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MILITARY REQUIREMENTS: TOO LITTLE OR TOO MUCH?

Col. Emidio VALENTE
Italian Army General Staff
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Deutsche Gesellschaft fur Luft- und Raumfahrt e. V.
Goethestr. 10, D-5000 Köln 51, F.R.G.

Curriculum Vitae of Col. VALENTE

- Col. Emidio Valente is an Officer of the Italian Army who started his career during World War II as a tank officer.
- After the war he became an observer with the Airforce and subsequently pilot-observer in Army Aviation.
- As fixed-wing pilot he has accumulated great experience as flight instructor and Chief of Flight Standardization.
- In 1962/63 he attended a helicopter course in the United States, at the Army Aviation Center of Fort Rucker, Alabama.
- Upon his return to Italy he reorganized the helicopter flight training at the Army Light Aviation Center and subsequently he was called to the A.L.E. Inspectorate as Head of the Materiel and Experience Section.
- He was then Head of the Army Light Aviation Section in the Research and Studies Office of the Army General Staff.
- Presently he is coordinator-officer of the development programme for the A-129 light anti-tank helicopter and responsible for european cooperation in the helicopter field in the Army General Staff.
- In 1979 Col. Valente addressed a speech on airmobility requirement of the Italian Army at the Fifth European Rotorcraft and Powered Lift Aircraft Forum in Amsterdam.
- In 1980 Col. Valente addressed a speech on European Cooperation for a tactical transport helicopter at the Sixth European Rotorcraft and Powered Lift Aircraft Forum in Bristol.

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by

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1. FOREWORD

I am pleased for the privilege of addressing this highly qualified Congress on behalf of the Italian Army and I am grateful as well for the opportunity of expressing a few ideas I trust may be helpful for a satisfactory understanding between the military operators of rotary-wing aircraft and the helicopter designers and manufacturers.

As in previous occasions, I am speaking as a representative of the Italian Army Aviation, namely, one of those services which have found in the helicopter the ideal means to acquire new operational capabilities and believe in the future growth of these capabilities through the elimination or at least the reduction of the current limitations in order to better counter more serious threats.

My current exposition is ideally following up the previous one I read in Amsterdam at the 5th Forum when I dealt with the military requirements as guidelines for the future.

I resume now the subject again prompted by the feeling that in the course of time and in view of the growing prospects being offered by the civil market, manufacturers are beginning to show signs of restlessness against particular military requirements as their full implementation might adversely affect costs in a way quite unacceptable in the case of machines intended for aerial work rather than for military deployment.

This explains the meaning of this lecture's title. Do military requirements impose perhpas major limitations to the helicopter diffusion? At the end of my exposition I hope to be able to demonstrate that the requirements

of military operators, if correctly interpreted at a time when modern technology increasingly widens the operational limits, represent, rather than a limitation, a challenge towards new and unconventional solutions which may prove to be useful or even invaluable for the attainment of a real progress.
Thus, in view of the restrained attitude adopted by some military circles in expressing their requirements one wonders if their demands are not perhaps still too constrained to achieve a real breakthrough.

2. EVOLUTION OF MILITARY REQUIREMENTS

With a background of over sixteen years' activity in all Italian Army's helicopter programs and in similar programs implemented in the allied countries through various international agencies, I can now try to make a retrospective review of the evolution of the military requirements and of the technical reactions by the helicopter industry.

To begin with, our fact is plain: the helicopter has not been timely understood by the military. If the first successful attempts in the 30s had lead to a clear understanding as to the role this machine might have played in the Armed Forces, particularly in the Army and Navy, its development would have been boosted in quite a different way so that the machine might have soon reached levels comparable to those reached by fixed-wing aircraft.

Thus, no military requirements did exist as the beginning. The path was then privately followed by a few industries with the scanty support of a few military forerunners who had often to face serious opposition from their ranks.

When it became apparent that the helicopter was capable of achievement quite beyond the reach of fixed-wing aircraft, they contented themselves to procure just what was available in the market, namely machines which ought perhaps to be considered as starting points towards further developments rather than operational vehicles.

However, it were just those machines that inspired new concepts which led in the 60s and 70s to the birth and development of the aeromobility concept and consequently to the expression of military requirements and to requests for specific answers from the industry.

Yet, still from a retrospective viewpoint, the exchange of ideas between the military and the industry did not always foster, in my opinion, or at least speed up the helicopter evolution as compared with the tremendous pace of evolution experienced by other aviation fields, such as the advent of the jet era, the modern combat aircraft featuring incredible performance, the space conquest.

