

**TENTH EUROPEAN ROTORCRAFT FORUM**

**INTRODUCTORY LECTURE**

**A DECADE OF EUROPEAN ROTORCRAFT FORUMS -  
A CHALLENGE, AN ACHIEVEMENT AND A PORTENT FOR THE FUTURE**

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# **A DECADE OF EUROPEAN ROTORCRAFT FORUMS - A CHALLENGE, AN ACHIEVEMENT AND A PORTENT FOR THE FUTURE**

by

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## **1. Introduction - The Germ of the Idea**

The European Rotorcraft Forum achieves double figure status on the occasion of the meeting in The Hague in August 1984. Although younger than the American Helicopter Society Forum which this year has, by human standards, reached comfortable middle age with the 40th meeting, the European baby has grown into a vigorous child that already exhibits originality and independence of thought and will.

The growth in terms of meeting places and dates is illustrated in Figure 1, from its birth in Southampton in 1976 to the present meeting, but before dealing with this growth it is right to record its birth.

A major step in European collaborative helicopter projects occurred when the Anglo-French package involving the Gazelle, Lynx and Puma was signed. By the early 1970's further collaboration was being explored and a holding company called Heli-Europe was formed between Aerospatiale, Westland Helicopters and MBB. A member of staff of that Paris-based company was Ian Simmons and he visited Southampton with Dr Martin Lowson of Westlands to talk about helicopter problems and research. During that discussion the suggestion was made that European helicopter developments were now so significant in quality and quantity that there was a need for a major meeting on the Eastern side of the Atlantic Ocean. This suggestion did not imply any criticism or lack of welcome by the American Helicopter Society for papers from Europe but that the cost of travel to the United States was sufficient to restrict the number of people who could attend.

It is, of course, a well known fact that good ideas do not usually occur in one place and it was soon determined that Dr (now Professor) Gunther Reichart had had a similar idea at almost the same time. Correspondence on the subject ascertained that both the group in Germany and the one in England were thinking along the same lines and it is good to be able to record that Gunther Reichart very sportingly agreed to the idea being launched in England with the agreement that if successful the second Forum would take place in Germany. That decision taken, the next question was venue and who would organise the meeting. A University was the obvious choice because it offered accommodation for both lectures and visitors. It then follows that Southampton was an obvious centre because of its close association with Westland Helicopters Ltd and the Royal Aircraft Establishment, its location relative to and its good communications with London and its known interest in helicopters.

These decisions taken the next step was to contact other countries through distinguished scientific and engineering persons. A copy of the letter and the list of addressees is attached as Appendix I. The responses were almost uniformly enthusiastically encouraging and so the first Organising

Committee was established and the scene was set for the start of the Forum.

The decision to proceed having been given, the next question was to find what support would be forthcoming in numbers of papers and range of subjects to be covered.

An initial discussion had to decide whether the forum should be restricted to open rotor aircraft or should embrace the wider spectrum of Powered Lift Aircraft which were then enjoying considerable advocacy in several countries. The decision was taken to include Rotorcraft and Powered Lift Aircraft explicitly in the title in an effort to attract speakers from both camps who would discuss successes and problems in particular areas on a common platform. It was hoped, perhaps naively, that this might allow a reasoned discussion on some topics which on other occasions had resulted in debates that produced much heat but little light. It will be noted that this title persisted up to the Eighth Forum when the response by Powered Lift Aircraft protagonists was adjudged to have been so disappointing that the title was changed to that currently in use - the European Rotorcraft Forum. The title does, however, reflect the fact that, with the exception of the Harrier type aircraft, vertical take off and landing is the sole preserve of the rotorcraft and, as far as production vehicles are concerned, this means the helicopter.

The issue of the 'Call for papers' meant that the sessions had to be defined. These were finally grouped under the following headings:

Design Philosophy and New Systems  
Dynamic Problems and Test Techniques  
Aerodynamic Problems of Rotary Winged Aircraft  
Environmental Problems  
Operational & Flight Test Problems  
Powerplant & Propulsion Aspects

If that is contrasted with the programme which is to be followed in the next three days, certain important changes have taken place as far as subject material as well as number of papers has occurred - this will be referred to in a later section.

