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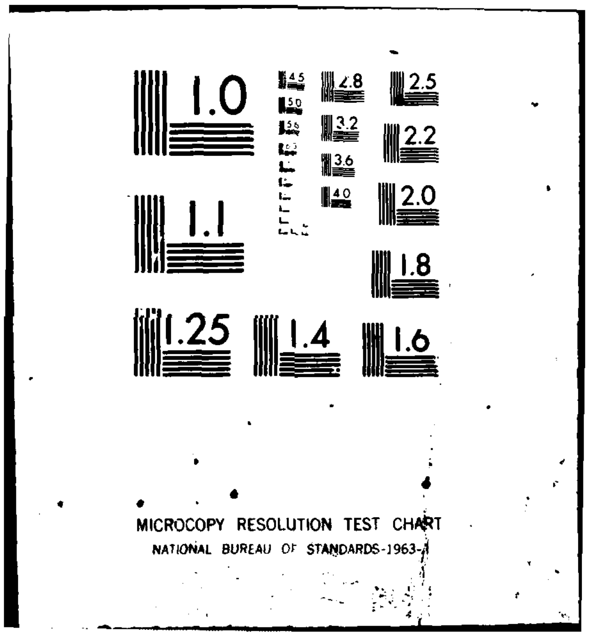
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AGARD Advisory Report No.149

TECHNICAL EVALUATION REPORT

on the

29th GUIDANCE AND CONTROL PANEL SYMPOSIUM

on

AIR TRAFFIC MANAGEMENT

Civil/Military Systems and Technologies

by

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TECHNICAL EVALUATION REPORT on the 29TH GUIDANCE AND CONTROL PANEL SYMPOSIUM on AIR TRAFFIC MANAGEMENT, CIVIL/MILITARY SYSTEMS AND TECHNOLOGIES

FOREWORD

In terms of systems theory, a symposium is an "investigator", which means "a set of entities which produce knowledge". We assert in this report that the 29th GCP symposium has produced considerable knowledge both in new managerial and technological avenues, and has been of high standard, justifying the superb job of the Programme Committee. The theme and content have led the present writer to situate some contributions in the framework of current management science considerations, and to include elements of the theory of investigation applied to large systems; this is a deliberate choice, leading perhaps to a more difficult task for the reader, but intended to interlink the messages of the contributors under convenient points of view, for the sake of an hopefully consistent evaluation of the entire meeting. We hope that the reader will be tolerant enough to accompany us along these lines.

I. SYMPOSIUM THEME

The theme of the meeting, as explicitly written in the announcement, is :
"to consider the air traffic control as a joint civil/military system, the emphasis "being placed on the compatibility, the coordination and the complementary aspects of "the two civil and military components. Based on the presentation of various possible "operational scenarios, the conference will discuss the adequacy of those ATC concepts "in current use and critically review recent advances [...] in technology. The transition "from the present state of operation incorporating the most advanced techniques will be "treated and possible transitioning issues will be proposed and discussed".

II. NEW "MANAGERIAL" DIMENSIONS : A REPORTER'S VIEW

Let us take first the "crisis" argument. Was the purpose of this meeting to help "solve", or resorb a sudden "crisis" situation, recently noted by the AT community ? Apparently not. It can be quoted from the A.T. Advisory Committee, 1969, that : "Air traffic is in crisis. The crisis now manifest at a few high density hubs is the direct result of the failure of Airports and air traffic control capacity to keep up with the growth of Aviation Industry ... Unless strong measures are taken, forces presently in motion will blight the growth of American aviation."
However, in 1972, Major General Shiely could say [AGARD-CP-105, p.11] :
"As a practising pilot, I marvel at the smoothness of operation demonstrated each day throughout the NATO family of countries..." after having said : "your demonstrated capability to work together with a common purpose and with consideration for the needs of others, has already resulted in an air traffic system that is a model of international cooperation". (Then follows, of course, a lucid view of urgent problems).

So, what happened ? Has the awful "crisis" of 1969 been "solved" in two years ? Then should we not learn lessons from this ? The answer, of course, is no, : (i) a problem is "solved" if at least it does not recur; and we see that it does recur, perhaps more intense than ever; (ii) there was no "crisis", but a challenge for professionals, facing anticipated situations. This challenge is persistent, but is now expressed from different points of view in the 79 meeting, which we comment here in six "managerial" dimensions, under the headings : "Economics, Synergy, Evolution, Control, Scope and Behaviour.

1) Economics : from cost to integrated organization

In 1972 also, in the same address, Maj. Gen. Shiely argued that "we find today that another major factor has been added - cost of operation". So, this topic is not new in 79; there was as much cost - performance study in 1972 as now [eg. AMACKER, CP 105, sect. II.8]. Economics was however more present at this meeting, and was more underlying the suggested systems; the specific cost of equipment was not the main new issue, but has been associated to a broader configuration, probably impossible to ascertain and design, of interrelated processes, involving the organizational and business world - see Session 1.

2) Civil/military : from cooperation to synergy

The quotation from M.G. Shiely was a toast to cooperation between two different worlds of teleology (expression of needs and objectives). Now, in 79, as will be seen in session II, new dimensions of concern appear, forming the following levels : a) basic communalities; b) characteristics of A.T. which reduce differences; c) emergence of common systems offering several potential exploitations; d) joint operation of some versatile information supports, the whole leading to synergy.

3) Evolution : from "change" to "degree of modification"

The emergence of the concept of "degree of modification" instead of the former concept of "change" (or "drastic substitution with") is in line with up-to-date management systems approach. It is presently reckoned, indeed, in multiobjective management, that resistance to change - it may be for perfectly respectable reasons - is higher than the resistance to a consensus on a needed degree of modification. Several papers follow this philosophy of presentation, a serious improvement in the process of ATM progress

4) Control : from intensity to levels

There appears, as in system theory, an interesting-although conceptual-distinction which raises a promising management dimension in AT. According to some contemporary literature, hierarchic "levels" of control cited are : cohesion - calibration - regulation - equilibrium of exchanges - adaptation - auto-organization - sanction. Now, intensity refers to the degree to which a certain level is reached, or aimed at. Intensity is mainly obtained by diminishing degrees of freedom, at a certain level, it goes, for example, from "providing information" to "authoritarian , positive control". Management is a set of resources , often technically supported, exploited for matching intensity and levels. In this respect, proposals described at the meeting are true advances in AT management. In our words, they contribute to management by two properties : generalization and integration.

5) Scope : generalization and integration

The property of being general means here the capacity of being useful for different chosen levels of control. The papers concerning data banks, modular microprocessors, data links, VLATME, GPS, contribute in this respect. Some papers, like RNAV-DME, PDME, RNAV-MLS, show work done to the benefit of some degrees, or intensity, of control. This too, is progress, but in another hierarchy. Now, a third set, where it seems more or less relevant to consider NAVSTAR, JTIDS, SINTAC, not excluding other ones, may be qualified as more "comprehensive", which means that they offer a technical potential for use both at different intensities and levels of control, that is, enjoy the property of being "advanced" in terms of management.

