THE ERASMUS PROJECT: "A FRIENDLY WAY FOR BREAKING THE CAPACITY BARRIER"

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The problem of capacity and efficiency in air traffic control is of deep concern throughout the world and is very much to the fore within the European Union. The European Commission has recently signed a contract to study the feasibility and the conditions of implementation of the En Route Air traffic Soft Management Ultimate System (ERASMUS) project. The project team is led by EUROCONTROL and is composed of DSNA/SDER (France), HONEYWELL (USA and Czech Republic), SITCA (Italy) and the Universities of Linkoping (Sweden) and Zurich (Switzerland).

A high level of automation has been introduced in the air segment over the last 50 years. The ATM system could therefore seem "archaic", for not taking full advantage either of the available precision navigation, air/ground data-links or FMS, which are already used worldwide for other purposes.

Most of the outside observers have difficulty in understanding why such potential, in terms of data accuracy and ground and airborne communication and computing capabilities, still remain quite so poorly used for contributing to the ATM "modernisation".

Except in the idealistic and improbable case of its full automation, the (ATC) system is, and will remain a manual system

The ERASMUS project could open up an original path to circumvent the main obstacle of controller/computer cohabitation.

Inaccessible "full automation"

A full automation of ATC would be irreversible, would suppose simultaneous equipping of all aircraft with data-links and most modern FMS, and imply the previous, but unfeasible safety certification of all the involved processes and of the system as a whole.

For these reasons, among many others, such an automation would call for a long period of transition during which manual and automated functions would have to coexist. During such a period, man and machine cohabitation would raise unsolvable problems.

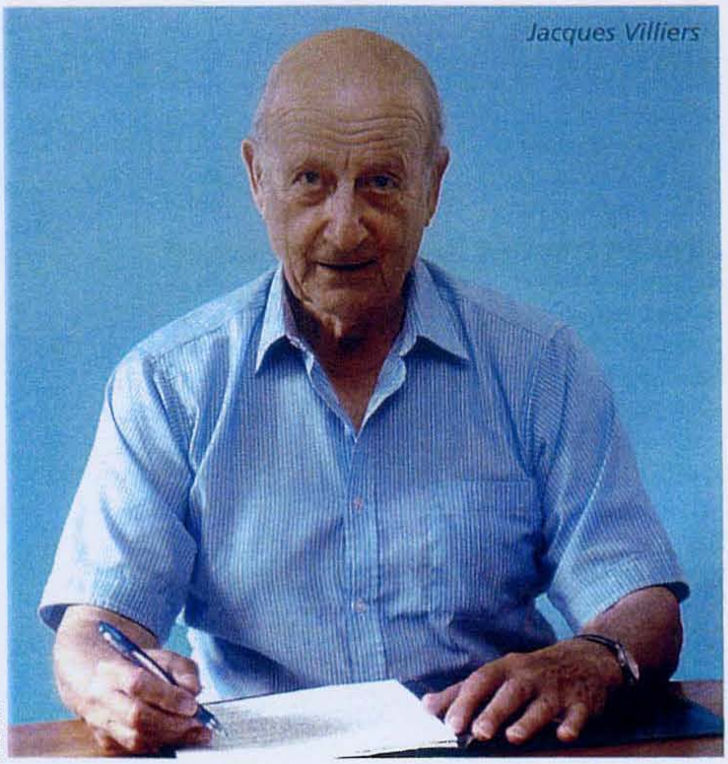


Photo: JV

The current system has been organised and tailored for drawing the full benefit from the controllers' cognitive capabilities and resources.

Major changes as "free flight", "free routes" or 4D deterministic navigation could lead to a more flexible and efficient system, but unfortunately would make the controllers' tasks more complex. Here lies a hidden paradox and the reason why none of these projects has even reached the stage of an actual experimentation.

Therefore, it must be understood that, except in the idealistic and improbable case of its full automation, the system is, and will remain, a manual system.

Understanding the controllers' work

Cognitive and mnemonic capabilities of human beings are different from those of computers, but humans are nonetheless able to perform what sophisticated software can barely achieve.

Controllers can handle quite dense traffic without any help of any advanced piece of software. How can they do this?

Controllers' real time tasks are highly complex and "en route" control is far from being just an organised series of "conflict detections" followed by "conflict resolutions" one after the other as many imagine.

Controllers must first detect every "problem" i.e. pairs of aircraft for which they cannot be guaranteed, ten or 15 minutes in advance, whether they are, or are not on safely separated paths. For so doing, they can rely only on fuzzy and incomplete data. Let's judge it.

For making full use of the 5n.m. separation, the ideal accuracy of the forecast positions should be of the order of 1n.m. (i.e. less than ten seconds of flight for an aircraft flying at cruising speed). This is largely out of reach in an open loop process. And the same goes for climbing or descending profiles.

It is too often forgotten that safety separations are ground referenced, while the flight is conducted according to horizontal and vertical airspeeds.

The fuzziness of the position forecasts is resulting from the imprecise and incomplete knowledge of airspeed, wind, turbulences and windsheers ,climbing or descending rates and the mental extrapolation in the three dimensions.

Therefore, each new "problem" detected by the controllers gives birth to a provisional separation assessment and is integrated into the set of pending problems, knowing that the forecast accuracy improved as the crossing moment approaches.

It must be understood that no problem can be solved outside the context of all others. The controllers must therefore elaborate a "revisable strategy" and survey the evolution of the situation.