As for the helicopter, the military, although expressing their requirements, seemed to accept with resignation the technical and technological limits: the aerodynamical mistery, the mechanical complexity and the restraints imposed by the available materials.

Although the technicians were doing their best to meet the military requirements, no real breakthrough was ever achieved as this would have certainly required a higher degree of financial support by governments and industries, regardless of the fact that these efforts would have been highly profitable in view of the promising outlook which was beginning to emerge in the civil and military markets.

To be sure, we have had machines capable of doing things otherwise unthinkable ... was this, however, the very best we could just have even in those times? If we consider for a moment the rather modest performance, the all-weather operational limitations, the mechanical complications, the expensive logistic support, the costs, the training difficulties we will easily understand how much did it cost us to reach acceptable aeromobility concept in view of the lack of new concepts, if not a breakthrough, in the rotary-wing sector.

Someone may argue that new means are available today, such as advanced avionics, new materials, computers, simulation systems, etc.

This is only partially right, as nowadays these means, or at least many of them, are just much more widespread, whereas at that time they were already available at large industry level and used for major aviation and space projects.

We must admit that the helicopter was being sold just as it was, without any major R & D costs. I refer here particularly to the United States, in view of the pressing requirements caused by the Vietnam war. Logically enough, this production spread worldwide not only through direct sales or license manufactures but also through the diffusion of technical concepts which did affect the design of all machines of those years.

Now, what is the current position? I would venture to say that the situation is a queer one and perhaps rather preposterous.
While on one hand the technicians do tantalize the military by putting forward the astonishingly wide possibilities offered by the advanced technology, on the other there seems to exist a marked concern among the technicians themselves (or perhaps the manufacturers) as they appear to fear that our requests, fostered by them, might lead to exceedingly sophisticated and expensive machines which could hamper the helicopter diffucion in an increasingly promising market, i.e. the civil one.

If this feeling is correct, I think the reason for that lies in the fact that even with means provided by the advanced technology,the industry hesitates before a real breakthrough and contents itself with the improvements of what has been so far achieved rather than to attempt new ways.

This is rather worrisome since an answer to our requirements solely in terms of growing costs and sophistication does encourage those among the military circles who are beginning to favour the return to simplicity and low-cost policy, a trend which might lead as well to the rejection of the tremendous operational potential of the helicopter which is still far from being fully exploited.

They who are worring about the helicopter sophistication seem to overlook how highly sophisticated a tank or a missile system is. The fact is that when the sophistication leads to easy handling, operational reliability and low logistic costs,this must be accepted.

3. MILITARY REQUIREMENTS

I would now attempt to analize the developing process of a military requirement from the conceptual viewpoint - keeping within the boundaries of the ground forces' aeromobility - highlighting the interaction between operational and technical aspects during such a process up to the requirement definition as a starting point for the subsequent phases which are to lead to the development and production of the aircraft.

It is perhaps worthwhole recalling the meaning of aeromobility when referred to the Army.

Aeromobility is the modern answer to the never-ending requirement of the ground forces to autonomously get over the terrain limitations in order to enhance their freedom of movement, to set up mobile airborne observation posts and to provide a new momentum to their offensive power.

By autonomously I do not mean to say, of course, that it does imply the renounce to the invaluable support provided by the Air Force. It rather implies, instead, the increase freedom of movement through the integration of aircraft into their ranks.

Aeromobility is thus the availability by the ground forces of aerial means of their own for tactical and logistical purposes, from a minimum extent in order to step up their operational capability through the supplementary support to the conventional action on the ground to a maximum extent in order to obtain new combinations of the classical warfare factors: manoeuver, mass, surprise.

It goes without saying that the exploitation of this actual revolution in the ground warfare - in fact, it can be a revolution rather than an evolution if the helicopter potential is exploited to the full - requires aerial means adequate to the functions to be performed and to the aeromobility level to be attained.

Which type of aircraft, though ... fixed-wing or rotary-wing?

Up to now no doubt has ever existed on the subject: the only possible choice was in favour of the helicopter, the only aircraft capable to operate off the frontline as a conventional aircraft and to convert itself close to the enemy into a ground vehicle able to exploit the terrain for its own protecion without being subject to any limitation to its mobility. Needless to demonstrate that also today and in the foreseeable future only an aircraft having vertical take-off and landing capability can meet the special requirements of ground forces.
One begins to wonder, however, if the conventional helicopter is still adequate or whether new configurations might perhaps provide performance more equal to the requirements of the modern warfare.
I refer for example to the tilt rotors, or to the counter-rotating rigid rotors, or to the compounds.