6) New challenge : regulative versus appreciative systems

Point 5) raises what is perhaps a new expression of a challenge we are now facing, as emerges from contributions to this symposium, interpreted by the present writer. It is useful to distinguish "regulative" from "appreciative" behavior, both of them contributing to obtain a certain level of control on a situation and its processes by a community of "stakeholders" (Groups of people interested in, or concerned by, a problem or an organization).
The former - the regulative one - in the context of our common concern here, implies several degrees of control : (1) provide valid data; (2) provide compatible technical means of communication; (3) indicate the desirable uses of information; (4) provide rules for transforming information into action; (5) provide authority for applying the rules; (6) state explicitly the allowed degrees of freedom (allowed "decisions" i.e. "unpredictable behaviors"). The degrees of freedom, here,can be in several dimensions : airspace, time, speed, language, reliance upon instrumental (technical) versus biological (human) capabilities, etc.
The latter - the appreciative one - is not expressed in degrees but in components, namely, the bodies concerned. A mnemonic acronym is "C.A.T.W.O.E.S" [cf. University of Lancaster], which stands for a) the "Client" of a problem; b) the "Actors" in the situation; c) the "Transformations" (and processes) involved; d) the "Weltanschauungen" of the individuals and bodies concerned; e) the Owner of a problem; f) the "Environment"; g) the other Stakeholders.

This expresses two hierarchies of complexity, extending a hierarchy based on time already presented in 1975 [RATCLIFFE, AGARD 209, VOL 1, p 3 and sq., and 139 and sq.]. Now, a "management" dimension appears in control when the reaching of a "regulative" degree is constrained by,or implies, consideration for the associated "appreciative system". It seems,for example, that in ATC a "regulative" system cannot go beyond degree (3) of control without implying high levels of appreciative systems.
It is the "new challenge" of ATM, beyond the dimensions of "capacity", as a quantity to process, stated in 1972, and "regulation complexity", stated in 1975, still persistant but kept up, technically speaking, with potential 1980 technologies.

The 29th symposium shows progress along these lines. [Session II, [41], [71], [73] [52]] are among the examples, as will be seen in the review of the sessions, where we shall speak about "R-properties (Regulative) and A-properties (Appreciative) of systems. The evolution seems to be the following. The concept of ICNI (Integrated communication, navigation, identification), "à la mode" in 1972, is tending towards "integration of regulative behavior", while R.S.I. (Rationalization (can embody its parts)), Standardization (common properties shared by subsystems and total system), and Inter-operability (capacity of working together), is tending towards "acceptance of appreciative behavior".

These broad comments about trends ascertained by the reporter are also intended to prevent the reader from a misleading view of the intentions of the Conference. It has not been, and was not supposed to be, a dialogue between organizations, that a very broad conception of "management" could encompass, but was a fruitful dialogue about concepts, problems and technologies which could make more joint operations feasible, for at least the common purpose of safety.
It is to the credit of both the Program Committee and the participants to have maintained the meeting within the boundaries of useful investigation without jeopardizing the efforts and time of the experts in debating the intricacy of the organizational world.

III. EVALUATION OF THE SESSIONS

III.1. The keynote session : operational scene and requirements

1.1. Session

A] The keynote address [11] by Air Vice Marshal Pedder, UK, will persist as a reference for further thinking : a dense and lucid statement of the present-day "problematique". In order to maintain some homogeneity in this report, we shall comment it in our own terms.
a) In the speaker's definition of A.T.M. we find that it is "an arrangement of services made by agencies... to achieve user's desired aims ... and needs ..."
Since these are to be met, not generated by, ATM, it helps to realize that the boundaries of ATM systems are inside the boundaries of appreciative systems, where ATM needs "perceptors"; said in passing, this perception function is a whole story by itself.

b) We also find ingredients which assist the understanding of what is referred to as the "C.A.T.W.O.E.S." of the situation (remember : Clients, Actors, Transformations and processes, Weltanschauung, Owner, Environment, Stakeholders). It can be seen that, were the G.C.P to enter this organizational and appreciative complex world, much would need to be done to clear up many ambiguities, not to mention the definition of geographical areas, - not as a trivial problem as may appear at first sight.

c) Highly relevant to the design and evaluation of systems, is the consideration of a set of desequilibria, or uneven conditions, from different points of view. Here follows a list, inspired by the keynote address, elaborated by the reporter :
1. in time : high seasonal, week-end, hourly peaks;
2. in space : uneven occupation of space; in particular, obviously more crowded terminal areas and route intersections;
3. in capacity a) uneven traffic capacity of national European ATS organizations;
b) uneven capacity of airports;
4. uneven weather conditions
a) fluctuating in time
b) generally associated with geographical regions;
5. uneven language qualifications of people with respect to control dialogue;
6. uneven capability or willingness of response to control stimuli;
7. potential variations of the context in terms of tension and hostility;
8. other desequilibria (technical maintenance capability etc.);
9. uneven regulative power in the civilian as compared with the military world.

Now, let us recall Gen.Shiely's statements about "smooth operation" [1972] and one of Air Vice Marshal Pedder's statements of purpose of ATM services : "expediting and maintaining an orderly flow of traffic". The confrontation of these purposes with the set of desequilibria helps to express criteria of "progress" when evaluating proposed ATC systems : (i) contribution to reducing some discrepancies and desequilibria;
(ii) usefulness in the context of, and despite persistent desequilibria.
Coping with fluctuations and desequilibria is the world of control; the list implies different "levels" in our terms, regulative as well as appreciative:so emerges the management challenge.

B] "ATM : the problem of evolving new concepts" [12] shows the high relevance here of the famous challenge between "piecemeal engineering" (adaptation to most pressing needs, with what is available) and "conceptual design" of future systems [K. Popper, 1946]. [12] argues that these two processes are not mutually exclusive.
Convincing or not, two contributions, at least, should come out from [12] to improve future work and GCP papers:
a) The author shows on his slides some changes implied while substituting certain technical systems with other ones. This is a serious progress in managerial dimension (point 3 of our introduction). Unfortunately, these slides were not joined to the paper, so that they were merely noticed.

b) A concept put forth by the author is "a scenario of purposeful change process". This matches up-to-date systems science concepts, in that it doesn't imply reliance upon more or less valid forecasts (see further), but induces designed phenomena (technologies and associated relations) in the future, which is a way of keeping some aspects of future environmental conditions under control : the "feed-forward control".

1.2. Panel discussion

From session I panel discussion - the only extended one of the meeting - with MM. Pedder and Freckelton answering the questions, it mainly emerges that :
1. There is a need for better data collection and exchange of information between civil and military AT stakeholders;
2. Market forces are driving forces; in the US, there is a significant increase in General Aviation fleet; in the U K domestic airspace, short distance traffic decreases.
3. The summer public transportation gives rise to congestion; a more adequate schedule is to be found, in cooperation with the socio-economic world.
4. A 4 to 5 % of global civilian budgets is proposed as a reference for contribution to ATC costs.
5. About new technologies, like NAVSTAR, SINTAC, SETAC, ADSEL/DABS, the question is whether aircraft should be equipped with several systems, or only one. It has been said that military aircraft would have to carry more than one system, because of security and identification, while civilian requirements could be met with one good system for safe navigation and general manoeuvres.

