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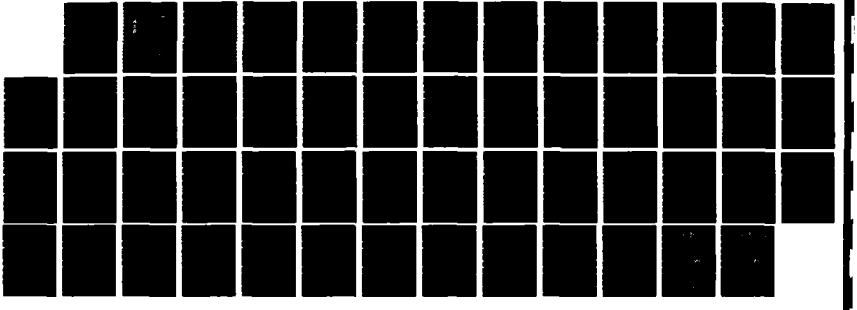

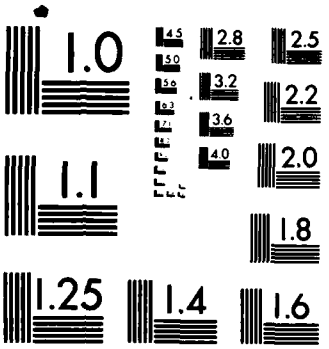

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ARMY SCIENCE BOARD

FINAL REPORT OF THE AD HOC SUBGROUP

ON

THE ARMY'S LHX PROGRAM (U)

DECEMBER 1984

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This report provides an overview of the Army Light Helicopter Family (LHX) Program; current and developing technology, risk reduction, senior program leadership, threat environment, speed requirements, crew size, commonality of aircraft types, weapons suite, and Tilt/X-wing aircraft.

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Item 7 (continued)

Mr. Gilbert F. Decker, Member
Mr. Robert L. McDaniel, Member

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INTRODUCTION

At the request of Ms. Amoretta M. Hoeber, the Principal Deputy Assistant Secretary of the Army (RD&A), the Army Science Board constituted an AHSG to study, analyze, and make recommendations on a limited number of critical issues related to the Army's LHX aircraft program. The HQDA sponsor for the subgroup's study was MG Louis C. Wagner. The terms of reference for the study are presented in Attachment A. The members of the subgroup are listed in Attachment B. Attachment C contains a listing of the military members on the study. Attachment D contains the ASB calendar of meetings.

This report describes some of the observations, analysis, conclusions and recommendations of the AHSG on selected critical issues related to the Army's LHX aircraft program. The basis for LHX, LHX program management, technology risk assessment, speed, and one versus two-man flight crew are discussed in the initial sections of this report. These issues constitute the more fundamental aspects of the Army's LHX program which were reviewed by the AHSG. Primary and secondary conclusions and recommendations are presented. Finally, a discussion of specific technologies and Army aviation programs is given in the appendices to this report. The discussion of each of these technologies and programs includes the AHSG's recommendations and conclusions on the same. A set of attachments follows the appendices.

PURVIEW OF THE STUDY

The LHX program represents an opportunity for the Army to replace an old and technically obsolete light helicopter fleet. Capturing this opportunity will impact positively on the Army's capability to defeat the future threat beyond the year 2000. Hence, the LHX program is critically important to the Army.

Issues Addressed. The following issues received intense examination:

- o Basis for LHX
- o Technology strategy
- o Risk reduction
- o Senior program leadership
- o Threat environment
- o Speed
- o Crew size
- o Scout/attack/utility commonality
- o Weapons suite
- o Tilt rotorcraft
- o X-wing aircraft

Issues Not Addressed. The AHSG did not examine in detail the following issues:

- o Payload
- o Range/Endurance
- o Stealth goals
- o Crash worthiness criteria
- o Number of engines

Approach to the Study. Throughout this study the AHSG remained cognizant of the unique challenge associated with LHX. Foremost is the fact that LHX is still in the formulation phase in which technology must be matured, be captured, and operational requirements be established. Examination of issues was undertaken with special attention directed to risk assessment of critical technologies involved with a specific issue. Special attention was also given to the projected capability of the future threat in rotorcraft technology. The depth of the AHSG'S concern regarding the Army's capability to meet the challenges of the years beyond 2000 cannot be overemphasized.

BASIS FOR LHX

ISSUE

On what basis can the development of a new rotor craft fleet, to replace the existing Army light helicopter fleet, be justified?

DISCUSSION

Justification of LHX may be stated in terms of capability to counter the threat, future mission requirements, force structure requirements, operational and supportability cost savings advantage over existing light helicopter fleet, and acquisition cost advantage over modifying available aircraft. Amplification of each of these factors is given below to unequivocally state the basis for LHX.

Mission Requirements: Expanded mission requirements guided by the Army's Air-Land Battle Doctrine define the need for a family of light rotor craft which must significantly exceed the performance of improved versions of the current light helicopter fleet. Future requirements for the light rotor craft fleet include a capability to fight worldwide, around the clock, air-to-air engagement, air-to-ground engagement against armor and soft targets, conduct reconnaissance and intelligence missions, conduct utility and general purpose missions, deep penetration across the Forward Line of Troops, and counter threat airborne operations in the rear area. Additional requirements, such as LHX being Nuclear, Biological, Chemical (NBC) operative, have been identified. LHX must satisfy these requirements on a 24-hour basis in a high-hot, adverse weather environment with sufficient effectiveness and efficiency to turn the tide of battle - to win the war.

Force Structure Requirements: The Army Aviation Modernization Plan and the Army Aviation Mission Area Analysis identify major shortcomings in aviation force structure in our present light fleet. More specifically, there is a planned increased in number of divisions concommitant with an inability of the AH-1, UH-1, OH-58, and OH-6 to meet the threat of the 2000s. This situation is exacerbated by personnel constraints. This net shortfall in light aircraft and personnel can be resolved by development of LHX with appropriate attributes driven by significant commonality (engine, dynamic component, core avionics) for the Scout/Attack and Utility versions of LHX, effective Reliability, Availability, Maintainability (RAM), and crew size (Single pilot). For example, a full LHX fleet has the potential of reducing the requirement for maintenance personnel by fifty-six percent (56%) over the current light helicopters projected to their 1990 inventory.

Operational and Supportability Cost Savings: The current light fleet of rotorcraft consists of aircraft purchased in the 1960s and early '70s and built with airframe and dynamic components and mission equipment from the '60s. Hence, this existing light fleet has accelerating operational and

supportability costs and manpower demands, poor RAM characteristics, and unacceptable logistics. LHX can be designed, developed, and procured at less expense than upgrading second generation aircraft to a likely capability. Life cycle costs of LHX is significantly less than upgraded second generation helicopters.

Operational and tactical obsolesence of the existing light fleet plus increasing economic and logistic supportability costs are quantifiable by problems with availability and costs of spares; by product improvements becoming non-cost effective and by relatively intense requirements for personnel training. If immediate significant purchases of existing light helicopters are initiated, the Army will risk possessing a large fleet with major materiel and threat obsolesence characteristics into the 2000s. LHX provides an opportunity for an enhanced capability at lower acquisition cost over procuring additional upgraded second and third generation helicopters.

