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THE PROJECT FOR ANTI-TANK HELICOPTER

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ABSTRACT

DESPITE ITS PROVEN UTILITY AS AERIAL PLATFORM CAPABLE TO ENHANCE THE EFFICIENCY OF LONG-RANGE ANTI-TANK MISSILE WEAPONS, THE HELICOPTER, IF NOT ADEQUATELY CONFIGURED AND EQUIPPED TO MINIMIZE ITS INTRINSIC LIMITATIONS (VULNERABI LITY, INTERFACE COMPLEXITY, SYSTEM FLEXIBILITY, ETC.) IN A MODERN BATTLEFIELD, MAY BE CONFRONTED BY SEVERE OPERA TION LIMITATIONS. TAKEN THIS IN MIND AND THE EXPERIENCE GAINED IN THE SUE OF ARMED HELICOPTERS THE A-129 HAS BEEN DEVELOPED.

SEVERAL TRADE-OFFS HAVE BEEN MADE DURING THE DEVELOPMENT PHASE BUT ALWAYS CONSIDERING THE FOLLOWING:TASKS:

- ACCOMPLISH THE MISSION AND:
  - .. AVOID DETECTION
  - .. IF DETECTED, AVOID BEING HIT
  - .. IF HIT, CONTINUE THE MISSION
  - .. IF EMERGENCY LANDING IS NECESSARY, MAKE IT SAFELY.

THE AGUSTA 129 IS THE RESULT OF THE OPTIMIZATION OF THE RE SPONSES TO THIS REQUIREMENT THROUGH THE ADOPTION OF THE MOST ADVANCED TECHNOLOGIES.

THE A-129 REPRESENTS, IN A MODERN BATTLEFIELD, A SIGNIFI- CANT IMPROVEMENT WHEN COMPARED TO NON-DEDICATED AIRCRAFT; FURTHERMORE ITS TECHNOLOGICAL IMPROVEMENTS MAKE IT POSSI- BLE TO COMPARE ITS EFFECTIVENESS ALSO WITH OTHER DEDICATED HELICOPTERS.

1. GENERAL: WHY AN ANTITANK HELICOPTER? (Fig. 1)

THE NATO DEFENSIVE DOCTRINE TO COUNTERACT WARSAW PACT FORCES WHICH ARE SUPERIOR IN WEAPONS AND MEANS AND ENJOY THE ADVANTAGE OF INITIATIVE, REQUIRES THE ADOPTION OF AN INSTRUMENT TO ADEQUATELY AND TIMELY OPPOSE THE ENEMY FORMATIONS ALONG THE GRAVITATIONAL AXES CHOSEN BY THE ENEMY.

THE ARMOURED RESERVES WHICH ARE PARTICULARLY SUITABLE TO MEET THE REQUIREMENT COULD SEE THEIR CAPABILITY OF EFFECTIVE AND PROMPT INTERVENTION JEOPARDIZED BY THE HOSTILE AVIATION THREAT. HENCE THE OPPORTUNITY TO RESORT TO THE ANTITANK HELICOPTER, WHICH BEING MUCH FASTER THAN ANY SURFACE VEHICLE AND ALSO NOT BEING SUBJECT TO THE LIMITATIONS POSED BY THE TERRAIN, OFFERS THE MOST EXTENSIVE POSSIBILITIES OF PROMPT INTERVENTION.

NONETHELESS, DESPITE ITS PROVEN UTILITY AS AERIAL PLATFORM CAPABLE TO ENHANCE THE EFFICIENCY OF LONG-RANGE ANTITANK MISSILE WEAPONS, THE ANTITANK HELICOPTER, IF NOT ADEQUATELY CONFIGURED AND EQUIPPED TO MINIMIZE ITS INTRINSIC VULNERABILITY, IN THE MODERN BATTLEFIELD MAY BE CONFRONTED WITH SEVERE OPERATION LIMITATIONS.

THE ROLE OF THE ATTACK HELICOPTER

IT IS A FACT THAT AS ANY NEW SYSTEM THE ATTACK HELICOPTER HAS ITS ADVOCATES AND CRITICS.

OUR OPINION IS THAT THE HELICOPTER IS NOT THE TOTAL ANSWER TO OPPOSING ARMORED FORCES NEITHER IT IS NON-SURVIVABLE AS CRITICS MIGHT OPPOSE. THE OUTCOME OF ARMED HELICOPTERS AGAINST ARMORED FORCES EQUIPPED WITH EFFECTIVE AIR DEFENSE SYSTEMS IS A FUNCTION OF BOTH THE HELICOPTER'S DESIGN AND ITS TACTICAL EMPLOYMENT.

REQUIREMENTS FOR ARMED HELICOPTERS ARE ALSO VERY MUCH SCENARIO DEPENDENT AND HAVE SEEN A CONSIDERABLE EVOLUTION IN BOTH KIND AND DEGREE OF ARMAMENT SUBSYSTEMS WITH THE PASSAGE OF TIME. THERE HAVE BEEN SEVERAL TRANSITIONAL STAGES IN THIS EVOLUTIONARY PROCESS. THE FIRST STAGE WAS SELF-DEFENSE OF THE UTILITY HELICOPTER.

A VARIETY OF MACHINE GUN, GRENADE LAUNCHER, AND ROCKET KITS WERE BUILT AND ADAPTED TO UTILITY HELICOPTERS TO MEET THIS PURPOSE. THE NATURAL EXTENSION OF THIS CAPABILITY WAS TO PROVIDE FIRE SUPPORT AGAINST IDENTIFIED TARGETS BEYOND THE IMMEDIATE ZONE OF GROUND COMBAT.

IT HAS BECOME EVIDENT, HOWEVER, THAT THERE WAS JUSTIFICATION FOR MAJOR TRANSITION FROM A MULTI-PURPOSE TO A SPECIAL PURPOSE ARMED HELICOPTER.

THE IMPLICATION THEREOF WAS THAT UTILIZING THE DYNAMIC COMPONENTS OF THE UH-1, A MACHINE DESTINED EXCLUSIVELY TO THE SUPPORT OF GROUND FORCES WAS DEVELOPED (COBRA).

ALTHOUGH AT THE TIME THERE WERE MANY WHO WERE SKEPTICAL AS TO WHETHER A DEDICATED ARMED HELICOPTER WAS TACTICALLY VIABLE AND ECONOMICAL, NONETHELESS THE COBRA HAD, IN VIETNAM, A GREAT SUCCESS. THIS SOLUTION, HOWEVER, WAS PROMPTLY AND REALISTICALLY EVALUATED BY THE AMERICANS THEM SELVES AS "INADEQUATE" FOR:

1) THE SUCCESS WAS BEING SCORED IN A "LIMITED REACTION" ENVIRONMENT;

2) THE AIRCRAFT HAS EVIDENCED SHORTCOMINGS UNDER FOUR BASIC ASPECTS:

- MANOEUVERABILITY
- AGILITY
- BALLISTIC PROTECTION (VULNERABILITY)
- CRASHWORTHINESS.