In view of subsequent contributions presented at the meeting, [e.g. 53,...,][session VII] , the reporter suggests that this should not be a definitive conclusion, since advanced multifunction systems are on the way in, and a more sophisticated version, or exploitation, could meet some specific military requirements.

6. Military-suitable systems may be restricted to NATO countries, while civilian ones should allow for worldwide coverage.
7. The changing role of the AT controller is a new challenge associated with the new technological evolution. (Pilots points of view were not mentioned in this meeting, except in [77]).

III.2. Session II. Civil - Military cooperation

2.1. Introduction

Let us start with some simple, fundamental points of communality between the civilian and military worlds in A.T. :

1. They all share the same airspace;
2. They have more similarities than differences;
3. They all want to avoid collision;
4. They all rely upon fuel supply;
5. The technologies to achieve a certain control are basically the same;
6. The "real estate" in cockpits is fundamentally the same;
7. There is a common (to pilots, controllers etc.) threshold of ability to discriminate between simultaneous signals (and concepts, ideas, actions). This threshold is about seven if we trust some work done in psychology and information theory.
8. The transient situation between peace and hostility, if it happens, is to be shared.

It is trivial, but useful, to recall that the military world has, to a very large extent, provided most of the efforts and resources having led to the development of equipments, to the benefit of the whole A.T. community. As compared with the 1972 and 1975 symposia, the present one introduces in a broad A.T. management concept a lucid debate on some important relations between aims and needs of the two communities, for example:

- the autonomy and imperatives associated with military operation, albeit some regular military transports (20 %) can share the civilian tracks;
- the military control centres are different from the civilian ones;
- the civilian infrastructure, and most of human contribution, should be ready for servicing the military scene in case of high tension, or in the context of hostility.

2.2. The session

A] A clear display of the context is given in the chairman's address, by Lt. Col. de DONCKER;

- the generalization of jets makes progressively irrelevant the vertical separation between the activities of the respective communities;
- increase of the speed vector, and of the parameters which characterize evolution in the vertical plane.
- development of G.A.

Recalling the context, the session II chairman sees commonly sought after, potential benefits arising from, and mutually supported by :

- ever increasing cooperation at the organizational level;
- development of technical systems allowing for highly reliable acquisition and transfer of information concerning any relevant item in air traffic.

Session II gives insights and realizations in this respect.

B] Eurocontrol, in [21] shows the product from an organization, emerging from and aiming at, cooperation, with safety and identification as dominant purpose. On the other hand, AVRADA, in [23] shows a product for potential civilian and military exploitation, to the best benefit of both.
The result is that the Eurocontrol ADMAR/ADKAR system, in our terms, is "an organization, serviced by hardware and software, to provide useful and valid information to both communities, and in particular to the ADRS (Air Defense Radar Stations), which perform their own test when this information is provided, and remain autonomous". Thus, the "appreciative system" in the organizational world, has been built beforehand; then the outcome is an integrated coverage of the upper airspace of a large - and rather crowded - geographical area. Let us stress that it corresponds to a high level of control ("auto-organization") and low intensity (information, not prescription). So, points 1) and 8) of our similarities are concerned.

The configuration contains the following features : (a) primary and secondary radar data are generated in the Maastricht and Karlsruhe centres; (b) the control over the communication networks is exercised by the Eurocontrol Centres; (c) the information is computer - processed and dispatched to the stations; (d) presented on SDD (Synthetic Data Display) when it concerns PR and SSR, and on EDP when it concerns Flight Plans; (e) the man-machine dialogue is by light pen when the SDD is used, otherwise by keyboard with programmable function keys.
Although not specifically "innovative" in terms of technological advances, the system as a whole was highly appreciated given the proven services, the high speed and reliability of data acquisition, transmission and display.

C] Paper [22] deals with the interface between civil ATC and Air Defense in the UK. The project is a centralization of civil information, based on the 9020 D computer, in London, and a A.D. centralization at two points. The problems of incompatibility of content and format of messages, and speed of data transmission, towards A.D. centres, can be overcome with the help of modern technology. Because of the high cost of the project, a breakdown into options is considered.

D] The third paper, [23], issued by AVRADA, suggests (and has tested) TMA control systems for helicopters, which are, in our introductory terms :
- using point 5 : basic common technology (ATC RBS),
- for point 2 : having more similarities,
- permitting point 8 : transient situation,
- given point 6 : real estate (it is a Very light Weight Equipment).

The "management dimensions" are here :

- coordination : by interoperability (approach and landing).
- adaptation : by modularity on the one hand, and possible switch from peace to hostility on the other hand.
- economy : users receive for small expenditure the benefits of high amounts already invested in beaconry.

Technically, the potential reduction in spacing, more suitable for helicopters, is obtained by a system exploiting the TLS signals (KU-band) and the answers IFF/SSR (L - band) with mode C, which permits simultaneously the guidance of the aircraft and the 3D display of the control elements. Each aircraft can be identified, tracked and guided in 3D, to perform its tactical mission. Precision is obtained by TOA and DAZ (Time of Arrival and Differential Azimuth) producing the intersecting passive coordinates, and implies one single active station, several, if desired, passive stations, and the airborne transponder.

2.3. Comments and debate

The latter example is of a potential, and proposed, implementation in a wider community of a military issued, "piecemeal engineered"system. A question raised here by the reporter about the potential extension to many categories of users is "should the "category of users" not be a "homogeneous fleet" ?" (for example "amenable to, and equipped for, a prescribed intensity of control"). Unfortunately, this question was not asked in the meeting, where very little time was left for debate.
The debate of session II mainly concerned [21], and confirmed that :(a) unlike the US,links are not compatible in Europe; (b) MADAP and KARLDAP transmit any altitude (correlated tracks); (c) the light pen has been chosen by controllers themselves.

III.3. SESSION III. Aspects of ATM philosophy

3.1. Introduction

The present writer suggests as "philosophy" for G.C.P. symposia :
"to conceive the investigation about "which knowledge is to be produced"."
Knowledge has three connotations : [Churchman, 1971]
A : - as a collection of information;
B : - as a capability of doing things correctly;
C : - as a potential for facing events, challenges, phenomena.
Here, the production is activity, the knowledge is the contribution, or output, investigation is the function, and conception is philosophy.
Other "philosophical issues" are worth being brought into the picture of ATM, for example :
- which level of control is to be considered (calibration, regulation, adaptation, organization ?)
- which intensity is feasible and desirable (accessibility to consensus, or to authority), or (surveillance - monitoring - intermittent - positive control, i.e. "degrees of control").

As an illustration of this, let us give two "extreme" combinations :
(i) the loosest control combination :/- organization/- access to/ - surveillance/
(ii) the tightest control combination :/- regulation/- authority/- positive/.
These "combinations" are the concern of a higher level of complexity, in the appreciative world for which GCP symposia are "investigation".
It resultsfrom this introduction that the evaluation of session III will be, in our terms, in the domain "of" producing knowledge A, B, C for versatile appreciative behaviors in ATC", in order to generate free and responsible choices.