Following the 'Call for papers', some 39 papers were accepted and a programme arranged lasting two days with a maximum of two parallel sessions. A third day was devoted to visits to Westland Helicopters Ltd or the Army Air Corps Centre at Middle Wallop.

## **2. The Development of the Forum**

The various centres in which the various meetings have taken place have already been mentioned. The success of the enterprise can be gauged in some way by the numbers of people and papers at each meeting. The relevant numbers are presented in Table I.

The steady growth in number of participants, papers and ladies attending is clearly seen. What is also interesting is that the number of participants per paper read has only increased very slightly in the last two years, highlighting the fact that attendance is often conditional on presenting a paper.

It is also interesting to examine the disaggregation of the participants by nationality (Table II). As might be expected, the largest number of participants in any country are nationals of that country.

Table III lists the number of papers read at each Forum by nationality of the authors. In several cases there were joint authors from different countries and I have tried to allocate credit without resorting to fractions of a paper - therefore these figures must be regarded as a good but not infallible guide. The American performance is very noteworthy and I am sure that their participation is greatly appreciated by all the other nations.

It is interesting to consider if there is anything in the pattern of attendance and presenting of papers.

The two countries (the USA and Britain) who have the highest average number of papers presented each year (as shown in Table III) also have the highest average number of papers per delegate. In the British case the values in Table IV for the Forums held outside Britain are about half those which apply to the Southampton & Bristol meetings. This clearly suggests that cost may play an important part in the decision. The French figures show a similar pattern. It is clearly desirable for the good of the helicopter industry if the ratio of papers to national delegate could be much smaller, so that an opportunity could exist for people who are much further down the learning curve to benefit from the examples, contacts and knowledge available at these international meetings. It is difficult to see how the costs of travel can be reduced but maybe other incentives can be found. It would be interesting to know the experience of the American Helicopter Society in this matter.

Let us now turn from the cold statistical data, only pausing to note that on any basis they show the achievement of the European Forums, and look at the technical content.

### **3. The Changing Technical Challenge**

It is not the purpose of a paper which reviews the first decade of European Forums to deal specifically with individual papers but rather to see if any patterns of development can be identified.

#### **Rotorcraft Configurations**

First, consider the rotor configurations which have been discussed in the Forums. It will come as no surprise that the conventional main rotor with anti-torque tail rotor machine has been examined most. Looking first at other configurations specifically discussed in a paper (that is discounting references in review papers) the number of papers dealing with the tandem rotor is (1), the coaxial (including ABC) (7), the tilt rotor (5) and aerofoil jet augmented rotor and circulation controlled rotors (principally X wing) and similar systems (5). Leaving the tandem rotor configuration, which does not appear to be under consideration for entirely new projects, of the others the two flying examples are both American, the Sikorsky ABC coaxial and the tilt rotor Bell X15 aircraft. The other project which appeared and then disappeared during this period was the coaxial remotely piloted helicopter. In spite of all the advantages which are claimed for the coaxial configuration, it appears that the single main rotor scheme is very strongly preferred in every country. In each of the discussions which have taken place on the papers given at the Forums there has been little challenge to these claims - why then is there so little interest? Could it be that the industry is demonstrating a steady evolution of a configuration, and is the risk of change too great, or is there a problem which has not been discussed? It would be interesting to have papers which said why configurations were not chosen but that is probably an academic rather than a

commercial point of view.

Again, it is interesting to note that the augmented lift aerofoil work does not appear to have reached a more advanced stage, although it has been under active consideration in several countries since 1953 in the case of the jet flap and 1959 in the case of circulation control. There seems to be no question that basic knowledge is entirely sufficient and the US have promoted several programmes which support the claims made in the papers - does this suggest that aviation, like rail transport, is moving into an era where the economics of existing designs are adequate to discourage new developments?