THE CONCLUSION WHICH CAN BE DRAWN IN FIRST DEGREE IS THAT IT IS NECESSARY TO DEVELOP AN AIRCRAFT EXPRESSLY DESIGNED TO MEET THE SPECIFIC OPERATION REQUIREMENTS AND WHICH HARMONIOUSLY COMBINES ALL THE FEATURES REQUIRED TO CARRY OUT THE EXPECTED ANTI-TANK BASIC MISSION WITH A HIGH SURVIVABILITY RATIO.

THERE ARE OBVIOUSLY TWO WAYS OF DESIGNING SUCH AN AIRCRAFT. ONE IS TO PUT WEAPONS ON AN "ADEQUATE" AND MULTIROLE HELICOPTER BY THE ADDITION OF A KIT.

THE OTHER WAY IS TO DESIGN THE HELICOPTER, FROM THE GROUND UP, AS A SHOOTING AIRCRAFT.

THIS HAS THE DISADVANTAGE OF MAKING THE AIRCRAFT A SPECIALIZED MACHINE BUT IT HAS THE ADVANTAGE OF PROVIDING A MORE EFFICIENT AERIAL ANTI-TANK.

WHERE DOES THE BOUNDARY LIE BETWEEN CONVENIENCE TO ADOPT A MULTIROLE RATHER THAN A DEDICATED HELICOPTER?

THIS QUESTION IS LIKELY TO PROVE MERELY ACADEMIC IN LIGHT OF THE FACT THAT IN ORDER TO OPERATE IT IS FIRST OF ALL ESSENTIAL TO SURVIVE.

AS A MATTER OF FACT, AN ANSWER WHICH TAKES INTO ACCOUNT THE FLIGHT PERFORMANCE AND WEAPON SYSTEMS ALONE WOULD NOT BE ENOUGH TO JUSTIFY THE BIRTH OF A DEDICATED HELICOPTER, ON THE GROUND THAT JUST AMONG NATO COUNTRIES (AND POTENTIAL ALLIED) DIVERSIFIED THEORIES ARE BEING PURSUED.

FOLLOWING IS A TABLE SHOWING HOW THE ANTITANK PROBLEM IS VIEWED IN THE NATO COUNTRIES:

		ANTITANK REQUIREMENTS (DATE IN SERVIC
USA	(*)	DEDICATED HELICOPTER (NOW)
ITALY	(*)	DEDICATED HELICOPTER (1987)
GERMANY	(*)	DEDICATED HELICOPTER (1993)
GREAT BRITAIN	(*)	DEDICATED HELICOPTER (1995)
SPAIN		MULTIROLE HELICOPTER (NOW)
FRANCE	(*)	DEDICATED HELICOPTER (1996)
GREECE	(*)	DEDICATED HELICOPTER (T.B.D.)
TURKEY	(*)	DEDICATED HELICOPTER (T.B.D.)
CANADA		DEDICATED or MULTIROLE HELICOPTER (T.B.D.)

N.B.: (*) NATIONS PASSED FROM A "MULTIROLE" TO A DEDICATED" CONCEPT.

IT IS INTERESTING TO NOTE THAT THE ARMED FORCES OF 7 OF THE 9 NATIONS CONSIDERED, AFTER HAVING DEPLOYED A SO CALLED ARMED MULTIROLE HELICOPTER, HAVE SUBSEQUENTLY ADOPTED OR INTEND PROVIDING THEIR RESPECTIVE ARMIES WITH A DEDICATED HELICOPTER TO CARRY OUT THE ANTI-TANK ROLE.

IT IS TO BE NOTED THAT TO CHANGE THE REQUIREMENT FROM A MULTIROLE HELICOPTER TO A DEDICATED ONE IS NOT A SMOOTH PROCESS.

FOR EXAMPLE, TO HAVE AN IDEA OF THE COMPLEXITY OF THIS TYPE OF DECISION-MAKING PROCESS, IT IS USEFUL TO NOTICE WHAT HAS HAPPENED, WITH TIME, TO THE A-129.

THE PICTORIAL HISTORY OF THE A-129 CONCEPTUAL DEVELOPMENT WILL HIGHLIGHT ALSO HOW THE DESIGN CRITERIA HAVE CHANGED WITH TIME GIVING IMPLICITLY THE ANSWER TO THE PREVIOUS QUESTION (MULTIROLE VS. DEDICATED).

IT IS, IN FACT, CLEAR THAT PREVIOUSLY UNKNOWN POSSIBILITIES PROVIDED BY NEW TECHNOLOGY FOR MORE EFFECTIVE RESPONSES TO THE REQUIREMENT HAVE EXERCISED A NATURAL IMPACT ON THE EVOLVEMENT OF THE REQUIREMENT ITSELF, THEREFORE PER-

MITTING THE DEVELOPMENT OF A SMALL, EFFECTIVE, "INELLIGENT" AIRCRAFT AT A LIMITED COST WHEREAS THIS WAS NOT POSSIBLE A FEW YEARS AGO.

THIS SHORT DESCRIPTION WILL EXAMINE THE COURSE OF ACTION TAKEN BY AGUSTA IN IMPLEMENTING THE REQUIREMENTS AND HOW THE REQUIREMENTS THEMSELVES HAVE BEEN IN TIME BETTER AND BETTER DEFINED TO REFLECT THE TECHNOLOGY EVOLUTION.

DEVELOPMENT HISTORY

THE EVOLUTION OF THE OPERATIONAL REQUIREMENT REQUIRED MANY YEARS' EFFORT BY BOTH THE ARMY STAFF AND AGUSTA. THE MAJOR DECISIONS TO BE MADE BY THE ARMY CONSIDERED THE NATO OPERATIONAL ENVIRONMENT THE THREAT OF THE 90S, MISSION EFFECTIVENESS AND "AFFORDABILITY".

PRIOR TO DECIDING THAT A "DEDICATED" COMBAT HELICOPTER WAS NEEDED, OTHER AIRCRAFT WERE CONSIDERED, SUCH AS THE AB-205 AND A-109.

NEXT CAME STUDIES TO DEFINE THE CONFIGURATION:

- ENGINE: SINGLE OR TWIN?
- WEAPONS: TOW, HOT, 25 OR 30 MM GUNS, FLEXIBLE SUPPRESSIVE GUN SYSTEM, ROCKETS, ETC.?
- COMMUNICATIONS: AIR-TO-AIR, AIR-TO-GROUND, LONG-RANGE, SHORT-RANGE, SECURE?
- LANDING GEAR: SKID, WHEEL, RETRACTABLE, FIXED, ENERGY ABSORBING?
- MULTIPLEX OR CONVENTIONAL AIRCRAFT SYSTEMS MANAGEMENT?
- SURVIVABILITY: SIGNATURE REDUCTION, BALLISTIC PROTECTION, CRASHWORTHINESS?
- AND MANY OTHER .....?

