PAPER Nr.: 88

THE CONFIGURATION EVOLUTION IN A MODERN ATTACK HELICOPTER.

THE AGUSTA A129 CASE.

BY

L. MAGISTRI, G. TRABUCCO AND M. GIULIANELLI

AGUSTA S.p.A.

CASCINA COSTA DI SAMARATE, ITALY

TWENTIETH EUROPEAN ROTORCRAFT FORUM
OCTOBER 4 - 7, 1994 AMSTERDAM

Printed by the Technical Highschool Haarlem

THE CONFIGURATION EVOLUTION IN A MODERN ATTACK HELICOPTER. THE AGUSTA A129 CASE.

Authors: **Mr L.Magistri, Mr G.Trabucco**
Product Support Department
Mr M.Giulianelli
A129 Program Management

AGUSTA S.P.A.
C.Costa di Samarate, ITALY

ABSTRACT

The configuration of a modern attack helicopter may seem, at first glance, a peculiar characteristic that does not evolve significantly in the operational life of the same aircraft. This may have been true in the past, but today the situation faced by aeronautical companies and Ministries of Defence in several countries foresee a drastic evolution of the requirements and consequently of the relevant products.
New operational requirements, the need to maximise on-board systems integration together with an effective integrated logistic support and training system, all of this constrained by narrowing defence budgets are forcing the attack helicopter producers and operators to revise the initial configuration and the logistic support philosophy of their products.
It's the intention of this paper to approach the subject with direct reference to the Agusta's and Italian Army's experience on the A129 Program.

1. GENESIS OF THE A129 PROGRAM

The first feasibility study for a dedicated light antitank helicopter appeared at Agusta in early 1972; preliminary design phases were held between 1978 and 1980; while the formal program go-ahead was notified in 1981 and first flight of the MANGUSTA prototype took place in September 1983.
Today, eleven years after that first flight, 21 A129 are in service in Italian Army Aviation and three of those have been fielded for 13 months in Somalia supporting the "Restore Hope" mission.
Such timing, also typical for the development of other military helicopters, clearly demonstrates the technical and the financial challange to which an aeronautical company is exposed in similar programs.

2. THE MONGOOSE TODAY

In this section is summarized the present status of the A129 program and the configuration of the helicopter presently in service in Italian Army Aviation.

2.1. THE ITALIAN ARMY CONFIGURATION VS THE ANTI-TANK MISSION

The operational requirement issued by Italian Army (Stato Maggiore Esercito, SME), that guided the design of the A129, specifies the need for a dedicated anti-tank helicopter able to:

* Carry an adequate Mission Equipment Package (MEP; including avionics for Communication, Navigation and Identification) and armament systems (anti-tank missiles and folding fin aerial rockets).

* Survive in a scenario characterised by sophisticated threats (as radar/I.R. guided missiles and anti-air weapons).

* Operate, day and night, in adverse weather conditions.

* Operate from unprepared fields and, in the field, assure high levels of fleet availability.

* Maintain a significant grow capability in respect to the weight, dimensions and cost targets originally established.

In response to such a requirement and with the target of reducing the crew work load, Agusta has developed for the A129 an avionic subsystem strongly integrated with the helicopter. Core of the integrated avionics is a redundant digital computer named IMS (Integrated Multiplex System) that is dedicated to control and manage the aircraft subsystems.
Physically the IMS is composed by:

* two equivalent computing units (named Master Unit) each one executing the same functions.

* two equivalent interfacing units (named Remote Unit) to which all non-1553B devices are connected.

* each crewmember can interface with the IMS by means of a multifunction keyboard and display.

The four computing unit (Master and Remote) are connected through a redundant data bus with a protocol designed in accordance to MIL-STD-1553B. The following avionic devices are functionally interfaced to the IMS, with different levels of integration:

- **Communication and identification equipment.**
  Two U/VHF radios, an HF transceiver and the IFF system.

- **Navigation sensors.**
  Radar Doppler, Radar Altimeter, AHRS platform for the aircraft stabilisation, a Vertical Gyro, an Air Data System, an ADF and pitot tubes.

- **Armament systems.**
  Including an anti-tank wire guided missiles system capable to acquire targets in day/night conditions by means of direct view optics and an Infra-Red sensor. A Laser Range Finder allows the determination of target range which is an essential factor for the accurate delivery of 81 or 70mm Folding Fin Aerial Rockets that are the area suppression weapon of the helicopter.