If one looks at the balance of the papers, it appears that helicopter manufacturers have responded to their customers' requirements by developing a better lift capability which can be interpreted as a better disposal load fraction.

If one draws a conclusion from the papers, it is that the helicopter is seen as being a vehicle which is essentially a good vertical lift machine which has a limited range and speed capability, but which performs certain operations which no other flying machine can and where its economics are acceptable.

Perhaps the strongest point which endorses this view is the depressing lack of any really new ideas in any of the Forums. Perhaps this indicates the stage of helicopter development but if we look at the same period for the fixed wing aircraft, the widespread development of swing wing aircraft, the formulation of the requirement for the agile fighter using active aerodynamics and direct lift control and the flight of advanced experimental aircraft involving laminar flow, etc., the contrast is clear. Even more if one looks at the younger field of Space, then the challenges are greater and the attraction to the original thinker higher. This causes me considerable concern because at University the reasons which cause students to opt for aviation and then for a particular branch of aviation is very much related to the challenge offered. It is much harder to attract the outstanding student to rotary wing work rather than Space or advanced combat aircraft. This is a challenge that I believe needs to be faced and the Forum can play its part.

### **Aerodynamics**

From the papers presented, the possible performance gains from advanced aerofoils are clearly shown and one can trace the development from research to in-service, a very substantial achievement. Furthermore, the shape of the tip of the blade has been known to be important and the research that has resulted in a variety of blade tip shapes is well represented in the proceedings of the Forum. The calculation procedures to predict these changes have represented a triumph of the computer programmers art but whether our physical understanding justifies the complication of some of the models is questionable. The mathematical modelling of blade aerodynamics & wake flows is of great significance to the industry but I still stand amazed at the success of many of the predictions made using elementary modelling. I hope that somebody will come up with a cost effectiveness measure for computer predictions - not only in aerodynamics - in terms of improved accuracy vs cost of development which can be used to guide research & development. Who should do this - clearly the manufacturers must specify the cost benefits in terms of improved prediction accuracy and therefore they have the lead. Perhaps a round table discussion at a Forum might be the place to start such a debate.

It is particularly interesting that the tail rotor which is widely recognised as the Achilles Heel of the single main rotor helicopter has only attracted four papers; one dealt with the shrouded tail rotor, 'the Fenestron', one with the application of modern airfoils and materials to a Sea King tail rotor, one with a twin tail rotor which might offer significant operational and safety advantages and the last referred to the novel 'Notar'. Four papers out of a total of 590 presented surely means that either the industry is satisfied with this noisy, awkwardly placed, potentially dangerous and sometimes control power limited device or that no new ideas for a replacement have occurred - one suspects that the latter is the case. Does this not make the addiction to this configuration the more surprising?

Before leaving aerodynamic aspects one must mention the attention given to drag reduction. It can be argued that the changes which can be made to fuselage shape are relatively limited in view of the roles for which the current rotorcraft are used. The direct determination of fuselage drag is one aspect of the problem which is further complicated by its variation with attitude, the nature and extent of the unsteady wake and the effect that this has on the tail rotor and directional stability and the fuselage yawing and pitching moments; all of these factors are influenced by the main rotor downwash. Leaving out mention of the subject in papers dealing with particular designs there appear to be 5 papers dealing with fuselage drag and 2 with rotor head/pylon drag. The relative lack of papers suggests that again one is waiting for inspiration, or that the problem is relatively intractable. This may be the case and if so in the case of the rotor head it may be another pointer which suggests that the edgewise rotor will be replaced by another layout at higher speed forward flight.

### **Dynamics and Testing**

Dynamics papers have represented a significant fraction of the total -this reflects the critical importance of this topic to a successful rotorcraft.

The papers can be subdivided into prediction of structural response, vibration production and alleviation, instabilities including ground resonance, and experimental determination of dynamic characteristics of model and full scale rotorcraft.