TO ASSIST THE ARMY STAFF IN MAKING ITS DECISIONS, AGUSTA PERFORMED SEVERAL CONFIGURATION STUDIES. THESE INCLUDED THE FOLLOWING:

- A-109 COMMON DYNAMICS, SIGHTING TURRET FOR DAY/NIGHT,SKID LANDING GEAR, CURVED CANOPY, TAIL ROTOR MID-VERTICAL FIN, MINITAT, FOR SUPPRESIVE FIRE, AND WHEN WITHOUT TOW MISSILES, 72 2 -INCH.
- THE CANOPY WAS CHANGED TO FLAT-PLATE, THE ROTOR DIAMETER WAS INCREASED, THE LOWER DORSAL FIN WAS ADDED.
- THE SIGHT WAS CHANGED TO THE PRODUCTION TOW SYSTEM, THE TAIL ROTOR RAISED, AND THE LANDING GEAR LOW PRESSURE WHEEL-TYPE TO COMPLY WITH THE IMPORTANT REQUIREMENTS OF CRASHWOTHYNESS AND OF MOVING THE HELICOPTER FOR SHORT DI

STANCES ON THE GROUND.

DURING THE PRELIMINARY DESIGN PHASE, MANY OTHER SIGNIFICANT CHANGES WERE MADE AS A RESULT OF TECHNICAL TRADE-OFF STUDIES AND INTENSIVE RESEARCH IN THE VULNERABILITY/SURVIVABILITY SECTOR.

- THE COCKPIT WAS RE-ARRANGED WITH THE PILOT ELEVATED, CRASHWORTHINESS ADDED, MANY OTHER SURVIVABILITY FEATURES AND ELECTRONIC EQUIPMENT ADDED, INTEGRATED SYSTEM MANAGEMENT INCORPORATED, PILOT NIGHT VISION INCLUDED; ALSO THE MAIN ROTOR SYSTEM WAS CHANGED TO PROTECT FLIGHT CONTROLS FROM BALLISTIC DAMAGE AND AN INNER STATIONARY MAST WAS INCLUDED FOR INSTALLATION OF A MAST MOUNTED SIGHT. THE MAIN ROTOR BLADES AND MUCH OF THE AIRFRAME MATERIALS CHANGED TO COMPOSITES.

  THE DESIGN OF THE ROTOR AND TRANSMISSION WERE STUDIED FOR COMPATIBILITY WITH GROWTH TO INSTALLATION OF THE TADS/PNVS AND THE 3RD GENERATION ANTI-TANK MISSILE. IT IS TO BE NOTED THAT THE LANDING GEAR WAS CHANGED TO THE FIXED ENERGY ABSORBING STRUT WITH WHEELS TO COMPLY WITH THE MIL-STD 1290.

  THIS IS THE CONFIGURATION OF THE ATTACK VERSION AS SHE FLIES TODAY.

THE SCOUT VERSION IS PLANNED TO HAVE THE TOW SIGHT REMOVED AND THE MMS ADDED. THE STUB WINGS CAN BE REMOVED OR USED FOR ARMAMENT SUCH AS LIGHTWEIGHT MULTI-PURPOSE GUIDED MISSILES OR EXTERNAL FUEL TANKS.

IN SPITE OF THE GROWTH, THE A-129 IS RELATIVELY SMALL WHEN COMPARED TO OTHER ATTACK HELICOPTERS. IT IS ABOUT 25% LIGHTER THAN THE AH-1S AND 50% LIGHTER THAN THE AH-64 IN THEIR PRIMARY MISSION CONFIGURATION.

THIS RESULT HAS BEEN ACHIEVED THROUGH ITERATIVE ANALYSES WHICH LED TO SPECIFIC TRADE-OFFS AND USE OF NEW TECHNOLOGIES.

IT IS WORTH UNDERLINING THAT TECHNOLOGY HAS AIDED SIGNIFICANTLY IN WEIGHT REDUCTION. IN PARTICULAR, SENSIBLE

SAVINGS HAVE BEEN ACHIEVED IN THE AIRFRAME, MAIN ROTOR AND SYSTEMS MANAGEMENT IN THE A-129 DESIGN.

NEVERTHELESS, ALSO THE AH-64 AND THE COBRA ARE BEING DEFINED BY THE RESPECTIVE MANUFACTURERS AS "SMALL, LIGHTWEIGHT AND LOW-COST".

THE APPARENT CONTRADICTION MAY BE EXPLAINED BY THE DIFFERENT PHASING IN TIME OF THE REQUIREMENT AND RELEVANT TECHNOLOGICAL RESPONSE.

AS A MATTER OF FACT, SINCE THE TECHNOLOGICAL RESPONSE SIGNIFICANTLY IMPACTS UPON THE WEIGHT AND COST PARAMETERS, WHAT COULD YESTERDAY BE DEFINED IN PERFECT AGREEMENT WITH THE SITUATION "LIGHTWEIGHT/LOW-COST" MAY NO LONGER BE TERMED SO TODAY.

IT BECOMES THEREFORE NECESSARY TO MAKE SOME CONSIDERATIONS ON THE MEANING OF "LIGHTWEIGHT/LOW-COST" FOR A MACHINE DEDICATED TO A SPECIFIC MISSION (IN OUR CASE, ANTI-ARMOUR), WITH REFERENCE TO THE A-129.

COBRA WHICH HAD ITS BAPTISM OF FIRE IN 1967 WAS BORN DURING THE WAR IN VIETNAM TO FULFILL THE REQUIREMENT OF DEPLOYING AN ARMED HELICOPTER SUFFICIENTLY FAST TO ESCORT TROOP TRANSPORT HELICOPTERS.

THE RESULTS ACHIEVED WITH THIS HELICOPTER WERE SO ENCOURAGING THAT THE U.S. ARMY CONCLUDED THEY NEEDED TO PROCURE A DEDICATED HELICOPTER CAPABLE NOT ONLY TO CARRY OUT ARMED ESCORT MISSIONS IN A RELATIVELY HOSTILE ENVIRONMENT, BUT ALSO CAPABLE TO ANNIHILATE THE THREAT POSED BY THE WARSAW PACT TROOPS.

THIS HAS IMPLIED THE NEED TO EXPAND THE CLASSICAL UTILIZATION OF THE HELICOPTER SO THAT TO BE CAPABLE OF REPELLING FIRST AND SECOND WAVE ATTACKS.

TO FULFILL THIS REQUIREMENT THE U.S. ARMY HAS DEVELOPED THE AH-64 WITH A VIEW TO OPERATE IN A HIGHLY HOSTILE ENVIRONMENT, AT GREAT DISTANCES FROM FRIENDLY TROOPS AND ENGAGING, AT THE SAME TIME, A VARIETY OF TARGETS. IN ORDER TO DO SO, THE WEAPON LOAD SHALL COMPRISE 8 HELLFIRE MISSILES AND 30 MM GUN.

WE EUROPEAN HAVE DEVOTED OUR EFFORTS TO DEFEATING THE PRINCIPLE THREAT OF THE FIRST ENEMY WAVE: THE TANK; IN THIS CONTEXT OUR HELICOPTERS SHALL BE OPTIMIZED TO PERFORM THE ANTI-TANK ROLE.

HENCE THE ITALIAN REQUIREMENT (AND INCIDENTALLY ALSO THE GERMAN'S), THOUGH CALLING FOR SURVIVABILITY AND CRASHABILITY FEATURES SIMILAR TO THE AH-64'S, REQUIRE THE HELICOPTER TO BE FITTED ONLY WITH ANTI-TANK MISSILES IN ITS PRIMARY ARMED ROLE.

THE AGUSTA A-129 IS THE RESULT OF THE OPTIMIZATION OF THE RESPONSES TO THIS REQUIREMENT THROUGH THE ADOPTION OF ADVANCED TECHNOLOGIES.