Having regard to aerodynamic and mechanical characteristics of the helicopter and its intrinsic limitations, military operators have up to now accepted these limitations, such as speed, favouring the asset deriving from the hovering flight capability.

A number of new operational situations are now emerging which could widen the requirements range, including that for greater airspeed. However, before dropping wholly or partially the conventional helicopter concept, in-depth studies should be made to investigate the advantages of new solutions versus a possible penality to a number of factors, such as costs and technical-logistical complication, which might be unacceptable to any ground force.

However, apart from any aprioristic observations as to the type of aircraft, the definition of military requirements is, as previously pointed out, the conclusion of a logical process starting from a specific operational requirement namely an operational target, expressed in the context of the Army's operational philosophy, which should go through the preliminary evaluation of a few factors, such as:

- economic resources and priorities to be given to the procurement of a new aircraft;
- technical condition of the existing flight line having regard to the need for replacement of obsolete aircraft and the introduction of new machines;
- definition of the new aircraft's operational role, in particular, whether if should be intended for a specific role or if can perform a variety of roles in various configurations;
- time of entering service.

A further line of thought should be then followed by those countries which in connection with the strenght of their armed forces and the available resources cannot set out a process of definition of the military requirements for a new aircraft disregarding the production outlet offered by the industry concerned. This should be such as to permit a proper development cost sharing over units produced.

In this connection I think I need not remember that nowadays the ratio between non-recurrent and recurrent costs for the development of advanced-technology designs may range from 50 to 150 and over, depending on to whether the new design incorporates already available components and systems or it has to be the result of a fully new development of all its components.

This involves therefore the need to assess in the international context of one's own alliances whether any joint requirements do exist and to spare no effort towards joint programs as their implementation would be not only economically but also operationally profitable in the light of those well known rationalization, standardization and interoperability concepts so widely claimed and so little implemented.

Anyhow, a contact between operators and technicians is necessary just in this preliminary phase in a steady and open effort to conduct parameter compatibility studies on the operational objectives on the basis of different hypothetical solutions leading to the determination of a final operational requirement after various tentative formulations backed by feasibility studies.

Thus, the operational requirement is an abstract of the requirement determination starting up from the assessment of the threat posed by the operational environment and of the other factors necessary to define as closely as possible the human, technical-logistics, financial context in which the new vector will be called to operate in order to come to a logical solution and to outline the machine in its basic aspects - tasks, principles of deployment, design criteria, performance, operational functions, human factors, logistics requirements - to be used as guidelines by the military technicians in the definition of the technical specifications and by the industry technicians in the working out of a design.

4. IMPACT OF MILITARY REQUIREMENTS ON TECHNOLOGY AND VICE VERSA

Military requirements and technology have been tied up to each other for a long time by an uninterrupted interaction process.

Although they provide to each other the necessary stimulus for evolution and development, the military enjoy the privilege of giving way to their own imagination steadily asking for something more and something better in connection with the outcome of the various rounds in the perpetual struggle between threat and protection.

In their turn, the technicians had to increasingly widen the technology boundaries in order to meet operators' requests, which were often contradictory to each other, and this has in turn offered new possibilities to the military.

All this, obviously, having regard not only to the technical requirements of modern warfare but also to the human factors generated by the spreading of the advanced technologies also in the field of civil applications.

This is particularly true in the Western countries, where the defense concept of quantity-oriented defense has been replaced by that of quality-oriented defense as it becomes evident the trend to leave the fight to a limited elite of specialists equipped with such highly sophisticated weapon systems as to render the war almost a sports

event to attended by the masses as interested on-lookers only, involved in the outcome of the confrontation like a modern repetition of the fight between the Oriatii and Curiatii of the ancient Rome.

Mind you, I am talking about a trend or psychological drive evidenced also at fiction level by films like "Star Wars" showing highly specialized servicemen fighting even in the outer space.

However, a concrete analogy does exist also in reality: in fact, when reviewing the war power of each of the two blocks currently dividing the world, emphasis is always given to the quantitative superiority enjoyed by one side versus the need for the other to balance this disadvantage with the deployment of more and more technologically advanced and sophisticated systems rather than with an equal quantitative power as this would imply an increased development of human resources, which nowadays are considered hardly prone to any sacrifice.