A major LHX program will also ease the aviation personnel shortfall through improved RAM, logistics, and crew requirements. Thus, when combined with projected fuel efficiency of advanced technology engines, operating and support (O&S) costs for LHX are less than upgrading the existing light fleet. A major reason supporting the O&S advantage of LHX over other alternatives is the reduction in types of aircraft constituting the light fleet. The projected reduction is nine (9) which is computed by replacing the thirteen (13) types of aircraft with two (2) LHX types (Scout/Attack [SCAT] and Utility) and efficiencies gained from Army Helicopter Improvement Program (AHIP).

Advanced Threat: Projected advances in Soviet rotorcraft capability, offensive operational doctrine, associated weapon system lethality, air defenses, rotorcraft air-to-air capability, and relative increase in manpower can be effectively countered by a new fleet of light rotorcraft. The new fleet must be designed to defeat the advanced threat. The status of existing and developing U.S. technology will permit development of an LHX which can defeat the advanced threat. A strategy to capture this technology must be developed and implemented. A classified description of the threat to Army aviation in the year 2000 has been prepared and is available in Headquarters, Department of the Army, Assistant Chief of Staff for Intelligence (DAMI-FIT).

RECOMMENDATIONS/CONCLUSIONS

LHX may be justified based on the following facts:

(1) Enhanced light rotorcraft fleet to defeat the future threat.
(2) Future mission requirements.
(3) Force structure requirements.
(4) Operational and supportability cost savings.

LHX PROGRAM MANAGEMENT

ISSUE

Is an exceptional management arrangement necessary to establishing the LHX program?

DISCUSSION

The LHX program is in the formulation phase during which technology is being matured and operational requirements are being established. This is a complex process within the Army that generally takes three to five years, frequently substantially more. The LHX was assigned a high acquisition priority accordingly. Program milestones were adjusted towards achieving an early operational capability. However, the procedural events necessary to beginning Full Scale Engineering Development (FSED) involve a number of concurrent and sequential events involving Training and Doctrine Command (TRADOC) and Army Materiel Command (AMC) activities and several DA headquarters staff elements. Events of the past months indicate that normal program development and concept formulation procedures are unlikely to result in the scheduled milestones being met unless exceptional management measures are implemented. Indications that the LHX formulation process is not progressing:

o Frequent referral of routine program management issues to high decision levels outside the normal process.

o Substantial budget management difficulties disruptive to ongoing and scheduled program development activities.

o Lack of full understanding by key authorities external to the Army reflected by delayed actions on the Advanced Rotorcraft Technology Integration (ARTI) reprogramming request.

o Turbulence in doctrine development activities in defining the tactical doctrine which LHX must support.

o Severely restricted dissemination of cost, performance, and risk data for a few emerging technologies that is inhibiting the formulation process by both materiel and combat development agencies.

o Effectiveness of preliminary design contracts diminished by uncertainties of many significant design requirements.

o Significant milestone incongruities, such as sizing LHX engine before important performance parameters are established.

In considering alternative management arrangements that could better assure the program will become established on a firm course, the AHSG looked

for examples of similar problems and how they were resolved. Two examples were instructive.

Following cancellation of the Cheyenne attack aircraft program, a special task force was established under a general officer. This special task force accomplished a full program definition in about 90 days. This effort established the Advanced Attack Helicopter (AAH) as a firm program that has resulted in successful production deliveries of AH-64 (Apache) helicopters several years ahead of the comparable time required for the less complex UH-60 (Blackhawk). Since that example, other special task force efforts have been less successful. Two efforts to initiate an Advanced Scout Helicopter (ASH) program and the Corps Support Weapons System (CSWS) were attempted by special task force and were not fully successful.

A more successful management initiative involved a complex series of inter-related problems associated with main battle tanks during the mid-70's. These problems involved several commands and staff agencies. It was apparent that prompt corrective action was required, and a coordinating authority that could address problems crossing staff and command line of authority was essential.

To provide an integrated management more responsive to the problem, a Tank Modernization Office was established within the Office of the Chief of Staff. This Tank Modernization Office was headed by a general officer who provided a central focus for matters associated with tank modernization. The purpose of this special management initiative was to provide a means of facilitating decisions and actions required to field the M-1, modernize the M-60s, accommodate the M-551s phase-out, address critical manning issues, and other tank-related matters requiring more expeditious action than could be reasonably attained by routine organizational and staff arrangements. This special arrangement was highly successful in providing the attention, assets, and environment necessary for the normal agencies, the Program Managers and TRADOC System Managers to accomplish necessary corrective actions. After the severe problems were reduced to a more manageable level, the charter of the office was modified and later disestablished. There is little question that this initiative was a success.

SUMMARY/RECOMMENDATIONS

The Army's position that the LHX is required beginning in 1992 and that technology to support the development on this schedule can be available is reasonably supported. However, there is reason to believe that the schedule is unlikely to be realized with the current management arrangement.

It is recommended that a general officer be assigned to the Office of the Chief of Staff with the specific task of coordinating the many activities necessary to establish the LHX program, at which time, normal management procedures are likely to be adequate.

TECHNOLOGY RISK ASSESSMENT

ISSUE

LHX requires an advanced aircraft configuration and a high technology mission equipment package, which presents degree of risk in the various options and building block technologies.

DISCUSSION

The cost of LHX is projected to be about sixty percent (60%) mission equipment package and weapons suite and forty percent (40%) airframe. As it is with procurments, technologies and associated risks are frozen into the system at the beginning of FSED when choices are made and generally lock the design. An FY 86 start for FSED is assumed, but it is our sense that risk factors will not be significantly altered if FSED is delayed by one or two years. The risk levels considered are low, medium, and high, which are considered in terms of a combination of the ability of technology achieving operations readiness, contribution to cost and schedule slippage, and achieving production readiness within the time frame of the program. In the aircraft categories, the risk progression is as follows:

TABLE I, AIRCRAFT VARIANTS

o Helicopters	Low risk (at 180 knots)
o Advanced Helo, Tilt rotors	Medium risk (to 280 knots)
o X-Wing	High risk (at any speed)

Because of production experience base, conventional helicopters are the lowest risk, but it should be remembered that even the AAH program did not proceed without its problems.

Advanced helicopter configuration such as compound, Advancing Blade Concept (ABC) and ABC compound base have been tested in research and engineering vehicle configurations and there is extensive wind tunnel data available. Likewise, the tilt rotor has undergone 15 years of testing in several variant vehicles, most recently the XV-15, and a large body of practical and simplified theoretical knowledge is available.

The X-wing concept, based on wind tunnel demonstrated characteristics, is still in the feasibility stage. Because of its promise, intensive work should continue in Research and Development, but consideration for deployment should be delayed until data on extensive flight testing becomes available. However good, X-wing is not a technical option in the LHX time frame.

Mission equipment package risk considerations can be taken into categories, i.e., controls and displays, sensors, flight controls, and weapons.

Since the selection and availability of some of the detailed sub-elements of the major Mission Equipment Package categories will facilitate single pilot operation, those items pertinent to this issue will be marked by an asterisk.