- **Night navigation systems.**
  Composed by an helmet integrated monocular display that allows the head up vision of flight symbology overlayed to the thermal image of the outside scenario, generated by a second IR sensor steerable by the pilot head position.
  In addition, the helmet cockpit and the external lights are compatible with Night Vision Goggles.

- **Basic aircraft subsystem sensors.**
  All the sensor monitoring the functional behaviour of the helicopter subsystems (Hydraulic, Electrical, Engine, Main/Tail rotors and gearboxes).

In addition to this, the A129 carries Aircraft Survivability Equipment (ASE) suite (Radar and Laser Warning, Radar and Infra Red Jammer); in particular Infra Red emissions from engine exhaust has been reduced.
Aircraft structures and critical flight components have been designed with crashworthiness and ballistic tolerance criteria.

2.2. THE REQUIREMENT FOR THE ILS DEVELOPMENT

On the A129 program, for the first time, Agusta has been requested by Italian Army to team with the operator and the main A/C subcontractors and to develop an integrated logistic support and training plan.
The main scopes of the ILS plan were the:

1. Development and execution of a plan aimed to the analysis of the aircraft maintenance needs, tailored on the operator requirements, and capable to meet the fleet supportability and availability targets.

2. Monitoring of the A129 initial performance on the field and verification of it's logistic support in order to define the corrective actions that will allow, in the maturity phase, to reach the reliability and maintainability goals.

3. Definition of a training program for operational flying crews and A/B level maintenance technicians. This task imply the development of an adequate set of school aids.

4. Integration, between Agusta and all it's subcontractors plus with Italian Army, for the management of the ILS efforts.

Consequently the A129 and it's ILS have been designed to provide the following features:

- Allow the helicopter operations in a field environment.
  This is accomplished providing the following capabilities:
  > It is possible to pressure refuel and rearm the aircraft with the engines on and the rotors spinning.
  > External loads reconfiguration can be performed in short time without any need for alignments or special equipments.
  > Daily maintenance inspections can be performed directly by the air crew; while hydraulic and electrical power is available for functional checks on ground by having one engine operating and the rotors stopped (accessory drive mode).

- Extended usage, for logistic purposes, of the potentialities offered by avionic integration.
  The IMS system, beside the several functions performed for mission and flight management, allows to record the significant parameters for the helicopter maintenance.
  The same data at the end of the flight are transferred, by means of a dedicated GSE named Data Loader/Unloader (DL/U), to ground computerised stations on which maintenance parameters of each single helicopter can be monitored.
  In this manner the operational status of the major critical components (as engines, dynamic components, etc.) is kept under control allowing the application of On Condition Maintenance criteria.
  The same GSE previously mentioned are also used to load/unload from the IMS all the tactical informations needed by the air crew during and after the mission.

- Helicopter / Equipment maintenance management.
  Is achieved, on the field at A maintenance level, with a minimum number of GSE and tools; while at B level electronic boxes are troubleshooted and repaired through an Agusta developed general purpose Automatic Test Equipment (ATE).
  An additional special equipment, used in conjunction with the ATE, allows Italian Army to implement new software baselines into the IMS for on board software maintenance tasks. Software modifications are anyway developed and qualified under Agusta responsibility.

- Training of air crews and maintenance technicians.
  Air crews training has been made possible through the development and delivery of:

  * Work stations for the preliminary familiarisation on the A129 cockpits (Part Task Trainer, PTT).

  * A Combat Mission Simulator with visual and motion features.

  Maintenance technicians are trained through:

  * Computerised systems for the initial familiarisation with the helicopter (Computer Based Training, CBT).

  * Maintenance simulators.

  * Synoptical panels.

2.3. THE A129 INITIAL DEPLOYMENT. A GENERAL COMMENT

As soon as the first helicopters were delivered, Italian Army started an intensive evaluation plan aimed to:

* The definition of the eventual aircraft limitations and its optimum operational envelope in day/night tactical flight, with different configurations and in extreme environmental conditions.

* The detailed determination and evolution of all the technical, logistic and maintenance aspects of the helicopter and it's related ground support equipment.

* The validation of standardised training programs for air and ground crews.

The evaluation efforts accomplished by Italian Army Aviation and in particular the firing campaigns, although did evidence certain malfunctions that always follow entry into service of new helicopters, allowed to confirm:

> The A129 compliance to the technical specification for flying qualities and performances of both the aircraft and its MEP.

> The performance, in day and night conditions, of the antitank weapon system.

> The accuracy at the longest range of the 81mm rockets system.

> The compliance to the requirement of the logistic support, the technical publication and the GSE delivered.