3.2. The session

Let us consider papers [31] to [34] as a whole. Referring to the introduced connotations of "knowledge", we have, as dominant themes :
A : [31] : the Italian "Study of Methods for ATM" attempts to "provide useful and valid information" with the help of a comprehensive model.
B : [32],[33] : Studies in the capability of doing; here, the control capacity.
C : [34] : Generating a potential, by suitable choice of data links.

Should the development of comprehensive models ([31]) be recommended ?

The present writer's answer is yes(this has not been debated), but keeping in mind that :
a. a model is a formalized expression of the lower bound of complexity;
b. it shows the minimum set of data and relations which inform about dependent variables;
c. it is very difficult to interlink such models, if they are individually built in a bounded context, or on a nation-wide basis.

Consider now [31]; [32]; [33] together. In [31] there is a submodel of control capacity; in [32] and [33], we find models of capacity, related to installed, or projected, equipments. Are there the same ? Except for obvious, basic parameters such as traffic load, apparently not, in the reader's interpretation.

So what ? A reason is that in both sets of contributions we find the information content of the "problematique", but as a comprehensive set of variables in the first, and as a comprehensive set of ATM activities in the second one. A recommended attitude would be to try to express the bridge between the two sets. Paper [33], by K. Brauser, is particularly relevant in this respect [automation and control capacity of ATC systems].

Some conclusions derived in these papers can be somewhat frustrating for promotors of technological improvements : the incremental gains in capacity (units per hour) are rather small, as compared with formidable technological efforts needed to obtain them.

According to [32], the main "jump" in capacity, provided other conditions are satisfied, appears to come with semi-automatic transfer of control (from 57 to 60 work units/hour), data link (65 to 70), and, eventually, automatic clearance delivery (75 to 80). However, we know, from session III contributions, that these marginal gains correspond to considerably larger gains in terms of complexity dealt with by the envisaged configurations : the set of interdependent relations shown in the models is far from being linear.

Paper [34] emerges now as a pragmatic contribution, ensuing from the preceeding issues : the most "feasible and desirable evolution" in a reasonable leading time is in Aircraft Integrated Data System (AIDS) and Data Links. It is suggested by the author of [34] that ADSEL/DABS is an interesting candidate, for the timescale under consideration, and given that it could be introduced as an evolutionary development to the present SSR equipment. This is, in our terms, typically "generating a potential" with managerial concerns in terms of timescale, evolutionary changes ("degrees of modification") and civil-military cooperation.

We derive a general comment from another consideration of the Italian model; the list of"inputs" is the following, where the brackets are ours : airspace routes [configuration], airspace constraints [conditions],radioelectric facilities[technical entities], ATC organization and procedures [organization rules], meteo data [parameters] aircraft performance [parameters], traffic statistics [data]. The output is "results". But what is "results" ? Of course, we know what simulation is, but cannot any of the cited "inputs" (except for meteo) be a "result" ? Even aircraft performance can "result", since, for example, aircraft would no longer hold in stacks for hours. So, the only true "input" exogeneous would be "future demand forecasts"; but is it not there that we perform the worst ? Thus, we open the question about what is really "dependent" and what is exogeneous "input" in A.T.M.

The careful study [35], on midair conflicts, supports the assertion that generating "potentials" able to obtain versatile results, as advocated in [34], emerges as a rational attitude from the first ATM philosophy session. It is shown in [35], in a fascinating way, that in some cases an automatic conflict alert would be issued too late or as a false warning; a data link transmitting the instantaneous heading or the roll angle of the aircraft to the A.C.C. would be helpful; independent but coordinated airborne and ground - based solutions are needed. Since airborne CAS are expensive, but ground based sometimes poor in low sites, combined equipment is supported by [35] - a high cost solution indeed.

Finally a statistical study [36] of the relation between risk and lateral separation led to the conclusion that a decision such as shifting from 120 to 60 Nmi should be postponed (as actually decided in Paris in October). The present writer is questioning some points of statistical methodology, but propones that an interesting "management philosophy" lesson gained from this paper is that, in order to elaborate contributions to safety, one should explore systematically the multidimensional components of risk, which we express by "the hierarchical field of uncertainty".

3.3. Panel discussion

Paper [31] induced a new interest in comprehensive models; the audience questioned the validation process (which needs another year), and the relevance of the criteria of workload overload, a still open issue.

A short debate following [34] left ADSEL/DABS as an interesting candidate; data link leads mainly to increase communication, speeding up response; a low capacity channel suffices, while air situation display to pilots is another level of equipment; an immediate gain is that when a pilot acts, he knows that ATC knows what he does. Thus, the Panel insists on the following : EARLY ACTION is required to DEFINE and VALIDATE a LINK, since delays are now very costly and various current developments are going to impede a common definition.

Another debate was associated with [35]; answers to 6 questions may be summarized in 3 statements : (1) airborne CAS is under development, but very expensive; (2) is thinkable for military, but not for civilian aircraft, where, for the sake of passengers comfort, we have to think in minutes, i.e. consider conflict, not collision, avoidance; (3) independent manoeuvres of aircraft can bring instability into the whole system, a serious, unsolved problem in C.A.S.

III.4. SESSION IV. ATM in Hostile Environment

4.1. Introduction

This session mainly focusses on the role of a fleet of helicopters, and associated problems. It can be integrated along the following line:
a) lessons from the most recent past (U.S. army) [41]
b) organizational improvements, or "solutions" [41]
c) required technical aids [42]
d) potential technical aids [42]
e) a proposed equipment to meet one of the main technical needs [43].
This is a good example of systems approach, leading to well supported choice of technical aids and services. It will be discussed in terms of "CATWOES" and hierarchical fields of uncertainty.

4.2. The session

The session begins with clearing up the fuzziness of responsabilities in the concerned organizations [41]. In our terms of "CATWOES", it defines Client, Actors, and Environment; then, we read in [41, p. 9] that "due to a number of international economic and political considerations, it is clear that Joint Tactical Microwave Landing System may be delayed until the 1990 s or beyond". Thus, the problem "Owner" (O) is not defined, and there is a time relation between the potential, or available technical aids, and the "problem owners and Stakeholders" (S). In the field of uncertainty, the problem "O" and "S" is the most uncertain dimension, as compared, for example with "where to go, where to land,how to identify, what does the terrain look like", which are questions in hostile environment, or battlefield, or "what weather conditions can be faced", etc., i.e. dimensions of uncertainty which could be presently apprehended by observation and expertise.