TABLE II, MISSION EQUIPMENT PACKAGE
(Asterisk denotes desirability for single seat operation)

CONTROLS AND DISPLAYS	
o Voice command (*)	Medium risk
o Color situation display	Low risk
o Helmet mounted display (*)	Low risk
o Terrain map - real time (*)	Low risk
SERVICES	
o Precision navigation pilotage (*)	Low risk
o Infra Red (IR) research and tasks	Medium risk
o CO_2 Multifunction radar	Medium risk
o Forward looking infrared	Low risk
o Millimeter wave radar	Medium/high risk
o Position Location Radar System (PLRS)	Low risk
o Joint Tactical Information Distribution System (JTIDS)	Medium risk
o Integrated Communications Navigation Identification Avionics	High risk
o Standard altitude and heading reference	Low risk
FLIGHT CONTROLS	
o Fly by wire	Low risk
o Fly by light	Medium risk
o Integrated flight control technology(*)	High risk
- Auto Nap of the Earth (NOE) at 25'	
- Auto terrain following at 50'	
- Auto obstacle avoidance	

CONTROL AND SIGNAL PROGRAMS

o Very High Speed Integrated Circuits (VHSIC I)	Medium risk
o Very High Speed Integrated Circuits (VHSIC II)	High risk
o Software	Medium/High risk
o Distributed processing	Medium risk
o Fiber optic bus	High risk

WEAPONS

o 30mm gun	Low Risk
o Tube Launched, Optically Tracked, Wire Guided (TOW) 2	Low Risk
o HELLFIRE (semiactive)	Low Risk
o HELLFIRE (fire and forget)	Medium Risk
o Lock on before launch Focal Plane Array (FPA) missile (*)	Medium Risk
o Guided hypervelocity missile (*)	High Risk
o Stand off weapons, autonomous acquisition	High Risk

The mission equipment package (MEP), as a whole is a risk challenge primarily from the point of view that sub-elements predominantly lie outside the low risk category, but also because of the need for integration through central and distributed processing and required associated software. To accomplish the vast data handling requires at least VHSIC I.

Finally, it should be noted, that the MEP risk and cost are essentially independent of the aircraft configuration.

RECOMMENDATION

It is recommended that the Army push the available technology for deployment in the LHX at least at the medium risk level to achieve future added capability for the Army's Air-Land Battle Doctrine consistent with current cost and schedule objectives and constraints.

SPEED

ISSUE

Approximate top speeds of conventional helicopters projected for the LHX time frame is 180 knots, advanced helicopters such as compound ABC is 220 knots, and tilt rotor about 300 knots. Are the speeds above those of conventional helicopters important or required?

DISCUSSION

In examining the issue of speed, it is essential to understand that a conveyance of characteristics and capabilities is required in the low speed regime. Namely, regardless of top speed, the configuration chosen should essentially retain the attributes of the helicopters at low speeds such as its ability to hover and to perform maneuvers necessary for NOE flight.

Minimum achievable altitude is a function of speed over contoured terrain. Therefore, the LHX configuration should maintain or exceed the maneuvering capabilities of conventional helicopters to maintain low altitude when traversing terrain at intermediate speeds.

At speeds above 180 knots no basis exists for comparison. For the purpose of this discussion we will consider the highest speed configuration, namely the tilt rotor which gives a substantial (over fifty percent) speed margin over the helicopter, yet it demonstrates the promise of retaining the desirable attributes of helicopters at low and intermediate speeds. Because of the small speed margins of advanced helicopter configurations, they are not combined for the purposes of this discussion.

In addition to the speed advantage, the tilt rotor, in the high speed regime, when it converts to a fixed wing aircraft configuration offers a much improved lift to drag ratio and thusly a considerably enhanced cruise efficiency. Therefore, this configuration has as much as a two to one increase in specific range. With the background above established, let us discuss the advantages of speed for the following cases:

1. Logistics

   - o Self deployment
   - o Greater productivity
   - o Greater positioning flexibility for Forward Area Rearming and Refueling Point (FARRP)

2. Minimum time response

   - o Air-to-air pursuit and evasion
   - o Extended battlefield operations
   - o Special Operation Forces (SOF)
   - o Mass to scene

3. Efficiency

- o More time on station
- o Productivity

For self deployment an LHX tilt rotor configuration would have a range of 1500-2100 nautical miles as opposed to 800-1200 nautical miles for a helicopter, a nearly two to one increase in range accompanied by a (50%) fifty percent reduction in time to traverse the same distance. This presents a decisive advantage for European, Latin American, and Near East self-deployment scenarios. The price to be paid is in ease of transportability. It is estimated that not more than three, more likely two, tilt rotors can be transported in a C-141B as compared to four helicopters, and that the time to disassemble and assemble will be more for the tilt rotor.

The new positioning flexibility for FARRP is also associated with the extended range capability. The FAARP can be positioned farther back and each will have the capability of servicing a more extended area.

Air to air pursuit and evasion capability are required to counter the emerging air-to-air threat. Speed and increased maneuverability are perceived as advantages in this scenario. A speed advantage is desirable in both pursuit and evasion as well as engagement and reengagement of opposing air-to-air maneuverability threat.

The concept of the extended battlefield in the Army's Air-Land Battle Doctrine calls for extended range and shortened response times from LHX.

For SOF missions, fast response time associated with speed and increased range are necessary attributes for missions effectiveness if not, as may be in certain cases, to the feasibility of mission. Rapid response time for mass to scene, for example to contain an armored breakthrough is perceived as necessary in the extended battlefield concept. Likewise, increased productivity realized from the reduced turn around time from resupply to mission area is an inherent attribute of speed.

RECOMMENDATION

It will be in the 21st century when LHX is fully established in the force structure. It will have to counter the future threat of that time, and it will have to be responsive to doctrines that will evolve in the intervening period. It is recommended that the current generation of decision makers provide the next generation of field commanders with attributes for LHX that surpass today's helicopters. The increased speed, shortened time of response, and maneuverability of a well designed high speed capable tilt rotor LHX will give the ingenuity of the new generation of field commanders an additional dimension whose implications will be fully appreciated and utilized by them.

ONE VERSUS TWO MAN FLIGHT CREW

ISSUE

Should LHX be manned by one or two aviators?

DISCUSSION

Aside from psychological factors in combat, workload is considered the main determining factors for the selection of one versus two crew members aircraft for the purposes of this discussion. Workload is generally at a steady level with changes of the level for various parts of the mission, with NOE and simultaneous weapons management being the most demanding. Generally, one pilot is sufficient for the workload especially if mission equipment package provides automatic navigational aids.

The workload, on the other hand, exhibits peaks for brief periods. These are associated with target recording, enemy engagements, weapons set up and weapons delivery. It is during these peak workload periods that one may overload the single pilot or reduce effectiveness and survivability. Precautions to overcome these overload conditions can be taken at the outset of the design of the weapons system. Particularly desirable items in the MEP to reduce workload peaks are repeated here for completeness:

TABLE I, SINGLE PILOT SENSITIVE ITEMS IN MEP

- o Voice Command
- o Helmet mounted display
- o Real time terrain map
- o Precision navigation pilotage
- o Integrated flight control technology
  - Auto NOE
  - Auto terrain following
  - Auto obstacle avoidance
- o Fire and forget weapons

Since peaks in the workload occur during maneuvers associated with and during every engagement and weapons delivery, concentration of MEP monitors associated with this process is desirable. The characteristics of the weapons being employed present a large impact on crew workload. With a fire and forget weapon, where the pilot does only target queing, workload peaks can be minimized.

Some reduced capability, compared to two crew members, may be experienced at least initially as system architecture and software are matured. Overall benefits of the single crew capability will more than offset any reduced mission capability that may result.