Vibration prediction has been the subject of a few papers but the thrust of the published work has concerned the alleviation of the vibration as perceived in the fuselage. The ingenuity expressed in the various systems discussed is considerable and while it is probably true that all classes of device have now been specified, the detailed designs which will emerge will, no doubt, continue to intrigue us all. If one was to pick an area where development will take place it will be in active as opposed to passive systems. It is interesting to note that this seems to be one class of problem which has not been solved by electronics - given time this will happen. In making that statement I have clearly ignored the case of active reduction of the aerodynamic forcing function by means of higher harmonic rotor control. I believe that only the 'pneumatic' rotors - the jet flap and circulation control rotors have demonstrated this ability at anything like full scale. However, almost every Forum has had papers on this subject. The difficulty appears to be to decide what is the objective of the exercise and to ensure that adverse effects do not occur in other cases, e.g. reduce fuselage vibration but increase blade stresses and thereby reduce fatigue life. It was originally suggested that the design of actuators with a suitable response was the stumbling block but in the first

forum a paper was given which showed that this was not the case. No doubt higher harmonic control will continue to occupy the next decade of Forums and it is probable that this will include detailed measurements from flight tests.

To me, a surprising number of papers have been presented on the topic of ground resonance - to be fair these occurred principally at the beginning of the decade under review. This seems a topic which is now well understood, the same cannot be said of the aero-mechanical instability. While this subject is energetically tackled it is never clear that the most cost effective (i.e. minimum penalty) solution is found. The development of new hub/blade designs taking full advantage of the design flexibility offered by advanced materials has added to the dynamacists challenge.

One topic which has appealed to me particularly is the use of computers to assist in the automatic formulation of the aero elastic equations. This is a topic which will be of increased importance in many problems, not only for rotorcraft dynamic problems. The progress made in the subject is significant but it remains a growth area.

Structural design for ride qualities and life remains a topic of importance. The application of finite element modelling to helicopters was clearly a frontier topic at the beginning of the decade, judging by the papers. It now appears to have taken its place as a useful tool in the design work alongside the more traditional modal or stick model approaches. The problem which I have when listening to erudite lecturers showing excellent agreement between theory and experiment is to know how many attempts have been required to achieve this success, or to put it another way, has the theory been trimmed to the experiment?

Several papers have dealt with structural manipulation to achieve desirable ride characteristics. These papers determine the areas where the change should be made and in some cases relate the magnitude of the change required to what may be practically achieved.

Techniques are now becoming available which will combine to make a very powerful tool in initial design and early development. However there will always be advances in structural techniques or material developments and one such has been the increased use of composites in all parts of the helicopter. Changes of this nature require much rethinking of some of the modelling techniques as well as the experimental determination of physical behaviour. Model tests and measurement techniques have featured in the papers for most years. Some definitive techniques have been reported by various authors. It is worth noting that there is a problem of scaling rotors dynamically and aerodynamically and that dynamic model tests do not attempt to get the aerodynamics correct. The development of special facilities, like pressurised tunnels, and maybe eventually the cryogenic tunnel, will go far to answer the doubts which have and still do hang over model tests in some conditions.

During the period under review two new large wind tunnels have come into use to complement the large French wind tunnels which have been in use for many years. These are the Dutch-German tunnel in Holland and the 5 metre pressurised tunnel in England. The former has already been used for rotor research but the latter has still to run its first rotor programme. Facilities such as these must feature in future programmes and, while nothing is on the same scale as the Ames laboratory in the U.S.A., it will be interesting to see their values relative to the finished product. Papers have also been presented

on flight test work and these have emphasised the difficulty of making measurements on rotating machinery in flight. Behind the measurement, for example, of blade pressures and stresses is a considerable story of equipment development, signal processing and conditioning. The information obtained from these tests is invaluable for validation of mathematical models and scaled model tests. The development of the RSRA Aircraft in the USA is of course the complete complement to model and ground based tests. The results which have been published to date have been interesting. The value of such an ambitious facility rather than the European approach of adapting existing aircraft will again make fascinating reading in the next decade.