WE SHALL ANALYZE HEREAFTER THE ADOPTED DESIGN CRITERIA AND SOME SOLUTIONS FOR THE A-129 WHICH HAVE EVENTUALLY BROUGHT AGUSTA TO THE ABOVE INDICATED ACHIEVEMENT.

TO START WITH, IT IS INTERESTING TO ANALYZE THE FOLLOWING TABLE SHOWING THE CAUSES OF HELICOPTER LOSSES IN RECENT PAST CONFLICTS WHERE THE HELICOPTER HAS BEEN EXTENSIVELY USED.

PREVIOUS EXPERIENCE IN COMBAT

A) HELICOPTER LOSSES IN VIETNAM

ENEMY FIRE 52%

IN FLIGHT	ON THE GROUND	SMALL CALIBER	MEDIUM CALIBER
70%	30%	92%	8%

OTHER REASONS 48%

PERFORMANCE	DESIGN (*)
54%	36%

(*) INCLUDES PILOT'S ERRORS

B) "6" DAY WAR EXPERIENCE

NO LOSSES REPORTED BY RADAR CONTROLLED MEDIUM/LARGE CALIBER WEAPON SYSTEM.

THE CONSIDERATION THAT EMERGES HEREOF IS THAT AT LEAST IN THOSE CONTEXTS, THE PREVAILING THREAT FOR THE HELICOPTER WAS CONSTITUTED BY SMALL MEDIUM-CALIBER, HIGH FIRE RATE MACHINE GUNS.

IN LIGHT OF THE INCREASE IN MACHINE GUN CALIBER, ADVENT OF GROUND/AIR MISSILES AND ANTI-HELICOPTER AIRCRAFT, HOW IS IT POSSIBLE TODAY TO ASSESS THE CAPABILITY OF SURVIVABILITY OF THE HELICOPTER? AND ACCORDINGLY, HOW CAN THE HELICOPTER BE SIZED IN TERMS OF REDUNDANCY, ARMOUR PLATING AND CONSEQUENTLY WEIGHT AND DIMENSIONS?

FIRST OF ALL SOME BASIC CONSIDERATIONS MAY PROVE HELPFUL.

IT IS OUR OPINION, PROVED BY RECENT EVENTS, THAT MANEUVERABILITY, LOW FLYING AND GOOD TECHNIQUE WILL MAKE THE HELICOPTER SURVIVABLE ON THE BATTLE FIELD.

IT WOULD BE, OF COURSE, ABSURD TO REACH THE CONCLUSION THAT THE HELICOPTER IS INVULNERABLE TO ATTACK BY AIRCRAFT AND DESTRUCTION BY MISSILES, OR LARGE CALIBER WEAPONS. ON THE OTHER HAND, IT IS EQUALLY ABSURD TO CONCLUDE THAT THE HELICOPTER WILL BE AN EASY TARGET, EVEN FOR ENEMY FIGHTERS WHICH, BEYOND BEING CONCERNED ABOUT FLYING CLOSE TO THE EARTH, MUST ALSO BE CONCERNED OF THE FACT THAT HELICOPTERS CAN TODAY DANGEROUSLY REACT BY MEANS OF AIR-TO-AIR MISSILES.

WE CAN SUMMARIZE THIS FIRST PHASE OF OUR DISCUSSION WITH THE FOLLOWING CONSIDERATIONS:

- AGILITY AND ADOPTION OF ELECTRONIC COUNTERMEASURES MUST PREVAIL OVER ARMOUR PLATING
- SIZE AND CONSEQUENTLY WEIGHT MUST BE COMMENSURATE WITH MISSION PAYLOAD REQUIREMENT AND RANGE

- REDUNDANCY MUST BE ACHIEVED THROUGH AN ANALYTICAL EXAMINATION OF THE DESIGN AND ADOPTION OF MODERN TECHNOLOGIES.

LET'S EXAMINE THESE THREE SUBJECTS MORE IN DETAIL.

POWER PLANT

THE PRODUCTION ENGINE FOR THE A-129, THE ROLLS ROYCE GEM 2-2 MK 1004, IS CAPABLE OF PROVIDING THE PERFORMANCE MARGINS WHICH WILL GIVE THE AIRCRAFT THE REQUIRED PERFORMANCE CHARACTERISTICS IN N.O.E. FLIGHT.

THE FAILURE OF ONE ENGINE DURING TAKE OFF, LANDING OR HOVERING IS MINIMIZED BY AN EMERGENCY RATING OF 1035 HP FOR UP TO 20 SECONDS.

THE ENGINE INTAKE HAS BEEN DESIGNED TO PROVIDE A DYNAMIC TYPE PARTICLE SEPARATOR, ICE PROTECTION (ELECTRICAL DE-ICING SYSTEM) AND AN EJECTOR SYSTEM THAT DILUTES THE EXHAUST GAS WITH FRESH AIR, RESULTING IN A LOW PLUME AND HOT METAL IR SIGNATURE EVEN WITHOUT A SPECIFIC IR SUPPRESSOR WHICH, HOWEVER, MAY BE INSTALLED IF REQUIRED.

TRANSMISSION

THE TRANSMISSION INPUT COMES FROM TWO SEPARATED INDEPENDENT DRIVES. IT IS NOT POSSIBLE FOR BOTH INPUTS TO BE HIT BY ONE 12.7 MM ROUND. THE TRANSMISSION CAN OPERATE 30 MINUTES AFTER LOSS OF LUBRICATION.

THE LUBRICATION RESERVOIRS ARE INTERNAL TO THE HOUSING.

THE TRADE-OFF OF PROVIDING TRANSMISSION OUTPUT BALLISTIC PROTECTION AFFECTED THE ENGINE INSTALLATION, FORCING THEM TO BE SPACED WIDER APART, WHICH RESULTED IN SLIGHTLY WIDENING THE FRONTAL VIEW OF THE AIRFRAME.

EVEN WITH THE LOSS OF TWO TRANSMISSION ATTACHMENTS THE A-129 WILL BE CAPABLE OF FLYING FOR 30 MINUTES.

ROTOR SYSTEMS

THE FULLY ARTICULATED FOUR-BLADED ROTOR SYSTEM WITH A SINGLE SPHERICAL ELASTOMERIC BEARING FOR EACH OF THE FOUR BLADES WHICH PROVIDE THE ARTICULATION FUNCTIONS, IS QUIET (LOW TIP SPEED), BALLISTICALLY TOLERANT, FOLDABLE, EASY TO MAINTAIN AND HAS A LOW RADAR RETURN (FLIGHT CONTROLS INSIDE THE MAST).

THE BALLISTICALLY TOLERANT TAIL ROTOR IS TWO-BLADED AND PROVIDES DIRECTIONAL CONTROL IN WIND GUSTS UP TO 45 KNOTS FROM ANY DIRECTION.

THE MAIN AND TAIL ROTOR BLADES ARE MADE OF COMPOSITE MATERIAL AND ARE BALLISTICALLY TOLERANT TO 12.7 MM, AND POSSIBLY 23 MM, TO BE DETERMINED BY FUTURE TESTING. THE TIP OF THE BLADES HAS BEEN DESIGNED TO REDUCE NOISE.