Hazards do exist, however, in the search for solutions based on increasingly advanced technologies. On the one hand, this trend is bound to lead to an endless cost increase and to the other to the production of weapon systems with extraordinary performance, whose reliability, however, being the product of the reliability of each of the integrated subsystems, runs the risk of being lower than that of simpler systems based on more traditional technology.

Talking about costs, at least as far as combat aircraft go (although, I think that the concept applies to any weapon system), it has been paradoxically affirmed that, should this trend towards the increase of unit cost for more and more sophisticated systems continue, in the early years of next century the whole budget of the U.S. defense will be hardly enough to acquire one aircraft per year only ... to be shared between Air Force and Navy for three days and half each week. ("AUGUSTINE" bill).

As to the reliability factor, it is argued that the installation of self-monitoring systems and the subsystems modularity make it possible to easily maintain efficiency also in operational conditions.

However, this implies a tremendous availability of spare parts, not just as loose parts but rather as subsystems and modules, and a high degree of intermediate and depot maintenance along wiht a steady flow of items to and from the frontline.

At this point, a number of questions might already be raised, in particular:

- whether by any chance I have not fallen in contradiction with my initial statement as to the need for increasingly advanced technological solutions to the military requirements in the rotary-wing field;
- whether I am not forgetting to talk just about the helicopter which is after all the focal point of my exposition.

I would answer the first question denying any charge of contradiction on two grounds:

- the first one is that the helicopter has not yet fully and rationally profited of all the possibilities offered by the advanced technologies;
- the second ground is that these technologies, rather than being applied in the various parts of the helicopter, should permit an overall re-thinking of the machine in revolutionary rather than evolution terms in order to produce something substantially, if not fully, different.

Let's think of the car: from its birth some ninety years ago, we have been witnessing a steady growth process of this vehicle which, nonetheless, is today not conceptually different from the original; and yet this growth process is proving uncapable to tackle problems like the energy crisis, cost rise, shortage of some raw materials, enhanced operator requirements, such as comfort, for example.

These emerging problems are prompting the industry to design the car in new terms, featuring requirements which shall not of course reflect more expensive and burdensome service and operational solutions.
I am personally sure that revolutionary projects are ready in the offices of leading car manufacturers and these will be implemented as soon as a trend reversal is experienced in the demand for conventional cars.
The following is the criterium that I expect will be adopted in the design of future helicopters, namely: technology as simplification factor, weight reduction, containment of purchase and operation cost, increase safety and performance, through a new design policy featuring fantasy and technology, with an increasingly extensive resorting to simulation and steady cooperation between technicians and operators, thus providing a steady verification of the requirements and solutions process.

I would also like to stress another aspect of this new design policy, namely the requirement that it be backed by a generous allotment of funds for basic and applied research. This allotment of funds shall however not center on a single project alone, but be extended to the entire helicopter industry, so that these initial liabilities might in the future turn into engineering and economical benefits for a great number of programmes.

In this respect, once again the requirement arises for a cooperation among government-backed industries and not only as far as military programmes are concerned, if a switch is to be made from a sterile and by now anachronistics commercial challenge to a sound and profitable competition.

Hereby I have implicitly answered my second question and I am wondering whether I have perhaps neglected the helicopter, departing from the subject of my address.

5. MILITARY REQUIREMENTS: TOO MUCH?

On this subject I should like to go into details as regards those military requirements which are of some concern to manufacturers increasingly dedicated to the commercial market.

I think that protection and survivability is one of the aspects which are likely to differentiate a military from a commercial helicopter.

If it is true that the helicopter has become an essential means for the ground forces, it is as well true that a medium or high-density battle theatre does not favour helicopter operation, because of hostile general and special anti-helicopter threats.

In the definition of the military requirements, particular emphasis is devoted to the abovementioned aspects, in order to configure an aircraft:

- difficult to detect and hit;
- if hit, capable to absorb, to a certain extent, the damage caused by enemy fire;
- featuring a high degree of survivability for the crew in the event of a particuarly hard landing.

Well, these requirements originate the implementation of at least three types of provisions, namely:

- the installation of sensors and counter-measures as for example radar warning systems, laser warning, jammers and deceptors of hostile tracking equipment;
- use of special paints;
- hardening or armour-plating of some vital systems

The incorporation of these provisions implies adding weight to the basic aircraft with a more or less severe reduction in useful load, but will not affect the non-military operator who can fully exploit the aircraft performance.