### **Operational and Regulatory Problems**

Operational problems have been dealt with at length in all of the Forums. The topics covered include handling and manoeuvrability - perhaps the catch word has been 'Agility' although what that means precisely is perhaps still open to question; the extension of and proving of the flight envelope - a particularly dangerous task when determining the ultimate limit of the helicopter - and this might be taken to include the extension of night flying capabilities using devices such as night vision goggles and low light television equipment; the development of flight control systems including the controls used by the pilot, and problems such as icing, blade erosion, aircraft corrosion, and operation from difficult locations - like frigate decks. Each of these topics brings with it, its own very special difficulty - not least the need to understand the basic physics of the problem as has been the case with blade icing. That progress is being made, sometimes slowly, is clear. All of these developments will expand the usefulness of the helicopter for both civil and military applications, but they bring with them problems of regulation.

There has been an increasing involvement over the decade under review of the regulating authorities and the papers have been a most welcome contribution not only for their content but also for the discussion stimulated. A much stronger wind of change is now blowing through helicopter civil regulations as a result of public pressure following incidents involving passengers. Military regulations are always under review and there is no doubt that the co-operation of these groups internationally is most beneficial to all.

The implications of this for helicopter design, construction and costs will be the subject of many papers to come. The cost of operation is a subject which has been behind many papers dealing with actual aircraft. The performance of the gas turbine power plant has been well represented in the papers, behind which one can see the search for ultimate performance in terms of fuel efficient power production which is then related to complication and cost coupled with ease of maintenance. Special engine problems have been covered in terms of intake design to accommodate the wide inflow conditions experienced plus the problems of foreign object damage that may occur. The control of the engine - particularly the change from analogue to digital control has occupied several papers - to meet the special requirements of the helicopter, including giving the pilot the greatest chance to save his machine in the event of one engine failing in a multi-engine machine at minimum operational penalty, has also been featured. This is a problem which will continue to exercise engine and helicopter designers certainly for the next decade. The choice of number of engines affects the transmission designer and papers on gearbox and complete transmission designs have reflected the attempts to minimise the large weight penalty which is incurred in what is basically a speed change device. The development of something which betters



the gearbox has long exercised good brains without solution but there will no doubt be a successful development. Meanwhile the problem of the mechanical condition of rotorcraft rotors, transmissions and engines has been attacked and papers on the subject have been read at several Forums. The need to successfully determine condition change and remedial action with a minimum of false alarms is going to become increasingly important in the immediate future. There will be an emphasis on detecting potentially dangerous faults and to anticipate time to failure with considerable accuracy for certain components. This again is an unspectacular but essential piece of work.

### **Environmental Factors**

In the field of the environment within and around helicopters, noise has been the dominant subject with several papers presented each year. In this subject the clear difference of design philosophy between some American and European manufacturers is seen by the U.S. attention to impulsive noise while maintaining other noise research at a lower level of importance. European workers have tended to maintain an interest in all noise source. Outstanding progress has been made in understanding and predicting rotor noise and this has been aided by good full scale and model testing. The development of the acoustic wind tunnel, of which the Dutch-German tunnel is probably the best facility in Europe, has been of great benefit to rotor acousticians. Noise certification for civil and military requirements for quieter and/or changed acoustic signatures will place new demands on the designers and it will be interesting to see if the operating penalties suggested in paper studies are borne out.

In particular the treatment of the tail rotor to minimise noise will be something to watch with great interest. Perhaps this will lead to the demise of the tail rotor.

### **Avionics**

The growth in the number of papers dealing with Avionic developments for rotorcraft has been spectacular throughout the Forums. The first session devoted to Avionics occurred at the 3rd Forum at Aix-en-Provence. The 10th Forum has three sessions all devoted to Avionic developments. The cost of the avionic systems in an advanced military helicopter can represent 50% of the total cost. Rather than discuss avionics as a topic by itself, this brief review has included some of these developments under the headings where the avionic work makes its contribution. Avionics will continue to make increased contributions to all aspects of rotorcraft development and the contributions to the Forums of the next decade will be of considerable interest.