ITS CONSTRUCTION IS CRUSHABLE IN ORDER TO WITHSTAND THREE STRIKE.

FLIGHT CONTROLS

THE FLIGHT CONTROLS OF THE A-129 ARE DESIGNED TO MAINTAIN SAFE FLIGHT AFTER ONE BALLISTIC HIT ON THE FLIGHT CONTROLS AND TO ACHIEVE A SAFE LANDING AFTER A SECOND HIT ON THE CONTROLS.

THE EXPOSED PITCH CHANGE LINKS TO THE MAIN A-129 ROTOR BLADES ARE BALLISTICALLY TOLERANT, TOO AND JAM PROOF.

THE PILOT'S PRIMARY CONTROL OF THE MAIN ROTOR IS A MECHANICAL HYDRAULICALLY BOOSTED SYSTEM, WHICH IS JAM PROOF.

HIS PRIMARY CONTROL OF THE TAIL ROTOR IS A FLY-BY-WIRE SYSTEM (INTEGRATED IN THE MULTIPLEX SYSTEM) TO A DUAL BODY ACTUATOR (REDUNDANT) INTEGRATED INTO THE TAIL ROTOR GEAR BOX. THE PILOT HAS A FLY-BY-WIRE BACK-UP SYSTEM TO CONTROL THE MAIN ROTOR ACTUATORS AND A MECHANICAL CONTROL FOR THE TAIL ROTOR.

A CRASHWORTHY/SURVIVABILITY FEATURE OF THE PILOT'S CONTROLS IS THE ATTACHMENT OF THE CYCLIC STICK AND THE CONTROL ROD TO THE BOTTOM OF THE SEAT.

DURING A CRASH SITUATION, IF THE PILOT'S SEAT IS STROKED DOWNWARDS, THE CYCLIC STICK ALSO DESCENDS, PREVENTING INJURY IN CASE OF PILOT BODY FORWARD MOTION.

THE COPILOT/GUNNER STATION IS ALSO EQUIPPED WITH A FLY-BY-WIRE SYSTEM TO CONTROL MAIN AND TAIL ROTORS AND AN OVERRIDE MECHANICAL CONNECTION TO COUPLE PILOT AND COPILOT CONTROLS. IF THE INJURED PILOT FALLS FORWARD ON THE CYCLIC CONTROL, THE COPILOT/OBSERVER CAN DECOUPLE THE PILOT'S CONTROLS AND OPERATE THE CONTROLS BY HIS FLY-BY-WIRE SYSTEM.

A STABILITY AND CONTROL AUGMENTATION SYSTEM (SCAS) IS INSTALLED IN THE PITCH, ROLL, AND YAW AXES TO REDUCE PILOT WORKLOAD AND PROVIDE COMMAND AUGMENTATION TO THE AUTOPILOT. THE SYSTEM WILL DAMP ANY SHORT PERIOD DISTURBANCES THROUGH ATTITUDE AND RATE FEEDBACKS, AND IT INCREASES THE PILOT'S CONTROL/AGILITY AT ALL TIMES BY ADDING A STABILIZING FACTOR IN ALL AXES.

COCKPIT

THE TWO CREWMEN ARE SEATED IN TANDEM WITH THE COPILOT/GUNNER AT THE FORWARD STATION.

ARMOR SEATS PROTECT THEM FROM THE BOTTOM, REAR, AND SLIGHTLY FROM THE SIDES.

ADDITIONAL SIDE SLIDING ARMOR REDUCES THE SIDE ASPECT VULNERABLE AREA TO ALMOST ZERO.

THE PILOT'S STATION IS ELEVATED TO PROVIDE OUTSTANDING VISIBILITY FOR NAP-OF-THE EARTH (NOE) FLIGHT.

SYSTEMS

EVERY SYSTEM ON BOARD IS DUPLICATED OR TRIPLICATED IN ORDER TO ACHIEVE THE APPROPRIATE REDUNDANCY.

- THERE ARE TWO SEPARATE FUEL SYSTEMS WITH A CROSS FEED CAPABILITY. THE FUEL TANKS ARE SELF-SEALING AND CRASH-RESISTANT. THE FUEL AREA IS FIREPROOF.
- TWO HYDRAULIC SYSTEM ARE "BURIED" AND SEPARATED IN THE CENTER OF THE AIRCRAFT. ONE IS ALSO BACK-UP FOR THE TAIL ROTOR ACTUATOR WHICH IS DRIVEN NORMALLY BY A SPECIFIC "DEDICATED" THIRD HYDRAULIC SYSTEM LOCATED IN THE TAIL AND DRIVEN BY THE 90° GEAR BOX.
- THERE ARE THREE INDEPENDENT SOURCES OF ELECTRICAL POWER.
- THE SCAS SYSTEM IS INHERENTLY QUADRUPLY REDUNDANT.

ALL THE SYSTEMS ARE MANAGED THROUGH THE IMS.

PASSIVE ARMOR

USE OF ESR STEEL FOR BEARING COVERS ADDED SIGNIFICANTLY TO BALLISTIC PROTECTION WITH VERY LITTLE WEIGHT PENALTY.

BURYING CRITICAL FLIGHT COMPONENTS AND OTHER INNOVATIVE

DESIGN FEATURES REDUCED THE NEED FOR HEAVY ARMOR SO THAT THE INITIAL WEIGHT ALLOWANCE FOR ARMOR HAS SINCE BEEN REDUCED BY 31% WHILE RETAINING THE SAME FULL SURVIVABILITY AGAINST A SINGLE 12.7 MM ROUND.

AS AN EXAMPLE, THE ROTATING OUTER (MAIN ROTOR) SHAFT PROTECTS THE FLIGHT CONTROL PUSH-PULL RODS, SINCE THEY ARE INSIDE.

THIS ALSO PREVENTS WIRE WRAPPING AND ICING ON THE FLIGHT CONTROL RODS. THE INNER STATIONARY MAST IS SPECIFICALLY DESIGNED TO ACCEPT A MAST MOUNTED SIGHT (MMS).

COMPOSITE

COMPOSITE MATERIALS ARE A BLESSING TO THE AIRCRAFT INDUSTRY, NOT ONLY BECAUSE OF REDUCED WEIGHT, MAINTENANCE, ETC., BUT THEY ALSO REDUCE RADAR SIGNATURE AND ARE MOSTLY BALLISTIC TOLERANT.

THE OVER ALL PLAN FOR USE OF COMPOSITES IS SHOWN FOR PRESENT AND FOR FUTURE USE.

THE PRODUCTION AIRFRAME CONSISTS OF COMPOSITE MATERIALS IN THE FOLLOWING PERCENTAGES:

- WETTED AREA (WITHOUT BLADES AND HUB)	:	70 PERCENT
- TOTAL WEIGHT STRUCTURE (MIL-STD-1374)	:	45 PERCENT
- TOTAL EMPTY WEIGHT	:	16.1 PERCENT.

CRASHWORTHINESS DESIGN FEATURES

THE A-129 DESIGN HAS INCORPORATED CRASHWORTHINESS FEATURES WHICH PROTECT THE CREW AND AIRCRAFT IN THE EVENT OF A CRASH.

