Let me express my deep satisfaction for having been invited to speak in such a significant occasion. Indeed I feel honoured and my appreciation is also justified by my long association with AGARD in the framework of the Aerospace Application Studies Committee: having been a member of this body for many years I have had precious opportunities to enjoy the benefit of the works performed by the various Panels, with an in depth knowledge of the trends of research in the forefront of technology. And here I would like to pay a tribute to those who founded the AGARD for the wise structure they devised a structure in which an institutional link between the military planners and the scientists has a fundamental place, allowing the former a better insight of the feasible developments in technology and letting the latter have a first hand knowledge of the real needs emerging from doctrine, strategy and in general geopolitical situations.

I firmly believe this to be a crucial point, and an argument worth of the greatest consideration by anyone who has responsibilities not only in the scientific or in the military world.

A very simplistic question is whether it is true that military needs drive research in the scientific fora or, on the contrary, the achievements in the technological fields dictate the developments of tactics, strategies, and eventually doctrines.

Like all simplistic question, the answer is neither simple nor unilateral: looking back on history good and solid examples can be found to support both thesis: at Crecy the technology of longbows had the upper hand of the knights cavalry that till then had been the decisive factor in battles and hence in wars. Can we derive from this episode that technology has changed the course of history by itself and that strategists were forced to change their attitude?

On the other hand, later on, the achievements in fortifications and strongholds were such that apparently conflicts were at a stalemate: no one could win, and only the death for natural causes of one of the contenders could eventually put an end to strifes. It was quite natural then to see the rulers of those times urging the scientists to devise new means, to increase the probability of success of a siege: Leonardo da Vinci was a very welcome guest of many European courts not only for his artistic skills but also for his far sighted ingenuity in inventing new war
machines. Can we then deduct that the advancement of technology is due to the demand for new devices and weapons made by strategists to scientists?

I am firmly convinced that the answer is much more complex than the questions and that the magic world is “interaction”: instead of discussing fruitlessly whether the push for advancement is given by the military or by the science world. I believe it is more convenient, and it bears more concrete results to study the continuing interrelationship between the two in an effort to improve the means of dialogue, opening doors and establishing institutional tables, around which aerodynamicists and pilots, chemists and gunners, technicians and colonels can sit together, to inspire and to be inspired in both directions, reciprocally.

I am fully aware that this is not a new idea: indeed the establishment of AGARD some decades ago responded to this concept, giving birth to a body or better a set of bodies, that have proven a very reliable and effective means of dialogue and thence progress. In a very humble and realistic attitude, we must continue along the lines which have been indicated by our predecessors, rendering this dialogue more and more open, establishing new fora, opening new opportunities for cooperation at all levels, not only at the level of the planners of the grand strategy but also during the day-to-day activity in the laboratories and in the test sites and fields.

The papers that are about to be presented show many good examples of such an attitude and similar procedures: we shall hear how the military staff and their technical bodies are heavily involved during development programmes. Military personnel daily cooperates with contractors to ensure that the results of the work by defence industry, both hardware and software, are fully in line with the expectations and the needs of the men and women who will be the final users in the field, putting them in the position to win the battles that they will be asked to fight, with the minimum risk for their lives.

Although this cooperation is performed at various levels, with procedures tailored to the contractual environment of the specific programme and with the legal constraints peculiar to each single nation, my experience shows that sometimes the initiative is taken informally by the operators on both sides, officials and industry, at working level, but when the matters are raised to the managerial teams, then some difficulties arise: the industrialists being reluctant to accept what they consider unduly interference by the officials and on the other side with the military keen to sponsor technical solutions they are in love with.

If this is the situation, and sometimes it is so, I think it is of the greatest importance that institutional ways be found and agreed so that an open discussion can be held at all times, thus enhancing the final result of development programmes. I am aware that some difficulties exist: the first one that comes to my mind is the cost of this cooperation, which can be identified as direct and indirect: direct costs
would be related to the organization of meetings, preparation of documentation and presentations, but what planners seem to be much more worried about are the indirect costs related to the modifications to hardware and software caused by the interference of the military, all resulting on the one side to what is commonly referred to as “goldplating” and on the other giving grounds to claims by the contractor either for delays and disruptions, allegedly originated by changes to specifications, or for major costs due to evergrowing requests by the officials. Nevertheless I believe that it would be very wise and beneficial if a code of rules could be established, giving terms of reference as clear and detailed as possible, so that the greatest benefit for future developments can be gained in a deep and thorough understanding by the contractor of the real concrete needs if the operator.

Leaving now this issue, which is for sure, in a way, philosophical but has far reaching practical consequences, I would like to address now something more specifically relevant for the activities of this distinguished audience.