### **Other VTOL Aircraft**

In this brief and far from complete summary of the papers presented at the Forums little mention has been made of the those on other types of VTOL Aircraft - namely the jet lift machines. The complementary roles that different types of machine can play has been strikingly demonstrated in operation and I still believe strongly that it is important for information to be shared between designers, researchers and users. In spite of the change of title of the Forum to exclude the words "Powered Lift Aircraft", I hope that a place will continue to be made for some papers dealing with this topic, as is still being done in the AHS Forum in the U.S.A.

## Discussion Sessions

Mention has been delayed until now of the attempts made at two Forums to include a Panel Discussion, namely at the 5th Forum in Amsterdam on the subject of the 'Future of Rotorcraft' and at the 8th Forum in Aix-en Provence where an Operator/Manufacturer Panel dealt with civil helicopter requirements. This panel also had the benefit of a questionnaire which had been sent to operators in advance. Both of these panels were extremely interesting and brought together the various disciplines in a unique way. It is to be hoped that these activities will be continued from time to time and on a range of topics.

## Particular Designs and Projects

Another class of papers has discussed particular rotary winged projects and illustrated the progress which has been made in meeting various operational roles. These papers, together with the discussion which has followed both in the lecture period and at other times during the conference, have conveyed a great deal of information and in many cases have illustrated how the various detailed disciplines have been used to achieve the result. These papers, coupled with subsequent contributions on flight tests, investigation of particular problems, detailed achievements, etc, form a basis against which all other work accomplished can be judged as well as giving one a basis on which further investigations can be projected.

Finally, one must mention the papers which have outlined the requirements for future machines. The thinking contained in these papers should be mandatory reading for all research workers in order to help them develop their ideas to obtain maximum chance of being used. Equally advanced thinking of what may be technologically feasible must be a spur to the user who is thinking about future vehicles - be they refits or new designs. In this respect I must mention the paper dealing with the LHX project, which to a non-designer seemed to offer the biggest challenge of anything which has been mentioned at these Forums. If all the options mentioned were to be included in the final specification it would be a technological challenge that could stretch every discipline to the limit perhaps some will say that it is over-ambitious. It appears to me that a challenge such as this is what the rotorcraft industry requires if the rotary winged machine is to continue to grow in stature and use in the aeronautical inventory.

Let me repeat - this summary of the technical sessions is one individual's subjective view of the nine Forums held to date. Whether the interpretation that has been put on the papers is agreed or not, I have little doubt that all will agree that the Forums have been a great achievement. The work in the technical sessions has been complemented, and in many cases underlined during the social and technical visits which have been a feature of each Forum - these are detailed in Table V but that listing can in no way reflect the enjoyment and profit of the participants who will each have their memories of the events.

## 4. The Future

The final section must deal with the last part of the title - a portent for the future.

With the tenth Forum here in Amsterdam the meetings have gone the complete round of the five host countries twice. It does not seem likely that

other European countries are likely to host the Forum unless an increase in rotary winged activity in one or other of them occurs and this does not seem likely at present. Equally, there seems to be no reason why any of the present five countries should cease to have a substantial rotary winged involvement and therefore continue to host the Forum. The fact that the continuation of the Forums has to be expressed in this way is both a compliment to the remarkably successful way in which each country in turn has taken on the organisation of its Forum with almost no documentation and certainly no money being passed from one country to the next. However, that success has depended on two things - the first is the willingness of very busy individuals to take time to organise each occasion, and I list the names of the International Organising Committees in Table VI, plus the willingness of industrial manufacturers, operators, research institutes, the military, universities and others to back the project, both with cash and time given by their employees. Whether this will continue to be the case is something which only time can tell but one major supporter withdrawing could bring the series to a halt. The advantages that all have enjoyed with this unique method of operation is the individuality that each Forum has displayed.