The main constraint on the controllers is therefore to optimise the management of their own cognitive resources. It can then easily be understood that the actual capacity of the airspace is not limited by the airspace itself, but by the highly limited capabilities of the human brain to handle more than a given set of data in a given time.

Respecting the controllers' work

Obviously, none of these brain processes can be known by the computer, thus preventing it to pretend participating actively in the controllers' work or making unsolicited suggestions.

The first and imperative requirement behind any attempt to make computers participating in the control processes is to avoid perturbing or disturbing the already overburdened controllers.

In a previous article, the author proposed a list of the "Ten Commandments" to be respected, in order to prevent the computer from becoming an added burden to controllers in attempting clumsily or tactlessly to help them.

It must be understood that the respective roles of machine and controller must be such that each of them is doing what it (or he or she) is able to do better than the other, but without disturbing what this other is left to do.

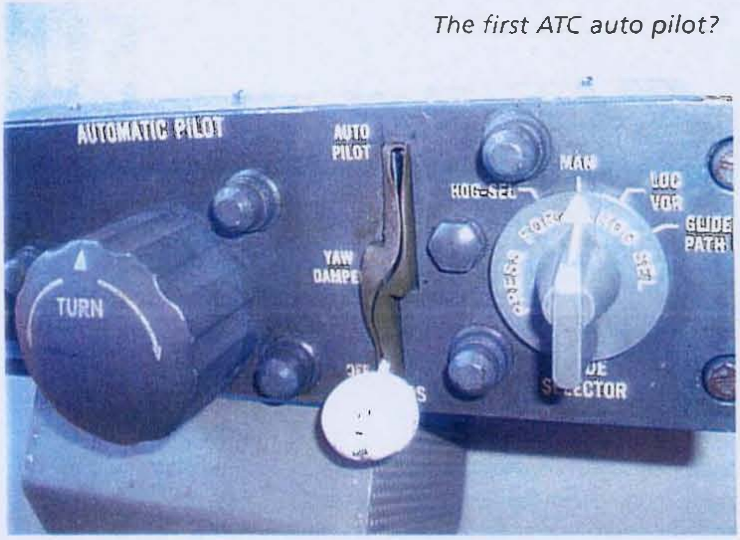
In a real time environment, this sharing of roles and their respective coupling constitute quite a challenge, having strongly in mind the uniqueness of responsibility in any given part of the airspace.

It must be also remembered that man and machine are provided with different data and computing abilities, this leading to different and incompatible conclusions and to different strategies.

In fact, there is a barrier of incommunicability between computer and controllers unless the controllers become the computer's slaves or spend most of their time playing a questions and answers game.

It is pure illusion to expect that a late taking in account of the "human factors" could make workable a previously machine-oriented conception.

The fact that the cognitive domains of air traffic controllers and computers are so mutually impenetrable, easily explains the present state of the art, but could lead to a desperate conclusion for the future of the system.



The first ATC auto pilot?

Photo: DP

An unnoticed no man's land: the "subliminal control"

Fortunately there exists, even if unnoticed until recently, a no man's land between these two domains, which enables the computer's capabilities to be fully exploited without encroaching on the controllers' domain, infringing the controllers' independence or interfering with their non-sharable responsibilities.

It is the fuzziness of the vision of the controllers that offers such an unexpected but so welcome opportunity: it opens to the computer a margin of action of a few knots on the speed of the aircraft (or an action on the rates of climb or descent) which is:

- Sufficient in a great number of cases for avoiding a problem to turn out into a conflict
- But slight enough to be imperceptive by controllers whose work is therefore not influenced or perturbed.

Such a computerised control is therefore "subliminal" as far as the controllers are concerned.

Moreover, these slight actions on pairs of aircraft selected by the computer affect only the two aircraft in question, without any impact on the rest of the traffic or on the strategy, the freedom and the cognitive management of the controllers. As a consequence, the controllers will automatically benefit from a "miraculously fluid" aircraft flow, the computer informing them of all the aircraft pairs thus "deconflicted".

Mathematical models developed in the frame of the ongoing ERASMUS project lead to forecast that a very large majority of the conflicts could be automatically "dissolved".

The "ATC auto-pilot" would guarantee the safety of the responsibility assumed by the computer

For doing so, a closed loop control has to be established between ground and airborne computers via a data-link providing, for the benefit of the controllers, what can be called an "ATC auto-pilot", playing to their benefit an equivalent role as the autopilot for the flying crew. In fact, controllers are thus freely provided with what they surely would do themselves, if only they had the necessary data and time for doing it.

The computer could display to the controllers the status of each problem on an electronic agenda, which moreover could serve as an efficient communication support between them. The close loop control of the "ATC auto-pilot" would guarantee the safety of the responsibility assumed by the computer, which could be increased by the complementary safeguard resulting from a sub-delegation to the concerned aircraft (ASAS).

Such a system can provide a significant advantage even if a limited number of aircraft were equipped, and will become increasingly efficient as more and more airlines will consequently be encouraged to fit out their fleet.

The problems of independence between controllers and computers would therefore be solved, thus providing the "missing link" for providing a smooth transition towards a more and more friendly and efficient system.

The numerous controllers who have been already consulted have welcomed the ERASMUS approach.

A large contribution is required from the controllers' community, in order to conduct this project in a realistic manner and to study the way they will "appropriate" to their own benefit the new potentialities which, at the end, they will be offered.

Good luck to the ERASMUS team!