RECOMMENDATION

It is recommended that LHX be a single seat aircraft. This is desirable from considerations of manpower savings and reduced training costs. The achievement of one man operation can be facilitated with technological aids to avoid excessive peak workload. These items should receive priority in the definition and development of mission equipment package and weapons delivery suite.

CONCLUSIONS AND RECOMMENDATIONS

AHSG's examination of the Army's LHX program has led to the following sets of conclusions and recommendations. We have a total of seven (7) conclusions and recommendations. Three are considered primary and four are considered secondary. These specific conclusions and recommendations are:

PRIMARY

A1. Speed/configuration

- Higher speeds are an essential ingredient of future doctrine/threat
- Higher speeds required are attainable by exploiting the demonstrated tilt rotor concept
- AHSG believes that the Army should make a decision on speed as soon as possible. An early decision on speed is important, because it would provide contractors with additional time to establish a competitive posture.

A2. Program management

- Centralized leadership is desired
- General Officer within Office, Vice Chief of Staff is recommended

A3. Crew size

- Single pilot operation is the proper goal
- Multipurpose fire-and-forget missile is desired to reduce peak pilot workload

SECONDARY

B1. Architecture and software development is a substantial challenge.

- VHSIC II
- Systems partitioning/distributed processing
- Lines of executable code
- Artificial intelligence
- Jovial, Ada

B2. Commonality of components is a desirable goal.

- Dynamic component
- Core avionics
- Other

B3. Selected emerging technologies are a concern.

- Passive signature reduction
- Active electronic countermeasures
- Millimeter (MM) wave radar

B4. Continuous simulation integrated into design process is essential.

- Airframe characteristics
- Control law validation
- Human factors/MEP
- Weapon's suite
- Pilot training

AHSG notes that the following technologies have been excluded from review:

- o Passive signature reduction
- o Active electronic countermeasures
- o MM wave radar

By not reviewing the above emerging technologies, a complete examination of many issues was not possible since some required LHX capabilities are dependent on these technologies.

APPENDICES

APPENDIX A

FIBER OPTICS

ISSUES

Use of fiber optics in "fly-by-light" LHX control system versus "fly-by-wire" flight controls.

Use of fiber optics in lieu of cabling and wiring in the flight avionics subsystem and the mission equipment package.

DISCUSSION

In both the applications listed under "Key Issues", the use of fiber optics potentially offers significant advantages compared to conventional flight control and cabling systems. The more salient advantages are:

- o Less weight
- o Resistance to nuclear effects such as electromagnetic pulse (EMP) and radiation
- o Resistance to electromagnetic interference (EMI) and electromagnetic compatibility (EMC) problems
- o High bandwidth and data rates
- o Lower cost

If the application of fiber optics to flight control/avionics systems were as mature as fly-by-wire and cable systems, there seems little doubt that these advantages would be significant contributors to an overall successful LHX mission design.

Weight is clearly a critical problem in any alternative being considered for the LHX. Therefore, design solutions for any portion of the system that save weight and are affordable are of high value.

Although it is not envisioned that the LHX would withstand direct close-in nuclear effects such as blast and heat, it must be able to operate in the vicinity of such effects. Electromagnetic pulse and radiation hardening of fly-by-wire or conventional flight control, avionics and MEP systems requires expensive filters and associated hardware. If fiber optics were used in the flight control, avionics, and MEP, a considerable portion of this weight and expense would be saved.

There are some benefits in the use of fiber optics in lieu of wires and cabling in reducing electromagnetic interference and electromagnetic compatibility problems, although not as significant as EMP and radiation hardening advantages.

Various sizing estimates of the signal bandwidth and data rates required for communications within and between subsystems have been made by the different contractor teams. These estimates differ somewhat, because it is too early in the overall program for precision. However, they all agree that the LHX will

have an extremely high overall data rate requirement. To meet this requirement with cables and wires will require substantial weight and bulk, whereas a small set of fiber optics bundles solves the problem completely.

During the time period envisioned for production of the LHX, including the product improvements that would occur over its life cycle, the cost of fiber optics hardware (fibers, connectors, electro-optic transducers, etc.) will be substantially less than cables, wire, and associated electrical hardware.

Considerations. The major considerations against the use of fiber optics all relate to risk of successful development of fiber optic components that meet the LHX performance requirements in time for the envisioned full scale development program. The major risk areas are:

o Splicers - splice hardware and associated tools and techniques to perform splices in the optic fiber.

o Electro-optical transducers (transmitters and receivers, probably using light-emitting diode (LED) technology).

o Connectors - to connect fiber to fiber and fiber to "wire." (Requires transducer technology.)

o Fiber optics bus technology with ability to drop off individual data channels or groups of data channels through bus interface units.

o Repeater technology - required to amplify the light in a distortion free manner for long fiber optic transmission lengths.

o Overall packaging design to meet environmental Military-Specifications (MIL-SPEC) requirements.

There is little doubt that fiber optics technology - theoretical knowledge, data bases, automated design aids, production processes, and test improvements - is maturing rapidly. It is currently being used in some commercial telecommunication applications in lieu of large, expensive cabling in urban cable plants. Many development programs are being touted by numerous companies that will use fiber optics in localized situations, such as buildings, campuses, etc.; however, most current estimates state that widespread use of fiber optics as a complete replacement for coaxial or baseband cable is still several years away. These estimates are based on economic factors and readiness of the technology.

Also, applications such as those described above are not as demanding in reliability, maintainability, survivability, and data rate performance as are the LHX requirements. Nonetheless, they represent a gauge by which judgment assessment of risk can be made in the application of fiber optics to the LHX.

Splicing technology is maturing rapidly. Actual splicers and the tools by which splices are made are now commercially available. This is a vital requirement for maintenance, repair, and product improvements of any fiber optics used aboard the LHX. This should represent a low risk area.

SUMMARY/RECOMMENDATIONS

Fiber optics, overall, clearly offers substantial performance, weight and cost advantages in a "fly-by-light" control system, other avionics, and MEP. There are technical risks associated with achieving the critical technologies in the time period envisioned for full scale development of the LHX. It is recommended that:

(1) Priority effort be given by the Army and its contractors, beginning now, to identify the critical component specifications required for fiber optic buses in the avionics, and mission equipment package, within the Advanced Rotorcraft Technology Integration program.

(2) Continue the pursuit of the Advance Digital Optical Control System program by Applied Technology Laboratory to reduce fly-by-light risks, and provide the data to Advance Rotorcraft Technology Integration contractors.

APPENDIX B

LHX AIRCRAFT CONFIGURATION/VERSIONS

ISSUE

What are the merits of the LHX family being composed of a SCAT-Utility mix compared to an LHX family consisting of a mix of Scout, Attack and Utility airframe configuration?

DISCUSSION

Central to selecting the mix of LHX airframes is total system cost over the lifetime of the fleet. Commonality of engines, rotors, drive systems, core avionics components and major subsystems, which will save Research, Development, Technology, and Evaluation (RDTE) dollars, must be exploited such that each vehicle designed for a specfic function is not overly penalized by carrying equipment of unneeded complexity. The greatest difference between a separate Scout and Attack version is armaments. An unarmed Scout in the years beyond 2000 is not acceptable. Justification of the combined Scout and Attack is made with identical mission equipment package requirements resulting in reduced weight differences between the two versions. RDTE costs for training devices and simulators for a SCAT option are less than the costs for training required for a separate Scout and Attack option. The SCAT option offers greater flexibility in tactical employment (attack units, air cavalry units, forward aerial artillery observer functions) than a separate Scout and Attack option.