In order to ensure that the Forums will continue it would be necessary to form some society and set up a central secretariat to deal with the task of organisation of each year's Forum. The expense of doing this would be relatively high and this would mean a membership subscription. It is natural then to expand the activity to include several meetings in the year. This could well dilute the number and standard of papers as well as the number attending both the individual meetings and the Forum, bearing in mind the desire of many people to attend some of the AHS, AGARD and other meetings held by the national Aeronautical Societies. It has therefore been concluded by the Forum International Committee after several discussions that the balance of the advantage lies firmly with the informal national organisation which has served so well to date.

The rotorcraft's future must also include more collaboration between countries. The papers at the Forum contain many examples of such exercises. The opportunity for people to work in other locations has over the past decade been progressively eroded away as recession has caused unemployment in each country which has quite naturally resulted in protectionist measures to ensure priority employment of that country's citizens. The Forum cannot cure this but it might very well consider taking a small step in the direction of reversing the pattern. A possible action could be modelled on the AHS Lichten Award and the European Forum sponsorship for the best papers at the AHS Forum to be presented in Europe and the best European Forum paper(s) to be given in America at the next appropriate Forum. Would it be possible for each country wishing to collaborate, to arrange an exchange for, say, 4 months of one young person (perhaps defined as under 30) who would go to industry or a research institute in another country? Each country would agree to take one per year and the method of selection would be by paper presented at the Forum. Such a scheme would involve greater involvement of young people at the Forum which must be to their benefit. Small steps like this can buy large advances given time.

The success of the European Forums has been achieved with a minimum fuss and a great deal of hard work by national committees once every five years. Its success is a portent for the future. The harmonious interaction with the American Helicopter Society and the links that have been established provide a means for even closer international collaboration. The past decade

has seen the consolidation of the place of the low disc loaded VTOL aircraft in the inventory of the military and its increasing use in the civil field. It has also seen the introduction and successful use of the high disc loaded VTOL aircraft. The period of consolidation and exploitation of the basic concepts may be drawing to a close but there are encouraging signs that new and exciting challenges are just around the corner. It is unlikely that the Forum can continue to expand in numbers of people attending, but the quality and range of papers will continue to improve. The opportunities to develop new ideas for information interchange within the framework of the Forums are many, and some will be realised.

The Forum as the annual meeting place of the European Rotorcraft Fraternity with many of their colleagues and friends from around the World, has the potential to be a valuable influence in many ways. I see it as being an important portent in a bright future. Long may the European Forum prosper.

#### **ACKNOWLEDGEMENTS**

In preparing this review I have been much helped by Dr. Bellavita, M. Petit, Professor Reichert and Professor Wittenberg, who have all given information on the Forums which they chaired, as has Dr. Thomas on the Sixth Forum. I am most grateful to them but hasten to add that the interpretation of the information and the conclusions drawn are entirely my responsibility. I would also like to take this opportunity to thank all those people who are not named but who have done so much for the Forums.

**TABLE I**

**Number of Participants, Ladies and Papers Read at Each Forum**

<b>Year</b>	<b>Forum Centre</b>	<b>No. of People Present</b>	<b>No. of Papers Read</b>	<b>No. of Ladies Present</b>
1975	Southampton	124	1 + 39	4
1976	Buckeberg	140	1 + 40	10
1977	Aix-en-Provence	197	1 + 41	42
1978	Stresa	254	1 + 73	52
1979	Amsterdam	229	1 + 65	60
1980	Bristol	238	1 + 70	33
1981	Garmisch-Partenkirchen	240	3 + 75	40
1982	Aix-en-Provence	455*	1 + 78	98
1983	Stresa	426	1 + 98	98

\*The Eighth Forum was unique in that a technical exhibition was included and 72 delegates were registered giving a total of 527 present.