The priorities which could emerge from this line of reasoning - not explicit in the meeting - are in favor of installing now equipments for flexible use, the required features being at least - following session IV authors, very light weight transponder and processing unit, Digital Map Generator, and easily manoeuvrable ground-based equipment to perform efficient search and active track, possibly at very low altitudes. Such sets are the most likely to cope with the largest variety of uncertain conditions, up to the extreme of complete autonomy of an aircraft lost in hostile environment, over an unknown terrain, with no ground service and in the worst weather.
Now, coming back to the theme of mutual benefits and cooperation in the A.T. communities, these aids could be relevant for civilian aviation encountering often similar conditions (but not hostile), - ie, a similar field of uncertainty, for example G.A., balloonists, and whatever; VLATME promotors argue that the price could be affordable by this category of users.

This session shows the relevance of the concept of field of complexity in the appreciative systems, especially those involving organizational bodies. It is a sort of cultural development of our society, leading to a proliferation of administrations, parastatal bodies with more or less undefined and overlapping responsabilities, including professional associations, groups of ecologists, tourist information offices, etc. See, for example, in the [rapport de la 25ème session ordinaire de l'Assemblée de l'Union Européenne Occidentale, document 802, 21 mai 1979] how many organizational bodies were recently created, or concerned with defense technical systems, and the variety of avenues of dialogue they imply.

So, A.T. "management" in hostile environment looks, in this respect, simpler, in terms of control levels, since peace is more complex, and under less control, than war.

III.5. SESSION V. Flight Management in Terminal Area

5.1. Introduction

Let us recall our presentation of the hierarchy of contributions :
1) Produce knowledge : - information; capability; potential;
2) Generate free and responsible choice;
3) Apprehend the "degree of change" implied by options;
4) Generate commitment from the appreciative, organizational world.
2) and 4) were more implied by the preceeding session; in session V, point 3) is our dominant avenue of evaluation.

5.2. The session

Three sets are here under main consideration, namely SETAC, RNAV, SINTAC.
Once more, how misleading are the acronyms ! Anyway, three "systems" roughly range from the more specialized SETAC [51], to the complementary RNAV-MLS [52], and eventually the most "integrated" SINTAC [53]. They also range from the least amount of change implied (SETAC), to the most "disturbing", SINTAC, if we express in terms of time, resources, commitment etc., the deviation from the present state of affairs that must be "digested" by the organizational levels of A.T. Management.

A] SETAC, in [51] offers a potential for 3.D. curved approach path, which can be reached by stepwise implementation; it is thus less "disturbing, first, technically, and second from an organizational viewpoint, as can be seen from the list of A.T. agencies involved in the decision of licensing [51, pp. 19-20].

B] The RNAV - MLS integration [52] raises another issue (further enhanced by S. RATCLIFFE in [71]). In our "CATWOES" terms, it is the "Weltanschauung" aspect. Indeed, R-NAV, with its richness in multiple sensors (VOR/DME, LORAN-C, Omega, Inertial etc.), and with its complementary MLS, raises the "high level", appreciative controversial issue of random routes, as opposed to prescribed tracks. This, together with the assumptions associated with the implementation (an especially appreciated and useful contribution (*) by the authors of [52, p.4]), brings the debate to the level of complexity of "consensus" amongst many stakeholders. That - plus the cost of equipment - is the price to pay to reach a high capability of flexibility.

C] Welearn from [53] that SINTAC, an integrated multifunction approach is now (in 1979, as compared with 1976) improved, and even compatible with **JTIDS.** The issue raised is integration as opposed to specialization. More and more "specialized, less disturbing systems are on the way [illegible] DABS [illegible] for data link and collision avoidance, precision DME, etc., to enhance present s[illegible]s. It is really a conflict ? Perhaps not in the long term perspective. Integrat[illegible] specialization, like centralization - decentralization, appear to conflict in a [illegible]ansient" view, but are "pulsations" in the economic, political, social and technical [illegible]lds, inherent to their evolution.
In conclusion, it would ask for considerable efforts to curb the apparent present pulsation t wards some advanced specialized systems; global integration is perhaps "disturbing" too much the present appreciative world. But the recommendation is that it would be a myopic attitude to forget them at present; advanced managerial attitude requires to prepare now, forthcoming pulsations; thus, full attention and support is suggested in favour of comprehensive, flexible, multifunction configurations like SINTAC, and systems offering similar potential.
It comes out, however, from the short panel discussion, that systems like this one are subject to become rapidly obsolete, and are very sensitive to the evolution of the context; the panel has not, however, developed this briefly told assertion. Moreover, it will be seen in [71] that NAVSTAR, for example, another global design, raises seriously challenging questions when its implementation is considered while other systems are still in use, obviously a practical situation that will be encountered in any change envisaged.

D] The MRAALS (Marine Remote Area Approach Landing System) [54], already implemented, has the interesting property of having a Multimode Receiver (MMR) operable with present ILS and forthcoming MLS; as a tactical landing system, it provides azimuth, elevation, range and range rate information of a quality suitable for category II operation, and is of very light weight. The configuration is more software dominated, so that changes in software requirements would minimize hardware modification - an economic advantage in terms of extended life. These arguments are put forth in [54].
A very interesting question asked by the audience can be expressed in management terms as the adaptation potential : the conflicting attitude between hardware stability/software instability and software stability/hardware instability, the latter being, according to the intervenant, less costly. The question was not debated, so no conclusion can be reported here, but we would suggest that this topic would be offered more space in a forthcoming meeting.

5.3. Panel discussion

The main messages from the 4 questions about [51] are the monitoring of the crew-equipment interface, again the need for data link definition, and the lateral clearance of obstacles in case of curved approaches, a preemptive condition . The RNAV-MLS integration problem was considered as one of the core issues. Two questions led to the following statements : (i) R-NAV can decrease time and workload by about 40 %, but the track - random routes issue is perhaps more open than ever; (ii) curved approach implies an environment problem (noise), its control is not necessarily lighter, and the interaction cockpit - controller may have a new content.
About [53], the SINTAC, two concerns are persistent : ready-to-operation "advanced" systems are awaiting the definition of new technologies needed, and field trials are difficult to organize with advanced integrated systems.

III.6. SESSION VI. Subsystem Technology

A] [61] is a promotion of the set LORADS-ASDE, (presently implemented at Singapore) standing for "Long Range Radar and Display System", and "Airport Surface Detection Equipment", Integration is here in terms of "distance from and of landing", covering, with qualities described by the author (but not debated), area control, approach, aerodrome control and surface; a list of ATC services performed is provided [61, pp. 25 and 26].

B] Paper [62] is partly a review of the art, partly an account of a particular embodiment of the technique of producing multiradar tracks by the combination of monoradar tracks. A good presentation, but letting little time for discussion.

(*) The slides, not included in the paper, were sent to the reporter, by courtesy of the authors.

C] The review of the proliferation of avionics, in [63], an omnipresent concern, results in suggesting POME as an interesting candidate in an integrated system, in view of : (i) desired interoperability of civil-military systems ;(ii) the ease of transition, this latter being a relevant criterion, in terms of less disturbing degrees of modification. A short brisk discussion following this good paper enhanced the role of a clear expression of needs in any problem of integration and proliferation.