On the other side, unexpected problems were identified in providing a complete and true night flying and firing capability. The process for the definition of an effective and safe approach for night combat training is still on going.
Globally the results gathered during the technical/operational validation phase are considered by Italian Army as positive and satisfactory. This fact has convinced the Italian MoD to deploy the A129, for its operational debut, in Somalia during the "Restore Hope" mission.
Consequently three Mongoose have been fielded from Jan.'93 to Feb.'94 in Mogadishu and were operated in environmental conditions well outside the original design envelope.
Seven pilots, four Italian Army maintenance technicians and two armament technicians were dedicated to the A129 Squadron and were able to carry out in the field all major operations and maintenace tasks, including the 300 hours inspection and engine/main gear box replacements.
At the end of the mission the Italian Army log books showed that the three helicopters flew around 800 hours achieving an average availability above 80% with an highest daily readiness (on monthly bases) of 92% and a minimum one of 75%.

3. THE CONFIGURATION OF A MODERN ATTACK HELICOPTER. Needs and constraints

The international events occurred in the last years have severely modified the political and militar balances that had determined, in the past 40 years, the policy of Ministries of Defence in NATO countries.
Today, after the experience gained in the most recent scenarios (as Afghanistan, Panama, Gulf War, ex-Yugoslavia and Somalia), appears evident that the new Attack Helicopter must be capable to cover, all around the world, several different roles eachone critical for the results of the military contest.
In addition the aircraft shall cooperate effectively in resolving less critical crisis where it could operate as a strong deterrent.
In other words the same helicopter must be able to operate in scenarios of "higher and lower intensity".
These considerations, together with other factors evaluated in the following chapters, will influence the configuration and logistic approaches of the A129 and of all the helicopters similar to it.

3.1. THE NEW OPERATIONAL ROLES

Without any intention of replacing the military Head Quarters experience in operational matters, it appears evident that the typical mission covered by Attack Helicopters in the past (antitank), in the new scenario must be revised to provide the aircraft with a range of capabilities of critical importance.

The term "higher intensity scenario" is used to identify those operations against well armed forces which are able (as were Armies of the Varsaw Pact) to create significant air and ground threats.
On the other hand for "lower intensity scenario" we intend the operations against less armed forces and peace keeping efforts such as the "Restore Hope" mission in Somalia.
In each of this roles the attack helicopter must be configured with different capabilities:

* Higher intensity scenario.
  In this type of operations the attack helicopter shall be configured with the following types of weapons:

  -- Air to Ground antitank missiles with long stand off ranges.

  -- A multi warhead rocket system for area suppression.

  -- A targeting Sight sensor with detection and recognition ranges that outstand the effective range of the on-board weapons.

  Due to the particular characteristics of this mission, it is evident the need to provide the helicopter with self defence capabilities as:

  -- An Air to Air missile system for medium range threats.

  -- A turreted gun system to engage ground and air targets at short range.

  -- An effective package of electronic warfare equipment.

* The lower intensity scenario
  In this type of missions, where can be envisaged the possibility to operate in large areas with presence of civilians, the following become essential:

  -- The availability of accurate point target weapon systems (as the gun or missile system); while rockets or laser guided weapons should be avoided for accuracy or safety reasons.

  -- The tactical mobility of the attack helicopter must be maximised allowing the installation of external fuel tanks.

In both types of scenario certain avionic subsystems enhancement becomes mandatory for the effectiveness of the mission; such as:

> **In the COMMUNICATION SUBSYSTEM**, the addition of a radio Data Link dedicated to the automatic transmittal/receival of the operational data (such as location of targets and friendly forces, threats or no fly areas) between the air and ground forces involved.

> **In the NAVIGATION SUBSYSTEM**, it is already mandatory the need to improve the accuracy of the navigation computation integrating the data provided by state of the art GPS and Inertial Navigation Platform. The improved accuracy of the on board navigation subsystem, if properly integrated with the weapon subsystem, will also allow to automatically hand over targets within the field of view of the targeting sensor.

> **Extensive COCKPIT INTEGRATION** is highly desiderable, due to the great amount of flight and mission data that the air crew must process in real time. This requirement leads toward the design of glass cockpits to include aircraft management multifunction displays, primary flight displays and digital map displays with tactical informations overlayed on typical geographical maps.

> **The INTEROPERABILITY REQUIREMENT**; the increasing number of multi-national missions, that we have seen in the last years, is going to influence the configuration of armed helicopters more then is expected.
Infact it will become mandatory, between the different nations, to standardise or at least to assure the compatibility of:

-- Communication equipment.