The future mission requirements for the Utility version are significantly different from those of the SCAT that unique airframes are warranted. Commonality of engines, rotor system, drive train, and transmission between the SCAT version and the Utility version is expected. MEP and weapon requirements for the Utility are less demanding than similar requirements for the SCAT Utility configurations.

RECOMMENDATION/CONCLUSIONS

A LHX family of rotorcraft, consisting of a mix of SCAT and Utility configurations, offers advantages over a mix consisting of separate configurations for the Scout, Attack, and Utility versions. It is recommended that:

o The Army stress the need for commonality for dynamic and core avionics components subsystems between LHX-SCAT and LHX-Utility to minimize acquisition costs and O&S costs.

o The Army develop training aids, devices, and materials concurrently for the LHX-SCAT and LHX-Utility.

o The Army develop the LHX-SCAT and LHX-Utility currently by the same contractor/government team.

o The Army control the LHX-SCAT and LHX-Utility mix by moderating quantities during production buy.

APPENDIX C

TILT ROTOR/XV-15 AIRCRAFT

ISSUES

Are there performance advantages provided by a tilt rotor configuration for LHX?

Are there cost advantages provided by a tilt rotor configuration for LHX?

DISCUSSION

Several rotorcraft configurations are candidates for LHX. These include the following:

- o conventional helicopter
- o conventional Advancing Blade Concept
- o compound conventional helicopter
- o compound Advancing Blade Concept
- o tilt rotor
- o X-wing

As cited in the above discussion on risk, the X-wing concept is not in the LHX time frame.

Trade-off determination (TOD) baseline designs which were generated based upon fallout maneuverability, i.e., engine power, and rotor design based on vertical rate of climb (VROC), dash speed and/or structural requirements have compared maneuverability for possible LHX configurations. In hover, the TOD conventional helicopter was predicted to be superior in maneuverability to other LHX candidate configurations. At speeds equal to or greater than 100 knots, the conventional helicopter was predicted to be inferior in maneuverability to other LHX candidate configurations. One may conclude from these TOD results that the conventional helicopter is a better performer at low speeds, the tilt rotor is a better performer at higher speeds, and that the compound configurations have a performance profile which is bounded by the conventional helicopter and the tilt rotor.

Comparing other configuration attributes such as: autorotation, vibration, weapon/sensor view control, maximum speed, productivity and endurance, the tilt rotor configuration is, on average clearly superior to the other LHX candidate configurations. On average the advancing blade concept configurations are superior to the conventional helicopter configurations but are inferior to the tilt rotor. The advancing blade concept configurations are heavier and more expensive than conventional helicopters. The specific attributes from the TOD designs are shown on the attached table.

TOD PROJECTIONS OF

CONFIGURATION ATTRIBUTES

	HELICOPTER		COMPOUND			
CHARACTERISTIC	CONV	ABC	CONV	ABC	TILT ROTOR	
AUTOROTATION	GOOD	FAIR	GOOD	FAIR	FAIR	L.S.
MANEUVERABILITY	GOOD L.S.* POOR H.S.*	GOOD L.S. GOOD H.S.	GOOD L.S. GOOD H.S.	GOOD L.S. GOOD H.S.	FAIR GOOD	L.S H.S.
VIBRATORY CHARACTERISTICS	HIGH	HIGH	MED	HIGH	LOW	
WEAPON/SENSOR VIEW CONTROL (BODY PITCH)	POOR	POOR	FAIR	FAIR	GOOD	
PERFORMANCE SPEED (MAX)	180	180	220	220	300	
PRODUCTIVITY	LOW	LOW	LOW	LOW	HIGH	
ENDURANCE SPEED RANGE	50-120	50-120	50-120	50-120	50-190	

*L.S. - Low Speed
H.S. - High Speed

Normalizing base line configurations on mission requirements, the tilt rotor configurations have a weight and cost penalty of approximately ten percent (10%) over the conventional helicopter configuration.

Additional factors to be considered in discussing the tilt rotor includes the following:

o Extensive testing of the XV-15 reduces tilt rotor technical risks for LHX application.

o Although not the superior performer at low speeds, the tilt rotor is a satisfactory performer at low speeds based on XV-15 experiences.

o A tilt rotor LHX will insure against conceding a future high speed performance advantage to the Soviets.

RECOMMENDATIONS/CONCLUSIONS

The advantages associated with the tilt rotor configurations consisting of superior performance (on average), lowest technical risk, and insurance against a future high speed performance threat outweigh the disadvantages of the small increase in weight and cost of a tilt rotor compared to a conventional helicopter. It is recommended that the Army select the tilt rotor configuration for LHX application.

APPENDIX D

SIMULATION

ISSUE

To what extent should simulation be used in the development process?

DISCUSSION

To the maximum extent possible airframe characteristics and dynamics minimum equipment package and weapon suite integration should be examined. Using such engineering simulation, if validly done, will give insight into machine and man machine interaction and contribute to risk reduction by providing timely design information before final hardware is cut. A variant of the engineering simulators can evolve in a timely manner to become the training simulator by providing an accurate analytical mathematical model.

RECOMMENDATION

Use engineering simulation to the maximum extent possible during development and evolve a training simulator from the above in a timely manner.

APPENDIX E

MEP/ARTI/AIRCREW INTEGRATION

ISSUE

Is the ARTI program sufficient to support a rational and objective one-man versus two-man cockpit decision? Are the mission equipment package technologies sufficient to support rational missions?

DISCUSSION

In general, the ARTI program analysis/evaluation methodology being employed by each of the contractors (as described in briefings to the LHX ASB panel) is sound. The overall methodology generally consists of the following patterns:

(1) Analysis and understanding of the 48 mission scenarios and attribute requirements provided by the Army.

(2) Derivation of functional requirements from the mission requirements.

(3) Preliminary man-machine task allocations.

(4) Preliminary definitions of candidate system configurations.

(5) Aircrew task workload analysis via simulation.

(6) Evaluation of aircrew workload for each system configuration in terms of systems mission effectiveness.

(7) Alteration of the process until "best" system is defined.

(8) Evaluation of technology availability/risk to support the "best" system functional requirements.

The current plans for the ARTI program indicate completion of Phase I during late FY84 and completion of Phase II by the end of FY85. Thus, if schedule is maintained, the results of ARTI will be available at the beginning of the LHX full scale development program.

A crucial output of the ARTI program will be the aircrew workload profiles. They will be the quantitative basis on which the decision of one vs. two-man crew will be based. The panel perceives a tendency by TRADOC to select the highest workload on the "busiest" segment of the toughest of the 48 mission profiles as the driver of requirements. This view will unquestionably support the need for a two-man crew. The panel believes that a different point of view should be adopted. Specifically, the Army should direct the contractors, as part of the ARTI program, to select a one-man cockpit and optimize it with the technology that is expected to be available via the ARTI studies, for flight control, avionics, and mission equipment package. This would probably lead to two or three alternate one-man configurations. Then, mission simulations, based on the finally approved 48 mission profiles, could be applied explicitly to three one-man configurations and specific pilot workload profiles developed.