FEATURES WILL PREVENT CREW FATALITIES AND MINIMIZE THE SEVERITY OF INJURIES DURING CRASH IMPACT UP TO AND INCLUD-

ING THE 90TH PERCENTILE (POTENTIALLY SURVIVABLE ACCIDENT AS DEFINED BY USAAMRDL TR 71-22). THESE FEATURES ALSO MINIMIZE AIRCRAFT DAMAGE TO THE MAXIMUM POSSIBLE EXTENT.

THE ENGINES AND TRANSMISSION INSTALLATIONS ARE DESIGNED SO THEY WILL NOT BREAK AWAY FROM THEIR MOUNTING STRUCTURE DURING CRASH IMPACTS UP TO THE DESCRIBED CRASH SURVIVAL LIMITS.

AIRFRAME CRUSHABLE STRUCTURE AND AN ENERGY ABSORBING MAIN LANDING GEAR WILL ABSORB THE CRASH LOAD ON THE NOSE, BOTTOM AND SIDES. TWO BOTTOM LONGERONS WILL ACT LIKE SLED RAILS DURING LONGITUDINAL CRASH, AVOIDING EARTH SCOOPING AND THE CONSEQUENT HIGH DECELERATION.

THE TRANSMISSION INSTALLATION ENSURES THAT IN THE EVENT OF BREAK AWAY, IT WILL NOT ENTER THE CABIN AREA.

THE CRASHWORTHY FUEL CELL HAS FRANGIBLE STRUCTURAL ATTACHMENTS TO ALLOW STRUCTURAL DEFORMATION WITHOUT RUPTURING THE CELL. ALL LINES HAVE SUFFICIENT SLACK TO ALLOW STRUCTURAL DEFORMATION WITHOUT BREAKING.

SUMMARIZING THE A-129 HAS THE FOLLOWING DESIGN FEATURES:

- SMALL SIZE
- LOW SIGNATURE
- AGILITY
- ELECTRONIC COUNTERMEASURES (ACTIVE AND PASSIVE)
- REDUNDANT SYSTEMS
- BALLISTIC TOLERANCE
- ARMOR PROTECTION
- CRASHWORTHINESS.

THESE FEATURES GIVE THE A-129 THE NECESSARY SURVIVABILITY TO OPERATE IN THE NATO THREAT ENVIRONMENT, FULFILLING THE FOLLOWING TASKS:

- AVOID DETECTION
- AVOID BEING HIT
- CONTINUE THE MISSION AFTER BEING HIT
- SURVIVE AFTER A CRASH.

VISIONICS AND ARMAMENT

THE SURVIVABILITY FEATURES JUST MENTIONED ALLOWS THE A-129 TO COME BACK TO ITS BASE, ITS FIREPOWER WILL ALLOW TO ACCOMPLISH THE MISSION.

THE A-129 CONTAINS THE ELEMENTS OF VISIONICS AND ARMAMENT WHICH ARE CONSISTENT WITH THE INTENDED MISSIONS.

THESE EQUIPMENTS ARE INTENDED TO ALLOW THE A-129 TO DELIVER ITS FIREPOWER UNDER DAY AND NIGHT CONDITIONS.

THE A-129 REQUIRES VISIONICS EQUIPMENT FOR TARGET ACQUISITION AND TRACKING, FIRE CONTROL AND NIGHT N.O.E. OPERATIONS.

THE ESSENTIAL ELEMENTS OF THE A-129 VISIONICS SYSTEM ARE:

- COPILOT/GUNNER'S SIGHT UNIT
- PILOT'S INFRARED NIGHT VISION SUBSYSTEM
- INTEGRATED HELMET AND DISPLAY SIGHT SUBSYSTEM (IHADSS)
- SYMBOLOGY GENERATOR.

THE COPILOT AND PILOT VISIONICS SYSTEMS WILL ENABLE MISSION ACQUISITION AND TRACKING AT NIGHT OR IN MARGINAL LIGHTING CONDITIONS.

THE A-129 FIREPOWER CONSISTS OF A TWO MAIN ARMAMENT SYSTEMS:

- TOW MISSILE ANTI-TANK SUBSYSTEMS AND
- AERIAL ROCKET SUBSYSTEM.

OTHER ARMAMENT SYSTEMS ARE ALREADY ENVISAGED SUCH AS:

- TRIGAT SYSTEM
- AIR TO AIR MISSILES
- GUN TURRET.

SYSTEM MANAGEMENT

THE PRIMARY DESIGN OBJECTIVE OF THE A-129 IS TO UTILIZE STATE-OF-THE-ART TECHNOLOGY TO MAXIMIZE ITS EFFECTIVENESS AS A WEAPONS SYSTEM WHILE ENHANCING THE LOGISTICS PARAMETERS OF RELIALABILITY, MAINTAINABILITY, AVAILABILITY, OR LIFE-CYCLE-COSTS. AS OBVIOUS AS THESE GOALS APPEAR, THE MOST ADVANCED MILITARY ESTABLISHMENTS HAVE FOUND IT REMAR

KABLY DIFFICULT TO ACHIEVE BOTH GOALS SIMULTANEOUSLY.

RECENT "NEXT-GENERATION" AIRCRAFT HAVE DEMONSTRATED THAT A HIGH DEGREE OF SOPHISTICATION LEADS DIRECTLY TO A HIGH MISSION ABORT RATE AND EXCESSIVE DOWNTIME. AS AN EXAMPLE, EXPERIENCE ON THE SIMPLISTIC AH-1 DEMONSTRATES ONE MISSION ABORT PER 40 FLIGHT HOURS WHEREAS THE DESIGN GOAL FOR THE MUCH MORE SOPHISTICATED AH-64 IS ONE MISSION ABORT PER 19 FLIGHT HOURS.

WHEN BOTH FLIGHT AND GROUND TIMES ARE CONSIDERED, BOTH NUMBERS GET WORSE (SOURCE OF DATA: U.S. ARMY LHX INDUSTRY BRIEFING, 17 NOVEMBER 1982.)
FURTHERMORE, ANALYSIS INDICATES THAT THE MORE SOPHISTICATED APPROACH TENDS TO BE MUCH MORE VULNERABLE TO MISSION ABORTS FROM BATTLE DAMAGE. OTHER EXAMPLES OF EXTREMELY SOPHISTICATED AIRCRAFT DEMONSTRATE THIS PRINCIPAL MORE GRAPHICALLY.
ONE OF THE BEST (OR WORST!) IS THE F-14 WHICH HAS DEMONSTRATED AN OVERALL AVERAGE OF LESS THAN ONE HOUR MISSION BETWEEN ABORTS (INCLUDING GROUND FAILURES).
RATHER THAN IMPLEMENT AN EXPENSIVE DEVELOPMENT PROGRAM FOR THE A-129 WHICH WOULD ULTIMATELY PROVIDE ANOTHER EXAMPLE OF UNFAVORABLE PERFORMANCE STATISTICS, AN INNOVATIVE DESIGN PHILOSOPHY HAS BEEN IMPLEMENTED WHICH REPRESENTS A SIGNIFICANT DEPARTURE FROM THE NORM.
TO UNDERSTAND THIS APPROACH, HOWEVER, IT IS NECESSARY TO REVIEW THE MECHANICS OF WHAT PRECIPITATED THE EXISTING POOR PERFORMANCE.
AS THE MISSION SCENARIOS HAVE BECOME MORE COMPLEX REQUIRING PRECISE TIMING AND NAVIGATION, AND AS THE WEAPONS HAVE BECOME MORE COMPLEX REQUIRING INPUT FROM VISIONICS, AIR DATA, AND COUPLING TO FLIGHT CONTROL, THERE HAS EMER-

