim Garman is a Senior Preliminary Design Engineer working in the New Product Definition Group for Sikorsky Aircraft Corporation. He has been working with Sikorsky for 12 years. For the last 2 years, Mr. Garman has had the lead technical responsibilities for the CH-53E Modernization and Service Life Extension Program (SLEP). Prior to joining Sikorsky, he was a CH-53E Super Stallion helicopter pilot in the United States Marine Corps. Since leaving active duty he has remained involved in the Selective Marine Corps Reserve and is currently the Commanding Officer of a reserve CH-53E squadron. Lt Col Garman's squadron, HMH-772, has been activated and mobilized in support of Operation Enduring Freedom and is currently making preparations to deploy overseas with the 24th Marine Expeditionary Unit.