Other provisions instead cover basic design and aircraft architecture and require therefore a thorough investigation in order to assess to what extent their implementation differentiate a military from a commercial aircraft.

Let's start from ballistic tolerance that can be achieved through the adoption of various criteria, such as:

- the use of materials featuring a better-than-metal response to fracture lines propagation following a hit. These non-metallic materials also offer the advantage of lower weight, higher resistance to wear, or if used for blade construction they enable the development of improved aerodynamic shapes, which alone already constitute a considerable performance improvement;

- systems' redundancy, and this applies also to safety of operation and I don't think this is merely a military "luxury" but something that may reassure any helicopter operator, especially, if he is required to operate under adverse conditions.
  On the other hand the weight penalty incurred for the implementation of redundancy requirements can be minimized by the design of non-conventional systems. I refer for example to fly-by-wire flight controls, to systems' centralized management and to the adoption of the so called Multiplex Bus System.
  All this not only means safety but operational fatigue reduction, operation simplicity and easier maintenance. This applies to all operators not to military alone.

Eventually the crashworthiness aspect seems to pose the severest problems and it impacts in particular on the military requirement.

Weight increases (unacceptable to those operators who regard crash as a remote occurrence) will be incurred if the crashworthiness requirement is to be implemented starting from a conventional design criterium. But also this problem needs to be investigated starting from a different angle, thus permitting to best combine material utilization with structural architecture and achieve solutions which do not depart to a large extent, as regards weight, from conventional.

On the other hand, are we sure that commercial operators are not willing to be protected against crash through the adoption of measures not only devoted to save the life of crew and passengers, but to avoid as well wrecking the aircraft?

I am sure we will not question, from a military and commercial viewpoint, the need for measures to minimize fire hazard following a crash.
We can say instead that the current crashworthy fuel systems may be improved in order to save weight and increase tank capacity.

Eventually, another requirement is very often cause for conflict between military and engineers, namely: single engine performance for twin engine helicopters.

This is an old story which does not refer to helicopters alone.

First of all it must be brutally said that it is unnecessarily penalizing, in terms of weight, complexity and cost, to duplicate a system if one of the two elements is not self-contained in an emergency.

In this respect, either we accept the principle that modern engines pratically offer a one hundred per cent reliability and a system duplication is therefore unnecessary, for power is concentrated in a single engine relative to the category of the aircraft; or if two engines are nonetheless required it will be necessary that each individual engine permits flight continuation or at least the capability of performing a safety controlled landing within the normal operation envelope.

In this sector engineers are expected to provide solutions, in their impossibility to stress any further the derating versus safety concept so as to avoid a too great impact on fuel consumption. They could instead find solutions providing enhanced quantitative and temporary emergency power margins with respect to current engines.

Reverting for a moment to the very high reliability of modern engines I would like to point out that for us military people, this is not only a technical problem (possible failures), but primarily an operational problem if we consider the external factors likely to determine an engine stoppage.

6. CONCLUSIONS

I should like to condense what I have so far said into some concepts which I find useful for a better understanding of the military requirements:

- First, the helicopter is no longer an auxiliary means for us, but a weapon system featuring the same indispensability level of all other systems required to integrate the battlefield;
- Second, the helicopter must be accordingly designed to reflect military requirements which cover all those elements which are likely to condition its operation, this is to say: operational environment, human factor, economical aspects;
- Third, before classifying as too burdensome the solutions necessary to satisfy the military requirements, the following should be investigated:
  - whether commercial operators are really affected;
  - whether solutions can be found which in the end prove to be a saving rather than a deterioration in cost, weight and complexity;

- Fourth, from the very moment of the formulation of the requirement, an exchange of mind is necessary between military operators and manufacturers, these latter also as representative of the civil requirements reflected by marketing;
- Fifth, new design criteria are essential, for the helicopter to reach the highest levels of aviation progress;
- Sixth, adequate industrial and governmental funding is to be made available to the helicopter industry, especially in Europe, for basic and applied research;
- Seventh, promote industrial and expand military cooperation among allies.

I wish now to wind up my address, which has touched upon motives of reflection on what can still be done in behalf of the helicopter, before it will be earmarked as a transitional means destined to be replaced in a more or less near future by who knows what science fiction vehicle, for example by anti-G platforms.

I leave you a message, a challenge, a good omen, in the firm belief that the provisions for thinking of the helicopter in new terms are emerging.