GED A VERY HIGH LEVEL OF INTERDEPENDENCE BETWEEN THE AIRCRAFT SUBSYSTEMS,WHEREAS PREVIOUSLY THESE SUBSYSTEMS WERE COMPLETELY AUTONOMOUS. THIS INTEGRATION OF SUBSYSTEMS HAS DRAMATICALLY IMPROVED BOTH THE WEAPONS PERFORMANCE, AND THE OVERALL PILOT/AIRCRAFT PERFORMANCE THROUGH IMPROVED DISPLAYS, CONTROL COORDINATION, WORKLOAD REDUCTION, ETC.. UNFORTUNATELY, THIS HIGH LEVEL OF INTEGRATION, OR INTERDEPENDENCE, HAS CREATED A WEAK CHAIN. THIS FIGURE SHOWS A TYPICAL RELIABILITY DIAGRAM IN WHICH, DUE TO INTERDEPENDENCE, ALL ELEMENTS OF THE CHAIN MUST BE FUNCTIONING PROPERLY TO ACHIEVE MISSION SUCCESS. NOTE THAT ALTHOUGH EACH PIECE OF EQUIPMENT MAY HAVE A REASONABLY HIGH PROBABILITY OF MISSION SUCCESS, THE RESULTANT IS TOTALLY UNSATISFACTORY.

THE MOST STRAIGHTFORWARD METHOD OF IMPROVING RELIABILITY IS TO SIMPLY MAKE EVERYTHING REDUNDANT. THIS WOULD INDEED PROVIDE SATISFACTORY MISSION RELIABILITY, BUT AT A 2-TIMES COST, WEIGHT, AND VOLUME PENALTY AS WELL AS DOUBLING THE MAINTENANCE COST (TWICE AS MUCH HARDWARE TO KEEP OPERATIONAL BETWEEN FLIGHTS).

SINCE THE OPERATIONAL PERFORMANCE GOALS FOR THE A-129 DICTATES ADVANCED TECHNOLOGY AND SOPHISTICATION, IT BECOMES IMPERATIVE TO RESOLVE THIS IMPASSE. TO THIS END, AGUSTA SET OUT TO EXAMINE THE APPARENT RELATIONSHIP BETWEEN MISSION SOPHISTICATION AND HARDWARE COMPLEXITY. A STUDY OF ALL AIRCRAFT SUBSYSTEMS INDICATED THAT A SIGNIFICANT PERCENTAGE OF THE HARDWARE FOR EACH SUBSYSTEMS WAS DEVOTED TO COMPUTATION CAPABILITY; THAT IS, IMPLEMENTING SMALL COMPUTERS IN EACH SUBSYSTEM TO SOLVE SPECIALIZED ALGORITHMS. OTHER SIGNIFICANT ELEMENTS OF HARDWARE INCLUDED DATA TRANSMISSION CAPABILITY BETWEEN SUBSYSTEMS AND FINALLY, CONTROL AND DISPLAY HARDWARE ASSOCIATED WITH EACH SUBSYSTEM (THE ABOVE MENTIONED COMPONENTS AS ALSO THE ONES WITH THE HIGHEST FAILURE RATE). THE OBVIOUS FIRST STEP TO

WARD REDUCING THE VOLUME OF HARDWARE, AND INREASING RELIABILITY, WAS TO REMOVE MUCH OF THE INDIVIDUAL COMPUTATIONAL CAPABILITY OF THE VARIOUS SUBSYSTEMS AND CONSOLIDATE IT IN A CENTRAL PROCESSOR. IN LIKE MANNER, THE SECOND STEP WAS TO ELIMINATE AS MANY DEDICATED CONTROLS AND DISPLAYS AS POSSIBLE AND CONSOLIDATE THESE IN A COMMON INTEGRATED CONTROL DISPLAY UNIT. AS DEPICTED IN THIS FIGURE, IMPLEMENTING THESE TWO STEPS, RESULTED IN THE DELETION OF DEDICATED PROCESSORS, CONTROLS AND DISPLAYS WHICH FAR EXCEEDED THE CENTRALIZED HARDWARE WHICH WAS ADDED.

HAVING PERFORMED THESE STEPS, THE AIRCRAFT WAS THEN SURVEYED TO DETERMINE IF ANY HARDWARE FUNCTIONS EXISTED WHICH COULD BE REPLACED DIRECTLY WITH SOFTWARE CODE IN THE CENTRALIZED COMPUTER.

FOR EXAMPLE, FUEL MONITORING AND CONTROL, HYDRAULIC MONITORING AND CONTROL, AND ENGINE MONITORING COULD BECOME PURE SOFTWARE FUNCTIONS THEREBY REPLACING RELAYS, LOGIC, LIGHTS, ETC., WITH A FRACTION OF A MEMORY CHIP. ALSO, IT IS NOTEWORTHY THAT THIS APPROACH PERMITTED AUTOMATIC RECONFIGURATION OF AIRCRAFT REDUNDANCY (FUEL, HYDRAULIC SOURCES, ETC.) IN THE EVENT OF BATTLE DAMAGE.

AT THIS POINT IN THE IMPLEMENTATION, ENOUGH HARDWARE WAS ELIMINATED SUCH THAT REASONABLE MISSION SUCCESS NUMBERS COULD BE REALIZED IN SPITE OF AIRCRAFT COMPLEXITY.

IN THIS CONTEXT, IT SHOULD BE NOTED THAT THE A-129 CONTAINS MANY SOPHISTICATED FEATURES NOT FOUND IN ANY OTHER HELICOPTER INCLUDING THE AH-64 (PERFORMANCE MONITOR, AUTOMATIC ELECTRICAL SYSTEM MANAGEMENT, HISTORICAL MAINTENANCE DATA RECORDING, WEAPONS COUPLING TO AUTOPILOT, REVERSIBLE FLY-BY-WIRE).

THE NEXT STEP IN IMPROVING MISSION SUCCESS WAS USE OF "FUNCTIONAL REDUNDANCY". THIS REFERS TO THE ABILITY OF THE SYSTEM TO "WORK AROUND" FAILED SENSORS THROUGH APPROPRIATE SOFTWARE. FOR EXAMPLE, FAILURE OF THE TOW SIGHT WILL CAUSE THE SYSTEM TO UTILIZE A SPECIAL IHADSS MODE WHICH WILL CONTINUE TO COMPUTE EQUATIONS FOR ACCURATE

ROCKET DELIVERY.

THE FINAL STEP IN ACHIEVING A BREAKTHROUGH IN BOTH PERFORMANCE AND RELIABILITY WAS TO MAKE ALL THE CENTRAL COMPUTING AND DISPLAY HARDWARE TOTALLY REDUNDANT.