Only if an overwhelming shortfall exists in many of the 48 missions should the decision be made to go to a two-man crew. Mission effectiveness thresholds can and should be evaluated with one-man crew emphasis. For example, (hypothetically) the data might show that a one-man crew can accomplish at least ninety five percent (95%) of the tasks for eighty five percent (85%) of the 48 missions. If such were the case, the size, weight, and support cost savings compared to a two-man crew would clearly support the rationale for a one-man crew.

The panel informally talked to several aviators to get their judgments on the question of crew size. No "scientific" sample survey was indicated; however, a strong difference of opinion surfaced that the panel suspects is correlated to age and experience of the pilots. Older more experienced pilots tended to say that one-man missions were commonplace in the older vintage helicopters of the 1950-1965 era and that they were effective. Younger lesser experienced pilots, who "grew up" with two-man missions, post 1965, tended to say that two-man crews were essential for effectivenss. It appears that there are strong opinions on both sides of this issue and that each side will, in all good faith, advocate its position, independent of analysis per se.

With this confusing environment, the panel believes the ARTI program should not be an open ended analysis that generates page after page of workload profiles and a "hope" that the obvious answer will emerge. Rather, the Army should specify that a one-man crew is desired and use the ARTI program to validate the decision. The Army should only back off to a two-man crew if overwhelming inadequacies are uncovered during the ARTI validation analyses.

Without this firm direction, the panel doubts that the ARTI, however good the methodology, will support the decision.

Turning to the question of mission equipment package technologies, one should keep it in mind that the ARTI workload profiled and the resulting mission effectiveness models are only as valid as the predicted performance of the mission equipment package subsystems.

Insofar as weapons are concerned, it is clear that the overall function of target engagement, target acquisition (detection, location, identification), weapons selection, firing, and guidance to target, will impose a demanding workload on the pilot. To the extent that these functions are automated or semi-automated by technology, the workload is reduced. The critical technologies that must be realized in hard subsystems designs to support these functions are:

- o Forward looking infrared
- o MM wave radar
- o VHSIC Based Processors
- o Self-contained homing missiles

The panel assesses that technology supporting the first three elements is sufficiently mature to be realizable in the time period for full scale development of the LHX. The fourth element is questionable. Current Army guidance that prohibits development of a special missile for the LHX should not be interpreted as using only the missile, that exists today. Rather, it should be interpreted as design guidance so that the LHX must be able to deploy the

missiles of today, but be able to accept new multipurpose smart missiles as they are developed.

Thus, at the outset of the program, the lack of a true self-contained homing missile is one deficiency that, increases pilot workload; even though the other technologies are available. However, this deficiency contributes as much to vulnerability as to increased workload. The panel perceives vulnerability as the critical issue relating to lack of a true self-guided missile and does not see it as a driver for a two-man crew.

Within the myriad of other functions of the mission equipment package, the most crucial are those that support navigation (in three dimensions) and automatic flight control so that day-night, adverse weather, low-level operations can be conducted. There are minimum levels of advanced navigation technology required to be able to conduct those operations, regardless of number of crew. For example, if the requirement for nighttime, poor visibility, nap-of-the-earth operations were removed, the demands on technology for the navigation system are reduced considerably, independent of number of crew. The panel believes that the integration of all the sensor technologies into the type of system that permits all these operations is a major risk area in the timeframe of LHX full scale development. Clearly, the Integrated Communications, Navigations, Identification Avionics (ICNIA) program sponsored by the U.S. Air Force, will not be mature by then. Therefore, some compromise will have to be made in those missions that are most demanding of navigation automatic flight control for the initial operating capability (IOC). The technologies that will be available, however, such as:

(1) Global Positioning System (GPS) Navigation of PLRS

(2) Joint Tactical Information Distribution System (JTIDS)

(3) Fly-by-Wire or Fly-by-Light

(4) Terrain Map processing and display

(5) Attitude and heading reference systems

(6) VHSIC-based high speed processors

will be a major advance in capabilities compared to systems today. They will support all the missions with the exception of nighttime, adverse weather, and and NOE flight.

Lastly, based on the briefings to date, the panel believes there is insufficient attention being given to the aircraft self-protect and electronic warfare aspects of the MEP. We offer no specific conclusions other than that requirements for these aspects should be developed and validated prior to start of full scale development. If provisions for these capabilities, should they be required, are not included, later modifications to accommodate them will cause program delays and extensive cost growth.

SUMMARY/RECOMMENDATION

The Advanced Rotorcraft Technology Integration (ARTI) program methodology is sound. Pilot workload analysis, validated by simulation, are an essential tool. The issue of one-man vs. two-man cockpit has strong competent, and opinionated advocates on both sides among the pilot community. Without a firm direction to configure a one-man cockpit and use of the ARTI methodology to test and validate, the configuration decision will be postponed needlessly. The ARTI program objectives should be restated to direct a one-man configuration and use the ARTI tools for test validation of the configuration. In general, the MEP technologies being considered will support rational missions except for the lack of a true self-contained homing missile. Such a multipurpose missile appears to be a generic need for many uses in the Army. The major impact of lack of such a system is increased vulnerability rather than a driver for added crew members. Integrated navigation, avionics, and flight control systems are a major risk in the time period envisioned for full scale development of the LHX. The impact will be a compromise in some operations, notably nighttime, low visibility, NOE. However, the technologies that are available will support a number of rational missions compared to systems today.

Aircraft self protect and electronic warfare requirements for the LHX are conspicuous by their absence. Provisions for these requirements should be well defined before beginning full scale development. This should be added to the ARTI scope.

(1) The ARTI objectives should be restated to configure and validate a one-man concept.

(2) The requirements for MEP should clearly state that the LHX must be able to employ specific current weapons but should be capable, via product improvement programs, of accommodating a self-contained homing missile should one be developed.

(3) Nighttime, poor visibility, NOE operating requirements should be removed from the IOC MEP specifications; they should be considered as a product improvement program when the ICNIA technology is mature.

(4) Aircraft self-protect and electronic warfare requirements should be defined by the Army and added to the ARTI program.

APPENDIX F

VHSIC I, VHSIC II, AND SOFTWARE

ISSUES

Will VHSIC chips be available in time to develop the processors required by the LHX Program?

Will the processors provide the combination of speed, memory storage, size, weight and power to meet the extremely high processing demands of the avionics systems and MEP of the LHX Program?

Are distributed processing architectures and software technologies adequate to support the requirements of the LHX Program?

DISCUSSION

There are some significant differences of opinion among the contractors regarding the peak processing requirements that will be generated by the LHX sensors and flight control/avionics systems. These differences are due, in part, to differences in configurations, design approach, and assessments of availability of sensor technology during the time period envisioned for LHX full scale development. However, all are in agreement, including the ASB AHSG, that the demands will be severe. One contractor, assessed that if the sensor communications and flight control technologies were available to meet every single mission requirement without exception, the general purpose instructions processing load would be 100 million instructions per second (MIPS). This figure represents somewhat of a pathological case in that precise estimates of the peak processing load for each mission profile and its time duration have not been made. Nor can they be accomplished until more design definition of the flight control/avionics and MEP's are completed. Thus, at this point in time, technical judgments must suffice in the determination of processing requirements and VHSIC availability to meet those requirements.

First, it should be pointed out that a detailed functional analysis of the flight control/avionics system and the MEP is likely to show that many of the processing steps can be organized to take place in parallel. Thus, substantial partitioning of the processing routines will undoubtedly be possible during systems design, which says that multiple processors can be assigned in parallel. Therefore, the demand in any given processor will be substantially less than the peak demand of the entire system.