-- Crypto devices for "secure voice" communications.

-- Ammunition inventory for Air-to-Ground, Air-to-Air missiles and rockets.

> **A true WORLDWIDE OPERATION CAPABILITY.** The last lesson learned is relevant to the capability to operate in different geographical areas. Helicopters which have been designed to operate in typical central Europe scenarios could find some troubles to be used for long time in very different environments as can be the tropical or artic one.
It is therefore necessary to provide the aircraft with kits that, installed only when needed, will improve the "technical survivability" without penalising permanently the helicopter.

3.2. THE CONFIGURATION EVOLUTION IN THE AREAS OF FAST TECHNOLOGICAL INNOVATION

The operational characteristics of this family of helicopters often force the aeronautical companies to choose tecnological solutions that in certain subsystems may induce high technical risks; therefore, reaching an adequate maturity in these critical areas, takes a significant operational experience and a consequent evolution of the A/C configuration.
In the A129 case the most challanging areas have been:

* **The night flying capability.**
This capability, essential for low altitude tactical flight (Nap-of-the-earth) and therefore intrinsically critical for flight safety, today is based on the use of light intensifying goggles (NVG) or InfraRed thermal sensors. In both cases the availability of head up flight and fire symbology overlayed on the sensor image is fundamental.
In consideration of the fact that the two sensors operate in different frequencies of the spectral band, our experience has demonstrated us that these two devices are complementary one to the other, with regard to the environmental conditions of the night or the particular phase of the mission.
Therefore, keeping in mind the need for a contemporary use of both devices, appears evident that requirements such as a minimum (if not completely automatic) adjustment of the images together with as low as possible head sustained weight, create human engineering and technical problems of difficult solution.
In addition the integration of the stabilisation and navigation sensors, to fine tune the behaviour of the IMS generated head-up flight symbology, have demonstrated to be a task of significant complexity that deserved many flight hours and iterations with S/W (and sometime H/W) modifications both in the IMS and in the other sensors.
The path to develop, qualify and field a visionic subsystem totally adequate for night and adverse weather flight in safe conditions, is still long.

* **The integration of new mission equipment.**
The installation of new mission and weapon systems in a highly integrated environment implies, beside the usual difficulties, also technical problems requiring approaches at higher levels (subsystem or helicopter).
An example, at this regard will probably help in clarifying the concept:

> During the qualification firings for the A129 Antitank Guided Missile system, the digital autopilot integrated into the IMS demonstrated to be more than adequate for the needs of this weapon, but when Agusta initiated the qualification of the 81mm rocket subsystem our test pilots reported a strong difficulty and heavy workload in maintaining the A129 in the optimal attitude.
> This effect was induced by the excessive manoeuvrability of the helicopter which is, on the other side, a mandatory feature for an effective Nap of the Earth flight.
> The situation has forced the Agusta's technicians to develop and validate a new set of autopilot laws that, once selected by the pilot, would enhance the A/C stability performance during firing phases, while maintaining the original agility requested during normal manoeuvred flight.

Consequently a delicate aspect is the need to phase the in-service date of a configuration block change, applicable to the helicopter, with the availability of a minimum set of updated GSE and training devices.
A mismatch may easily create a long delay before the modifications are made available to the operator; the result is an encrease of the overall program costs and longer response by the Company in resolving the operational disturbs that generated the change request.

5. CONCLUSIONS

The all italian experience (Army and Agusta), but very innovative, of the A129 has clearly indicated us the need to apply, in military programs similar to ours, three basic concepts:

* **INTEGRATION**

* **FLEXIBILITY**

* **LOW COSTS**

This, practically should be translated into the:

* **INTEGRATION**, into the same attack helicopter, of the weapons/mission equipment that will allow to cover a multirole capability.

* **INTEGRATION** between the professional capabilities of the manufacturer and the operational knowledge of the end user.

* **FLEXIBILITY** to respond in a timely manner to the operational needs arising day by day from the field.

* **FLEXIBILITY** in developing onboard avionics and logistic/training systems capable to minimise the impact of future changes and also to handle different configurations contemporary in service.

* **LOW COSTS** to survive in a very competitive market governed by the severe defence budget cuts.

To achieve the above goals a fundamental aspect, that unfortunately is often underrated, is the **HUMAN FACTOR.** Infact to develop and maintain weapon systems technologically sophisticated as the A129 there is a strong need to keep and support the professional knowledge, of both technician and the operator, gained in may years of experience in similar products.