THIS HAS THE EFFECT OF NOT ONLY IMPROVING PEACETIME MISSION RELIABILITY TO A LEVEL BETTER THAN THE SIMPLISTIC AH-1, BUT GIVES THE A-129 A SIGNIFICANT IMPROVEMENT IN SURVIVABILITY TO BATTLE DAMAGE. IN FACT, A SINGLE HIT TO ANY OF THE PRIMARY CONTROL UNITS WOULD NOT EVEN CAUSE ANY DEGRADED OPERATION SINCE ALL MISSION CRITICAL FUNCTIONS ARE FULLY (AND AUTOMATICALLY) BACKED-UP.

ALL THIS WAS IMPLEMENTED IN THE INTEGRATED MULTIPLEX SYSTEM (IMS) WHICH IS AN OVERALL REAL-TIME CONTROL AND DISPLAY SYSTEM WHICH INTEGRATES THE FUNCTIONS OF THE FOLLOWING SUBSYSTEMS:

- COMMUNICATIONS
- NAVIGATION
- FLIGHT CONTROL
- WEAPONS CONTROL
- ENGINE CONDITION MONITOR
- TRANSMISSION AND HYDRAULICS
- FUEL SYSTEM
- ELECTRICAL POWER DISTRIBUTION
- AIRCRAFT PERFORMANCE MONITOR
- CAUTION AND WARNING.

THROUGH THIS TECHNIQUE OF MULTIPLEX INTEGRATION, IT IS POSSIBLE TO SHARE COMMON INPUT SENSORS AND OUTPUTS BETWEEN THESE FUNCTIONS AS WELL AS MAKING MAXIMUM USE OF ALL AVAILABLE DATA TO OPTIMIZE PERFORMANCE OF EACH OF THESE FUNCTIONS.

IT WILL BE NOTED THAT SYSTEM INPUTS AND OUTPUTS ARE DISTRIBUTED AMONG THE FOLLOWING SIX UNITS:

- MASTER UNITS (2 EA.)
- REMOTE UNITS (2 EA.)
- WING UNITS (4 EA.).

CONTAINED WITHIN A MASTER UNIT IS AN HIGH-SPEED MULTIPRO GRESSOR COMPUTING STRUCTURE WHICH EXECUTES CONTROL AND COMPUTING FOR EACH SUBSYSTEM FUNCTION. EACH MASTER UNIT HAS THE CAPABILITY OF COMPLETELY OPERATING THE ENTIRE SY STEM INDEPENDENT OF THE OTHER MASTER UNIT. CONSEQUENTLY, TOTAL PROCESSING REDUNDANCY HAS BEEN PROVIDED.

THE PILOT AND COPILOT INTERACT WITH THE IMS THROUGH THE FOLLOWING SIX ADDITIONAL ASSEMBLIES:

- MULTIFUNCTION DISPLAY (2 EA.)(OPTION FOR 3 EA.)
- MULTIFUNCTION KEYBOARD (2 EA.)
- REMOTE FREQUENCY DISPLAY UNITS (RFD)(2 EA.).

THE MULTIFUNCTION DISPLAY (MFD) IS A CRT BASED DESIGN WHICH PROVIDES BOTH GRAPHIC AND ALPHANUMERIC OUTPUT.

INTERACTION WITH THIS DISPLAY IS ACCOMPLISHED THROUGH THE PUSH-BUTTONS INTEGRAL TO THE DISPLAY AS WELL AS THE LARGER MULTIFUNCTION KEYBOARD (MFK).

SELECTED INFORMATION SUCH AS CURRENT RADIO FREQUENCIES AND WARNING/ADVISORY MESSAGES MAY ALSO BE DISPLAYED UNDER SOFTWARE CONTROL OF THE SMALL ALPHANUMERIC REMOTE DISPLAY UNITS.

EXTENSIVE BUILT-IN TEST IS EMPLOYED TO MANAGE THE REDUNDANCY SUCH THAT FOR 95 PERCENT OF THE FAILURES, THE SYSTEM WILL AUTOMATICALLY BRING THE APPROPRIATE BACK-UP ELEMENT ON-LINE. IN THE CASE OF FLIGHT CONTROL OUTPUTS, CROSS-CHANNEL MONITORING IS EMPLOYED TO ENSURE THAT ALL FIRST FAILURES ARE DETECTED REGARDLESS OF THE "COVERAGE" OF THE NORMAL BUILT-IN TEST.

IN TERMS OF "WHAT IT MEANS" TO THE USER, THE A-129 SHOULD PROVE TO BE A HIGHLY EFFECTIVE WEAPONS SYSTEM - NOT JUST BECAUSE OF ITS ADVANCED FEATURES BUT DUE TO ITS MISSION AVAILABILITY. AND, MOST IMPORTANTLY, THE IMPROVED MISSION AVAILABILITY TRANSLATES DIRECTLY INTO REDUCED COST FOR THE USER.

WITH THE IMPROVED AVAILABILITY FOR MISSION PERFORMANCE, THE USER CAN ACCOMPLISH HIS MISSION REQUIREMENTS WITH FEWER AIRCRAFT IN INVENTORY. AND BECAUSE OF THE REDUCED NUMBER, ITS LOGISTIC, MAINTENANCE, AND OPERATIONAL SUPPORT COSTS ARE ALSO SUBSTANTIALLY REDUCED.

IN THIS RESPECT THE A-129 SHOWS A SIGNIFICANT DEPARTURE FROM THE ESTABLISHED TREND BY PROVIDING BOTH SOPHISTICATED PERFORMANCE AS WELL AS MISSION RELIABILITY.

TO SUM UP, THE USE OF NEW TECHNOLOGIES, A SPECIALE CARE IN DESIGNING THE AIRCRAFT SYSTEMS AND IN BUILDING IN INHERENT SURVIVABILITY FEATURES, MAKES THE A-129 THE MOST MODERN COMBAT HELICOPTER NOW FLYING.

THE AREAS IN WHICH A SIGNIFICANT PROGRESS HAS BEEN MADE ARE (IN PARENTHESIS THE WEIGHT GAINED VS. A CONVENTIONAL HELICOPTER):

ROTOR - SINGLE ELASTOMERIC BEARING, COMPOSITE BALLISTICALLY TOLERANT, LOW NOISE	: 15%
TRANSMISSION - NO EXTERNAL OIL LINES, 30m DRY RUNNING CAPABILITIES, MMS COMPATIBLE, MODULAR ENGINE DIRECT DRIVE IN PUT	: 10%
FLIGHT CONTROLS - DUAL, TRIPLE REDUNDANT, FLY-BY WIRE, BALLISTICALLY TOLERANT ACTUATORS AND CONTROLS, PROTECTED	: 20%
SHAFTS - MAIN ROTOR: MMS COMPATIBLE, BALLISTICALLY TOLERANT, PROTECTS FLIGHT CONTROLS	: 10%
TAIL ROTOR: BALLISTICALLY TOLERANT, SELF CENTERING AND ALIGNING	: 10%
FUSELAGE - USE OF COMPOSITE MATERIALS (70% OF NETTED AREA)	: 21%
A/C SYSTEMS MANAGEMENT - INTEGRATED MULTIPLEX SYSTEM	: 25%