D] Finally, it has been learned from [64], promoting the Ferranti F100L, that powerful enough, compact and flexible microprocessors, and other Large Scale Integrated Circuits devices, are of such imminent availability, that, according to the author, there would be already no, or very little, justification for orienting technical choices towards systems implying large mini and mainframe computers. In discussion, the point was made that many customers do not wish to "go out on a limb" by adopting a processor that is available from only a single supplier.
In general, it is not easy to report consistently about these rather disconnected papers, despite some efforts by the chairman to bring pressure on speakers, who overran their time, no lesson from debate can be retained.

III.7. SESSION VIII. Advanced Systems

7.1 . Introduction

What means now "advanced" ? Let us quote [AGARD - AG - 209 - Vol II, p. 671], where Table III gives "Defence Navigation System Characteristics", reproduced hereunder :
a) Essential : worldwide coverage - high accuracy - common - grid capability - continuous availability in real time - passive user/non saturable system - acceptable survivability-security - anti-jam - operation with dynamic users - satisfactory portability/size/weight-minimal frequency allocation problem - freedom from ambiguities.
Desirable : All ground stations on U.S. territory (*) - minimum propagation limitation - acceptable operation underwater (*) - provide worldwide time reference - compatibility and integrability with other military (civil requirements - evolutionary growth from R. and D. to operational capability.
Except for (*), could not these characteristics be listed by a broad civilian community as well ? Thus, it could be argued that a NAVAID is more "advanced "when it acquires more of the abovementioned characteristics, while not degrading other ones beneath an acceptable threshold.
Now, it has been put forth in 1972 already [AGARD CP 105, p. 20-1] that "the unique pro- "perties of satellite - based relays provide the only viable means of achieving complete "coverage to ground level of the entire airspace, coupled with uniform and highly accu- "rate surveillance position fixing". This statement was [same quotation] associated with the provision that ground-based data processing/decision making facilities, and landing and terminal region aids - possibly independent of any satellite, may also be required; thus "satellite systems would provide some specific elements of services required".
In 1975 [in AG 209, p. 692 and sq.] some lessons are gained from considerations concerning propositions of satellite - based systems (S.B.S.), like AEROSTAT, ASTRO-DABS, AATMS, NAVSTAR. The qualities of pervasive coverage and improved surveillance accuracy, plus G.P.S. capability. But the troublesome point is that contradictory assertions are made in the same well-documented study, for example : "SBS are possibly less costly" - "are expected to be more costly" -"are associated with highly uncertain costs...". More important is the conflicting view that "while SBS can accomplish many functions, presently ground-based, and thus have the property of being "general purpose"..., "the differing applications, requirements, coverage characteristics and modes of operation of the various classes tend to favour special purpose systems, with multiple deployment to provide the desired services" [AG 209, p. 693].
Thus, in this respect, a fundamental contradiction emerges from the potentially "advahced" capabilities ("essential and desirable properties") of multifunction systems, like SBS, and the advance, or progress, of the global ATC services, the steps of which are expressed in user's communities acceptances. The problem seems to lie in the ambiguity of the concept of "advanced" - apart from the technologies involved. The present writer, referring to multicriteria analysis concept suggests to ascertain two sets, S and E, of properties. The S - advance would refer to "generate a set of properties which meet essential and desired characteristics of A.T.C.S., in view of arriving at better future States"; the E-advance would be "to generate a set of processes in ATCS which support a more desired Evolution". We encounter here the dichotomy, known in systems management, between teleology of states and teleology of processes, both being the pursuit of goals.

7.2. The session

Dealing with precision navigation, JTIDS, DABS, ADSEL, SINTAC, session VII offers a fascinating view of how most of essential and desirable properties can now be acquired.

A] ADSEL (Selective Address SSR), new version, is in [76] confirmed as a surveillance and communication facility, gaining its main S - properties by the acquisition made (All - call interrogation transmitted at low rate - which reduces garbling problems), monopulse receiver system, and data link. The main E-property is that the ADSEL transponder is interchangeable with existing SSR transponders, a degree of modification for which progressive acceptance should not be a major problem. This could thus be an example of relatively moderate, specialized advance (with high - level technology), in the S - class of criteria, but a fast progress in the E-class : a self-contained facility, implying only two computers, is in the range of already proven "feasible changes".

B] In a similar way of improvement [75] and [77] give additional information about DABS and a DABS/ATARS combination, with DABS transponder and ATARS display supported by a rather powerful computer architecture (39 units, if our count is good). The main service is to provide pilot and controller with valid (i.e. accurate etc.) and useful information (i.e. on due time, providing ATARS resolution etc.), including (forthcoming) Minimum Safe Altitude Warning. It seems to be a rather heavy configuration. So, obvious improvement with respect to S- properties. But is it really "E-advanced" ? In a time perspective, it has been first conceptualized in the late 60's, testing and revisions are currently on the way (with good results, see [77]), implementation is considered around 1984, while anticipated density of 1995 (forecasts not published in the paper) can be coped with, and while it is asserted that it will provide "sufficient aircraft capacity to meet the traffic growth well into the next-century" [75, p. 1] . So, the main E-property is a time-quantity relation; other ones are progress from, and compatibility with, ATCRBS, at reasonable incremental costs (does it mean "stepwise" instalment ?), and the use of presently available components. To evaluate further "E-advances", more is to be known about the potential acceptance by many user categories (and nations) about "integration" and "general" properties, and, given the time perspective of [75] , about the following : were the whole DAAS/ATARS, as described, generally installed, "what if" other propositions, for example implying inertial coordinates, were some day proponed as determinant for progress ? That would be satisfying a teleonomy of Evolution.

C] In our terms, the Joint Tactical Information Distribution System, JTIDS, is a set of networks. While DABS/ATARS is a configuration intended to provide different, hierarchical levels of information, JTIDS offers also multiplicity of information, issued from the technical uses of a Time Division Multiple Access System. The combination of information content and multiplicity generates two main dimensions of "comprehensive" properties of advanced systems : generality and integration. Paper [73] is especially clear about the functions performed by JTIDS networks, and even the services or equipments that the existing JTIDS potential could replace; the list is impressive : ATCRBS, VOR, DME, ILS/MLS, DABS, IPC, CAS, RNAV, in [73, p. 8] . Moreover, because of the variety of code combinations in FPT (frequency, phase, time), it has a kind of software flexibility, and could meet civil as well as military requirements, and even, to a desired extent, can be of common use in a cooperative ATC System.
It can be concurrently used with ATCRBS/DABS, if existing, and leads to potential reduction in avionics. Finally, the equipment needed to join the JTDIS community is affordable by G.A. and austere terminals, if they are contented with less sophisticated service (e.g., for example, non-randomized phase codes). That seems enough to make many people happy, even reporters obsessed by multicriteria analysis, and R,B,S or E-properties. Our comment follows.
Let us notice that these are not ATM "functions", but AT information support and services, developed on the ICNI concept, "à la mode" in 1972, having now a fascinating follow-up. "Function" is a word having 5 different meanings in management science; which one is implied in [73] by the author is not of paramount importance : exploitation of information is a process implied when performing any function in management. Our point is that here the exploitation of information depends on "the extension of the community of the system subscribers", A.T. individuals and communities joining the network "club". They would be "more ATC advanced" with respect to both type S and type E properties, but dependent on the acceptance of the network, and sensitive to the high technical qualities of the information system they rely upon, e.g. the precision of time synchronization and sequencing.
So, since the altitude is read (or measured by) on conventional altimeters, or need an air-ground Data Link (to be informed on vertical tracks and thus on safe separation) a relevant question is the confrontation with other "potential" "clubs" like those of "airborne autonomy", or GPS, or Inertial coordinates, SBS, and their associated accuracy, which is hopeless to obtain with radar.* So, the discussion about advanced systems, like JTIDS, has to reach an appreciative level, beyond any evaluation : in this case, the problem is one of autonomy versus network dependence.