Secondly, as has been recognized by all the required, processing is very specialized "number crunching", such as vector arithmetic, metric operations, and the like. These types of operations can be realized in special VHSIC chips such as systolic processors which run many thousands of times faster than flexible, more general purpose machines.

The main point of this discussion, so far, is that systems partitioning and processing architecture are even more important than VHSIC technology by itself in determining if enough processing "horsepower" can be put aboard the LHX. An inefficient, poorly defined, and poorly organized processing systems

architecture will not be able to meet the severe demands regardless of VHSIC technology. It is clear that distributed processing, tied together through either a bus structure or a star network with a central controller, will be required.

Before addressing VHSIC specifically, some discussion on the viability of distributed processing architectures is necessary. If a star network were adopted, each processor assigned a task or set of tasks would communicate only through a central processor who would be the communications "traffic cop", as well as perform certain high level systems processing architecture. Among its disadvantages are:

(1) Failure of the central processor kills the whole system so significant reliability and/or redundancy is required.

(2) The processing load on the central processor may be too severe to fit into size, weight, and volume applications.

Another approach, and the one seemingly favored by the contractors, is to use a bus architecture. The panel generally agrees that this is a preferred approach. Here, processors communicate freely with other processors over the bus. The disadvantages are:

(1) Each processor requires a bus interface unit to tie into the bus.

(2) For the LHX requirements, an extremely high data rate (bandwidth) bus is required.

The advantages are significant:

(1) The system has graceful degradation. Failure of any give processor does not affect the rest of the system.

(2) The processing load can be distributed and redistributed fairly easily to ensure optional balancing.

(3) Systems growth is substantially simpler to achieve.

For purposes of the VHSIC discussion, the panel assumes that a bus architecture will be used which takes maximum advantage of distributed architecture. Thus, the processing load in any given processor and in particular the "busiest" general purpose processor drives the VHSIC requirement. Unfortunately, as mentioned earlier, no accurate sizing estimates for the processing load for any architecture are yet available. However, Table I indicates the viability of meeting various levels of processing requirements with VHSIC I technology.

TABLE I

GP Processor Requirement	Probability of Meeting with VHSIC I
Less than five million instructions per second (MIPS)	Very High
5 - 7 MIPS	High
7 - 10 MIPS	Medium
Greater than 10 MIPS	Low

The basis for this table are the data presented by the contractors during briefing to the panel, plus some added discussions with two VHSIC contractors on their current work in developing Military-Standard (MIL-STD) 1750 A processors with VHSIC technology. A 5 MIP machine in a small configuration (1/2 Average Transfer Rate [ATR] case or less) is a very powerful computer. The panel believes that a solid systems engineering effort leading to an optimal distributed processing architecture can support the LHX objectives using VHSIC I technology.

Having the basic technology, both VHSIC and processing architecture, to support the LHX design is of marginal value if the software technology is not in hand to "make it play". The nature of the software risk is more difficult to pinpoint than the processing hardware and VHSIC risk. It is really a multitude of interrelated factors.

First, the sheer size of the software package, measured in lines of executable code, will undoubtedly be very large for the LHX program, even when many functions are relegated to special processors during systems engineering allocations. There will still be a very large number of routines, subroutines, and units in software. By analogy, if the software package in the LHX were no greater than that of the EH-60 Helicopter, or the Boeing 767 commercial airplane, there would be several hundred thousand lines of executable code in the flight control/avionics and the MEP. The fact is that the LHX will be even more complex than these examples.

Second, large real-time software systems are difficult to manage during the design and development phase. If not absolutely tightly specified early in the program, via a strong-disciplined software requirements engineering effort, costs will mount substantially beyond original estimates, schedule slips will occur, and software will become the critical path item in the program, rather than the critical hardware technologies that have been cited.

Third, large, complex real-time software programs contain millions of executable paths through the instructions. Some of these paths are not desirable nor intended. Were any of these paths to be executed during actual missions, the output result could, at best, be mission-event failure and, at worst, fatal in the LHX. Therefore, strongly disciplined software verification and validation techniques must be employed during the full scale development program. A major, robust software test and software/hardware integration test program must be completed. Thorough software user and technical documentation must be obtained and validated. Otherwise, costly errors in terms of time and dollars to repair, and perhaps in lives, will occur after fielding.

The aforementioned discussion is valid for mature instruction set architectures and mature high order languages, such as FORTRAN. It is even more valid since newly introduced instruction sets, such as NEBULA and Ada, have been enumerated in other studies. However, a complete development and support environment for Ada is not at a high level of maturity at the time of this report. Validated Ada compilers are few in number and, although they are accurate, the efficiency of their executable object code is not yet known. The LHX Program Office must make an early determination, prior to start of full scale development of the availability of software support tools before settling the software language and architecture requirements in concrete.

Reference is made to Army Science Board Summer Study Report, August 1983, "Acquisition of Army Software" for more detailed discussions and recommendations on software in tactical Army systems. The panel concludes that software technology is sufficiently mature to support the LHX program provided the recommendations in this document are followed without exception.

SUMMARY/RECOMMENDATIONS

The present state-of-the-art in distributed processing architecture and the progress in developing MIL-STD 1750 A processors with VHSIC technology will support the development of the LHX flight control system, other avionics, and the MEP in the time period envisioned for LHX full scale development. However, this conclusion must be verified by early quantitative estimates of the processing load that will be demanded by the various sytems. If, as preliminary estimates by the contractors indicate, the processing load per processor can be handled by a processor with a 7 MIPS or less capability the conclusion is clearly valid.

Software poses as much, if not more, developmental risk as does the VHSIC and computer architecture technologies. Advanced systems engineering and performance allocation methodologies must be employed from the first day in the full scale development program so that a precise software requirements engineering effort can be completed by the time of the detailed systems design review. If detailed and qualified software requirements specifications are not in hand and placed under tight systems-level configuration management by the time of system design review, there will unquestionably be unplanned schedule slips and cost growth in the software. A strong software verification and validation (V&V) program must be employed by the development contractor and an independent verification and validation (IV&V) program should be employed by the government program office. If the NEBULA computer instruction set architecture and the Ada high-order language are selected as standards for the program, there will likely be some added schedule and cost risk and there should be only a small added technical performance risk. These risks can be reduced if a strong, technically competent software management team is made part of the LHX Program Office. This team should ensure early availability of software development tools, such as Ada compilers, liners, editors simulators, and operating system.

Provided these steps are taken in both hardware and software, the panel concludes that the VHSIC I, distributed computer architecture, and software development technologies are sufficient to support the performance goals of the LHX Program.

(1) The panel recommends that quantitative estimates of the processor load be pursued in depth as early as possible (even prior to start of full scale development) to validate that present distributed processing architecture, bus technology, and VHSIC technology will support the LHX Program.

(2) The panel recommends that the software development management disciplines enumerated in ASB Summer Study Report, August, 1983, "Acquisiton of Army Software", be employed without exception in the LHX Program.