The first consideration I want to underline is the obvious one that man was not intended in the beginning as a dweller of the third dimension: we are not given wings, nor we possess aninstinct of orientation like the one of the migratory birds. Nevertheless we want to fly higher and faster and more than that, we want to be able to operate in such and unfriendly environment. This is the ultimate scope: to have the capabilities to exploit the air and, being military, to deny its use by the opponent.

During the last decades the expression “man-machine interface” has become very common, to indicate the facilities (controls, gauges, screens, warnings and what else) that allow an operator to use a complex system, be it mechanical, hydraulic, electronic etc.

Well, I consider an aircraft a similar interface; an interface between the man and the environment above the ground. In this sense I call it a “man-environment interface” and then I apply to this system the same criteria and the same logic used in ergonomy. In particular, one of the most important parameter is the degree of “user-friendliness”, which for an aircraft translates into ease of conduct, harmonized controls, carefree handling and not only for the flight controls, but also for the engine and for the systems, for the weapons and for the utilities. I belong to the generation of the F-104 and if you ask any pilot with a Starfighter experience in his career, I have no doubt that his preference goes to it, for the unsurpassed sense of power, but more so for the awareness of having broken in a wild horse, ready at any moment to unsaddle his rider. Very romantic, but also very impractical. What is asked today of you is an interface between the man and the air to which the pilot has to devote almost no attention, so that he may dedicate nearly all his capabilities and his resources to execute his mission, be it a dogfight or a logistic airlift.

But one can easily object that this aim has already been achieved. The aircraft of this generation, and even those of the former one, are already easy to fly: a “first tourist” is no longer the exception, but the rule, on a first line fighter. More than that, the active control technology has already attained such levels of
sophistication that the performances of flying machines have reached and surpassed the limits of human beings: you can easily design a system capable of a 15 Gs turn but nowhere can be found a pilot able to sustain it. So the question is whether there is any room left for further advances which still are possible are worth the effort and the money they are going to cost. Has the ultimate aircraft been designed? Is the F22 the maximum usable technological development? Of course the answer is no. Otherwise we would not be here to discuss and to share our ideas on how to open new domains.

The point is that the environment for which you are designing the interface is not static, it is not only a physical concept: its challenges are modified and increased almost on a daily basis by the various actors in the geostrategic scene. Hence the need for continual research so as to be always in a position to counter the threat or, to use a more fashionable word the risk. The likely opponents have better sensors? More accurate and reliable radars with better electronic counter counter measures? No problem: we will open the door to the stealth technology: but how compatible are the stealth requirements with the basic laws of physics? I suspect there is no compatibility at all and a close look at the F117 is the best proof of that. I also suspect that only the joint efforts of a bunch of scientists, ranging from aerodynamics, through computer sciences, could succeed in making such a thing fly, and fly effectively, with valid operational results. I recall that once Sir Geoffrey De Havilland expressed the concept that only beautiful aircraft can fly beautifully. This is no longer the case: also ugly aircraft can fly, albeit with the help of a complete suite of computers and today the ugliness is dictated by operational considerations. I can well mechanics will be devoted to the severance of the links of conventional physics in an effort to release flying qualities from the observance of the laws we have been living with up to now.

It is not an easy road: after the initial enthusiasm, which is typical wherever a new door is opened, a more cautious approach has become necessary. What has happened during the development programmes of the Gripen and the F22 has undoubtedly introduced a degree of uncertainty into the minds of engineers and programme managers with an everincreasing need for validation procedures with an absolute degree of reliability.

This is certainly a field worth of further analysis: the validation tools require daily refinements and room exists for increased and more reliable capabilities which will yield safer developments while allowing shorter times for achieving fully tested operational envelopes. Finally I would like to draw your attention to a spin-off offered by the active control technology, which in the present and foreseeable circumstances is becoming increasingly important. I am talking of the influence of this technology on life cycle cost in general and on structural life in particular.

Too often in the last decades we have witnessed cases of flight lines being grounded for sudden failures of vital components of airframes. These occurrences have thus given birth to heavy and costly fixes with very unpleasant consequences on the operational as well as on the financial side. I do believe that the tools you are developing will prove extremely beneficial to smooth and reduce the fatigue
spectrum of all types of aircraft. The consequence will be lighter structures, longer maintenance cycles and therefore and overall reduction of ownership costs.

The same beneficial effects will be experienced by the systems and the equipments on board that in their operating life will stand stresses of a reduced magnitude, thus increasing the in-field reliability of weapon systems.

Let me conclude now, underlining that we, the military, as final users of your efforts and your studies, do expect further advances. The world scenario which has emerged after the fall of the Soviet empire may induce a dangerous trend of reducing the momentum of research in the field of military technology. I firmly believe it is important to stress that this would represent an error which would not be forgiven by our successors.

The message I want to leave you with is that NATO countries must maintain their technological edge: by this edge the cold war has been won without any combat and only such an edge will allow us to win the peace for the future generations.