D] This is the kind of issue raised in [71 , by S. RATCLIFFE] and [78, by TOBIAS and o'BRIEN] . In [71] , where NAVSTAR is chosen as a reference for the argumentation, the difficulties of (i) transition from present equipment; (ii) the presence of mixed systems in the airspace, are shown to prevent gain in global performance, although a formidable 4-D information is provided, because, among other reasons, of incompatibility of coordinates (distance from the Earth's centre). Now, the last phrase "the day may come when the general track-keeping capability of the aircraft population is better than the tracking capability of the surveillance system, and some rethinking of the whole ATC concept may be necessary", expresses one of the ultimate challenges in the appreciative world, emerging from "advances" in regulative systems.
In [78] we see how obviously desirable regulative behavior, like advanced fuel conservative procedures, are leading to more complex appreciative problems, and where, thanks to Messieurs Tobias and o'Brien, our main stakeholders, namely pilots and controllers, are brought into the picture in the last pages presented at this meeting.

7.3. Panel discussion

The position taken by an intervenant against time control of flights - because of the penalties for the companies, has not been contradicted. The author of [73] confirms that, with an implementation of JTIDS, a military aircraft arriving in the TMA would not have to "choose" between " TMA" and "base" reference, since there would be enough capacity for both simultaneously.

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*) also since worldwide coverage, even with radio-relays, is not thinkable.

A question about DABS [75] concerned the anticollision problem : is it essentially ground or air-based ? The answer is that in BCAS, namely CAS using DABS, the computation is made on the ground, and the resolution transmitted to the aircraft. It is a hierarchy: A) proximity; 2) changes of flight plans; 3) resolution command (ATARS) in case of imminence; and finally 4) an airborne potential exists (BCAS), where or when no DABS can be used.

7.4. Debate

The general debate held Thursday was initialized by the consideration that three advanced systems, JTIDS, SETAC, ADSEL, are derived from military needs; a relevant point is thus the comparison and interferences of the different projects. Other views expressed are :

a) JTIDS is insensitive to high pulse signals like DME, but exploitation of JTIDS in civil ATC may lead to possible interferences.

b) An imagined coexistence or substitution problem, involving for example ADSEL, DABS, JTIDS, is to be set in the time dimension of a technical scenario : SSR is just installed, and has to last for perhaps 20 years; DABS is still an improvement which lies between the SSR and SETAC or JTIDS which are to be tested for military purposes in 1983, and which could lead to implementation starting around 1985; then simpler versions could be handed over to the civil world, rather easily.

This is *by no means* a "choice" or a "conclusion" by the audience, but a useful example of a time-scenario by an intervenant. NAVSTAR and SINTAC, for example, are on another time-scale.

c) In SINTAC [74], indeed, the interoperability is of initial concern; here the identification by questions-answers should become exceptional, since an initialized identification is included within SINTAC; also, absolute or relative positioning is possible, helping, for example, aircraft that are more or less lost.

IV. FINAL ADDRESS, BY THE PROGRAM COMMITTEE CHAIRMAN

The audience enjoyed a final address by Dr. Benoit, the main points of which were the preemptive concern for safety, which implies the capability to handle increased capacity, the present challenge of the economics, the improvements needed in "management" concepts, and the mutual benefits of civil/military cooperation.

V. WRITTEN COMMENTS FROM PARTICIPANTS

Two short comments were received.

1. Most lectures were of high standard, but in quite a few, not always relevant with respect to actual European environmental conditions; sometimes more technical details than practical applications.

2. The conference room was small. The instructions to authors were good, but not always fulfilled in terms of time keeping, and speed of talking, so that it was difficult to have a lecture interpreted. A very well organized meeting.

The reporter acknowledges for written comments from the Chairmen, concerning sessions 2, 3, 6, 7.

VI. CONCLUSIONS

"Producing knowledge" is a main contribution of G.C.P. symposia; this meeting has gone much further than a mere description of technological progress, and offered worthwhile insights into the "problematique" of ATC improvement; as introduced in the foreword, an attempt has been made here to uncover some of such avenues of contribution, using propositions of large systems theory as a guide for reasoning and evaluation. We suggest thus that some ways of thinking associated with the issues of this meeting could be worth further consideration.

1. Reflexions about possible ways of reducing complexity as well as coping with complexity; by this is meant, for example, exerting some influence on market forces to prevent congestion, promoting communications without physical travelling, etc.

2. Thinking in terms of management : the "managerial" concern can be given explicit dimensions, six of which having been distinguished as underlying the global contribution of this meeting.

3. Introduction of the concepts of "intensity" and "level" of control.

4. Distinction between "regulative" and "appreciative" systems; the latter, associated with human behaviour and organizations, opening their own avenues of complexity, to be investigated by appropriate "soft" methodologies.

5. Explicitation of multicriteria analysis for project evaluation.

6. Consideration of the list of "desequilibria" as a useful guideline.

7. Explicit use of the concept of "degree of modification" when envisaging the shift from present to proposed systems.

8. To clear up the awful and misleading list of acronyms.

9. Remember the famous phrase by P. Valery : "we enter backwards into the future".

APPENDIX : PROGRAMME

TUESDAY 9 OCTOBER 1979

0830-1000 Registration
0935-0950 Staff Meeting: Authors, TPC, Session Chairmen, Equipment Operators.
1000-1020 Opening Ceremony
1020-1030 Opening Remarks by Programme Chairman

KEYNOTE SESSION: OPERATIONAL SCENE AND REQUIREMENTS

Chairman: Dr A BENOIT, BE

1030-1230

11 AIR TRAFFIC IN NATO EUROPE. ITS CHARACTERISTICS AND ITS NEEDS
Air Vice Marshall I M PEDDER, OBE, DFC, RAF, Chairman of NATO Committee for European Airspace Co-ordination (CEAC) and Deputy Controller, UK, National Air Traffic Services, London, UK.

12 AIR TRAFFIC MANAGEMENT. THE PROBLEM OF EVOLVING NEW CONCEPTS *
S FRECKLETON, Plessey Radar Limited, Surbiton, UK.

SESSION II: CIVIL MILITARY COOPERATION

Chairman: Lt Colonel J de DONCKER, BE

1400-1530

21 REMOTE DISPLAY OF PROCESSED RADAR AND FLIGHT PLAN DATA AT AIR DEFENCE STATIONS FOR IDENTIFICATION PURPOSES †
M A WOODS, Eurocontrol, Bruxelles, BE.