ATTACHMENTS

A. Terms of Reference for the Study

B. AHSG Membership

C. Army Advisors

D. AHSG Calendar

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310

21 NOV 1983

Dr. Wilson Talley
Chairman, Army Science Board
One Clipper Hill
Oakland, CA 94618

Dear Dr. Talley:

I request you appoint an Ad Hoc Subgroup (AHSG) of five to seven Army Science Board Members (ASB) to examine a limited number of critical issues related to the Army's LHX aircraft program. The LHX is important to the Army in that it responds to a need to replace a helicopter fleet that is old and technically obsolete. Although the Army is proceeding with a comprehensive concept analysis, there are several critical issues that require additional validation and confirmation for the FY 85 Congressional budget submission and hearings as well as the FY 86-90 POM formulation. This requires that the AHSG complete the essential elements of its deliberations no later than mid-January 1984. My ASB staff is prepared to assist in accomplishing this activity on an accelerated schedule.

The AHSG should conduct a comprehensive review of LHX requirements, technology and specific critical issues that are expected to be addressed in the Congressional hearings. The nature and importance of these issues impact on early decisions in the LHX program development. The enclosure identifies several potential issues with their respective impacts. However, in the time allocated to achieve results from the AHSG, we believe only the most important key issues should be addressed. Specifically, we would like to have the AHSG address the following:

o Review the importance of speed as it relates to the Army's Airland Battle Doctrine and more advanced extended battle concepts and the scenarios in which the LHX may be required to operate in the 1990's and 2000's. The uncertainties of the future, the extended battlefield, and such occurrences as air-to-air encounters/combat identify LHX speed as a critical design factor that influences engine size, aircraft size and weight, aerodynamic design, configuration, etc.

o Review the management and technical aspects of incorporation of significantly advanced signature reduction concepts in the LHX aircraft development. Management of stealth goals involves diffusion of technology, GFE/CFE and security control of the advanced technology. Technical aspects of the review should consider performance potential and payoffs for LHX, specific goals that should be identified, and technical diffusion among the design teams. We do not believe that execution of the management task will require access to sensitive data; however, the technical aspect may require special access, preferably by not more than two members. If possible, advantage should be taken of ASB members with the required clearances.

o Review other potential issues shown in the enclosure and those which are considered critical to Congressional hearings and POM formulations as time permits. It may be appropriate to continue the LHX AHSG activities to address issues other than those cited as an on-going effort.

BG(P) Robert F. Molinelli, DAMO-FD is the HQDA sponsor, Mr. Richard L. Ballard, DAMA-WSA is the senior advisor, MAJ Lou Herrick, DAMO-FDD is the staff assistant and COL Matthew Kambrod is the cognizant deputy in OASA(RDA) for this group.

As discussed above, it is most urgent that this AHSG initiate its efforts as soon as possible and provide results in the mid-January 1984 time frame.

Sincerely,

Amoretta M. Hoeber

Encls

Amoretta M. Hoeber
Principal Deputy Assistant Secretary of the Army
(Research, Development and Acquisition)

MEMBERSHIP

ARMY SCIENCE BOARD AD HOC SUBGROUP

ON

ARMY LHX PROGRAM

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DIRECTOR, MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)

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HQDA STAFF ASSISTANT

LTC EMERY L. HERRICK

STAFF OFFICER, ODCSOPS

ARMY SCIENCE BOARD

AD HOC SUBGROUP CALENDAR

DATE	LOCATION	EVENT
15-16 DECEMBER 1983	PENTAGON, WASH, DC	o SUBGROUP IS FORMED
		o INITIAL BRIEFINGS ON LHX PROGRAM
		o DECISION MADE THAT ASB WILL STUDY LHX IN A TOTAL SYSTEM APPROACH
22-23 DECEMBER 1983	AVSCOM, ST LOUIS, MO	o ASB IS BRIEFED ON THE LHX TRADE-OFF DETERMINATION BOARD FINDINGS
		o REVIEW OF LHX TECHNOLOGY, PROGRAM SCHEDULE, AND FINDINGS
5-6 JANUARY 1984	DCD, FT RUCKER, AL	o ASB IS BRIEFED ON THE LHX TRADE-OFF ANALYSIS PROGRAM
		o "USER" REQUIREMENTS FOR LHX ARE PRESENTED AND REVIEWED
12-13 JANUARY 1984	PENTAGON, WASH, DC	o ASB CONVENES TO DISCUSS FINDINGS FOR DEVELOPMENT AND REQUIREMENT FOR LHX
		o INITIAL REPORT IS PREPARED
		o SIDE ISSUES ARE DEVELOPED FOR FUTURE STUDY
19 JANUARY 1984	FT RUCKER, AL	o PRESENTATION TO GENERAL OFFICER REVIEW
20 JANUARY 1984	PENTAGON, WASH, DC	o PRESENTATION TO PRINCIPAL DEPUTY ASSISTANT SECRETARY OF THE ARMY (RDA)
12-15 APRIL 1984	AMES RESEARCH CTR	o REVIEW TILT ROTOR, X-WING, SIMULATOR, TECHNOLOGIES
30 MAY - 1 JUNE 1984	PENTAGON, WASH ,DC	o REVIEW XV-15 FLIGHT TEST RESULTS, X-WING PROGRAM, ASSEMBLE FINAL BRIEFING REPORT
12-14 JUNE 1984	FORT ORD, CA	o BRIEF TO ASB WEAPON SYSTEMS FUNCTIONAL SUBGROUP

GLOSSARY

AAH	-	Advanced Attack Helicopter
ABC	-	Advancing Blade Concept
ADOCS	-	Advanced Digital Optical Control System
AHIP	-	Army Helicopter Improvement Program
AHSG	-	Ad Hoc Study Group
AMC	-	Army Materiel Command
ARTI	-	Advanced Rotorcraft Technology Integration
ASH	-	Advanced Scout Helicopter
ATL	-	Applied Technology Laboratory
ATR	-	Average Transfer Rate
AVSCOM	-	Aviation Systems Command
CSWS	-	Corps Support Weapons System
ECM	-	Electronic Countermeasures
EMC	-	Electromagnetic Compatibility
EMI	-	Electromagnetic Interface
EMP	-	Electromagnetic Pulse
FAARP	-	Forward Area Rearming & Refueling Point
FLOT	-	Forward Line of Troops
FORTRAN	-	Formula Translation Computer Language
FPA	-	Focal Plane Array
FSED	-	Full Scale Engineering Development
FUE	-	First Unit Equipped
FY	-	Fiscal Year
GPS	-	Global Positioning System
ICNIA	-	Integrated Communications, Navigation, Identification, Avionics
IOC	-	Initial Operating Capability
IR	-	Infra-Red
IV&V	-	Independent Verification and Validation
JTIDS	-	Joint Tactical Information Distribution System
LED	-	Light Emitting Diode
LHX	-	Light Helicopter Family
MEP	-	Mission Equipment Package
MIPS	-	Million Instructions Per Second
MM	-	Millimeter
MIL-SPEC	-	Military-Specifications
MIL-STD	-	Military-Standard
NBC	-	Nuclear, Biological, Chemical
NEBULA	-	Computer Instruction Set Architecture
NOE	-	Nap of the Earth
O&S	-	Operating and Support
PLRS	-	Position Location Reporting System
RAM	-	Reliability, Availability, Maintainability
R&D	-	Research and Development
RDTE	-	Research, Development, Technology, and Evaluation
SCAT	-	Scout/Attack
SOF	-	Special Operations Forces
TOD	-	Trade Off Determination
TOW	-	Tube Launched, Optically Tracked, Wire Guided
TRADOC	-	Training and Doctrine Command
VHSIC	-	Very High Speed Integrated Circuits
V&V	-	Verification and Validation

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