22 THE UK AIR TRAFFIC SERVICES/AIR DEFENCE INTERFACE †
J W BENNETT, R A USHER, Royal Signals and Radar Establishment, Malvern, UK.

23 HELICOPTER AIR TRAFFIC MANAGEMENT SYSTEMS WITH CIVIL/MILITARY INTEROPERABILITY
J T SAGANOWICH, AVRADA, Fort Monmouth, NJ, US.

SESSION III: ASPECTS OF AIR TRAFFIC MANAGEMENT PHILOSOPHY

Chairman: Dr H WINTER, FRG

1600-1730

A Criteria and Human Factors

31 A STUDY FOR DEVELOPMENT OF METHODS FOR AIR TRAFFIC MANAGEMENT
R PETRIOLI, S PARDINI, Selenia, Rome, IT
G BERTONI, C BONIVENTO, University of Bologne, IT.

32 SYSTEM, AIRSPACE, AND CAPACITY REQUIREMENTS FOR FUTURE ATC SYSTEMS
R SEIFERT, G OCH, Messerschmitt-Bölkow, Blohm GmbH, Munich, FRG.

33 AIR TRAFFIC CONTROL AUTOMATION: ITS IMPACT AND USE IN THE SELECTION AND SCREENING OF AIR TRAFFIC CONTROLLERS **
J O BOONE, Civil Aeromedical Institute, FAA, Oklahoma City, US.

WEDNESDAY 10 OCTOBER 1979

SESSION III: ASPECTS OF AIR TRAFFIC MANAGEMENT PHILOSOPHY (CONT'D)

Chairman: Dr H WINTER, FRG

0930-1030

B Communications and separation

34 DATA LINK. THE KEY TO IMPROVEMENTS IN CIVIL/MILITARY AIR TRAFFIC MANAGEMENT?
M E COX, Eurocontrol, Bruxelles, BE.

35 MIDAIR CONFLICTS AND THEIR POTENTIAL AVOIDANCE BY PROGRESSIVE IMPLEMENTATION OF AUTOMATION
O WEBER, DFVLR Institut fuer Flugmechanik, Braunschweig, FRG.

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† Published in CP-273 Supplement (Classified).
* Not available at time of printing.
** Not presented at the meeting.

36 DETERMINATION OF THE SAFETY IN A NORTH ATLANTIC ORGANIZED TRACK SYSTEM WITH REDUCED LATERAL SEPARATION

G MOEK, C R TRAAS, National Aerospace Laboratory, Amsterdam, NL.

SESSION IV: AIR TRAFFIC MANAGEMENT IN HOSTILE ENVIRONMENT

Chairman: Ing de l'Armement B VANDECASTEELE, FR

1100-1230

41 US ARMY USERS OUTLOOK ON AIR TRAFFIC MANAGEMENT

H MALONEY, US Army Aeronautical Services Detachment, Heidelberg, Germany, and
L R KREPS, ATC Officer 5th Signal Command HQS, Germany.

42 THE DEVELOPMENT AND TEST OF A TACTICAL SELF-CONTAINED LANDING SYSTEM

N K SHUPE, AVRADA, Fort Monmouth, NJ, US.

43 VERY LIGHTWEIGHT AIR TRAFFIC MANAGEMENT SYSTEM USING AN ELECTRONIC SCAN ANTENNA

P J WOODALL, J L SHAGENA, The Bendix Corporation, Baltimore, MD, US.

AFTERNOON: TECHNICAL TOUR

THURSDAY 11 OCTOBER 1979

SESSION V: FLIGHT MANAGEMENT IN TERMINAL AREA

Chairman: R S VAUGHN, US

0900-1030

51 TECHNICAL AND OPERATIONAL FACTORS CONCERNING THE LICENSING AND INTRODUCTION OF A NEW MICROWAVE LANDING SYSTEM FOR CATEGORY II

K G BRAMMER, K D KRICKE, Elektronik System GmbH, Munich, FRG.

52 THE INTEGRATION OF AREA NAVIGATION AND THE MICROWAVE LANDING SYSTEM

D W RICHARDSON, System Control Inc, West Palm Beach, FL, US and
P M RICH, FAA, Washington, DC, US.

53 SINTAC - C TMA -- APPLICATION OF SINTAC - C IN THE TERMINAL AREA DURING LANDING AND GROUND TAXIING

Lj MILOSEVIC, Thomson - CSF, Arcueil, FR
J HETYEI, Thomson - CSF, Saint Denis, FR.

54 EVOLUTION AND TRANSITION OF TODAY'S MILITARY LANDING SYSTEM TO COMPATIBILITY WITH PRESENT AND FUTURE CIVIL/MILITARY SYSTEMS

A J SHAPIRO, The Singer Company, Kearfott Div, Little Falls, NJ, US.

SESSION VI: SUBSYSTEM TECHNOLOGY

Chairman: Mr S RATCLIFFE, UK

1100-1230

61 INTRODUCTION ON LORADS AND ASDE

E C PRIEBEE, Hollandse Signaal, Hengelo, NL.

62 AIR TRACK. AN ATC MULTIRADAR TRACKING SYSTEM BASED ON THE TRACK COMBINATION METHOD †

G A LIEBELT, W SEELS, AEG Telefunken, Ulm, FRG.

63 PDME AS A CORE OF COMMON MILITARY AND CIVIL RADIO EN ROUTE NAVIGATION AND LANDING AIDS

M BOEHM, Standard Elektrik Lorenz AG, Stuttgart, FRG.

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† Published in CP-273 Supplement (Classified).

64 <u>APPLICATION OF MICROPROCESSORS IN AIR TERMINAL CONTROL SYSTEMS</u>

D L STODDART, Ferranti Computer Systems Limited, Bracknell, Berks, UK.

<u>SESSION VII: ADVANCED SYSTEMS</u>

Chairman: Professor W M HOLLISTER, US

1400-1500

71 <u>PRECISION NAVIGATION FOR AIR TRAFFIC MANAGEMENT</u>

S RATCLIFFE, Royal Signals and Radar Establishment, Malvern, UK.

72 <u>JTIDS - AN INTEGRATED COMMUNICATIONS, NAVIGATION AND IDENTIFICATION SYSTEM AND ITS POTENTIAL FOR AIR TRAFFIC MANAGEMENT</u>

D D NEUMAN, The Mitre Corporation, Bedford, MA, US.

73 <u>SYNCHRONIZATION, MEASUREMENT OR THE DISTANCE AND POSITION DETERMINATION IN THE SINTAC</u> †

Lj MILOSEVIC, J C CHARAVIT, Thomson-CSF, Arcueil, FR
P LAURENT, Thomson-CSF, Saint-Denis, FR.

FRIDAY 12 OCTOBER 1979

<u>SESSION VII: ADVANCED SYSTEMS</u> (CONT'D)

Chairman: Professor W M HOLLISTER, US

0900-1030

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