**TABLE II**

**Attendance by Nationality**

<b>Year</b>	<b>GB</b>	<b>GE</b>	<b>FR</b>	<b>IT</b>	<b>NE</b>	<b>US</b>	<b>Other</b>
1975	85	9	12	1	8	6	1
1976	23	71	12	3	12	16	3
1977	19	41	91	11	13	19	3
1978	15	31	29	105	7	51	4
1979	30	35	21	32	79	39	9
1980	91	46	28	23	20	37	13
1981	42	94	26	24	8	27	23
1982	42	53	35 <sup>4</sup>	29	12	25	12
1983	49	83	36	176	15	61	6

**Key**

GB - British	NE - Dutch
GE - German	US - American
FR - French	IT - Italian

**TABLE III**  
**Papers Presented by Nationality at Each Forum**

<b>Year</b>	<b>GB</b>	<b>GE</b>	<b>FR</b>	<b>IT</b>	<b>NE</b>	<b>US</b>	<b>Other</b>
1975	22	5	5	0	2	4	1
1976	12	16	6	1	0	6	0
1977	12	9	10	1	0	9	1
1978	12	7	13	5	1	35	1
1979	16	7	8	3	10	18	2
1980	25	9	10	0	1	21	5
1981	17	24	11	5	2	14	5
1982	15	19	20	5	2	16	2
1983	15	17	11	16	3	31	6
<b>Av:-</b>	<b>16.2</b>	<b>12.5</b>	<b>10.4</b>	<b>4</b>	<b>2.3</b>	<b>17.1</b>	<b>2.6</b>

**TABLE IV**  
**Papers per National Delegate at Each Forum (Percentage)**

<b>Year</b>	<b>GB</b>	<b>GE</b>	<b>FR</b>	<b>IT</b>	<b>NE</b>	<b>US</b>	<b>Other</b>
1975	26	55	42	0	25	67	100
1976	52	22	50	33	0	39	0
1977	63	22	11	9	0	47	33
1978	80	23	45	5	14	69	25
1979	53	20	38	9	13	46	22
1980	27	20	36	0	5	57	38
1981	40	25	42	21	25	52	22
1982	36	36	6	17	17	64	17
1983	31	20	30	9	20	51	100
<b>Av:-</b>	<b>46</b>	<b>27</b>	<b>32</b>	<b>10</b>	<b>12</b>	<b>55</b>	<b>42</b>

**Key**

GB - British	NE - Dutch
GE - German	US - American
FR - French	IT - Italian

TABLE V

TECHNICAL AND SOCIAL VISITS AT EACH FORUM

I.	Southampton	Social Occasions	Conference Dinner. Medieval Banquet at Rhinefield House.
		Technical Visit	Alternatives:- Westland Helicopters Ltd. Army Air Corps - Middle Wallop
II.	Bückeburg	Social Occasions	Official Reception. Conference Dinner.
		Technical Visits	Hubschrauberzentrum e.V D.F.V.L.R. Braunschweig.
III.	Aix-en-Provence	Social Occasions	Buffet campagnard. Sightseeing tour in Aix-en-Provence Dinner at the 'Chateau de la Pioline'
		Technical Visit	SNIAS Marignane.
IV.	Stresa	Social Occasions	Sightseeing musical Dinner on board ship on Lake Maggiore. Dinner at Villa Caproni
		Technical Visit	Agusta
V.	Amsterdam	Social Occasions	Official Reception. Forum dinner preceded by canal cruise.
		Technical Visit	German-Dutch Low Speed Wind Tunnel.
VI.	Bristol	Social Occasions	Official Receptions. Forum Banquet. Visit to Bath.
		Technical Visits	Alternatives:- Smiths Industries Ltd. Rolls Royce Ltd. Bristol. Royal Aircraft Establishment, Bedford. W.H.L. Ltd.

VII.	Garmisch- Partenkirchen	Social Occasions	Official Receptions. Conference Dinner.
		Technical Visits	Alternatives:- Messerschmitt-Bolkow-Blohm - Ottobrunn. Messerschmitt-Bolkow-Blohm - Donauworth. Motoren Und Turbinen-Union - Munche
VIII.	Aix-en-Provence	Social Occasions	Official Reception Visit to Aix-en-Provence by night Forum Banquet at Chateau d'Ansouis
		Technical Visit	S.N.I.A.S. Marignane
IX.	Stresa	Social Occasions	Dinner at "Pinin" restaurant Dinner at Villa Cicogna
		Technical Visit	Agusta Cascina Costa



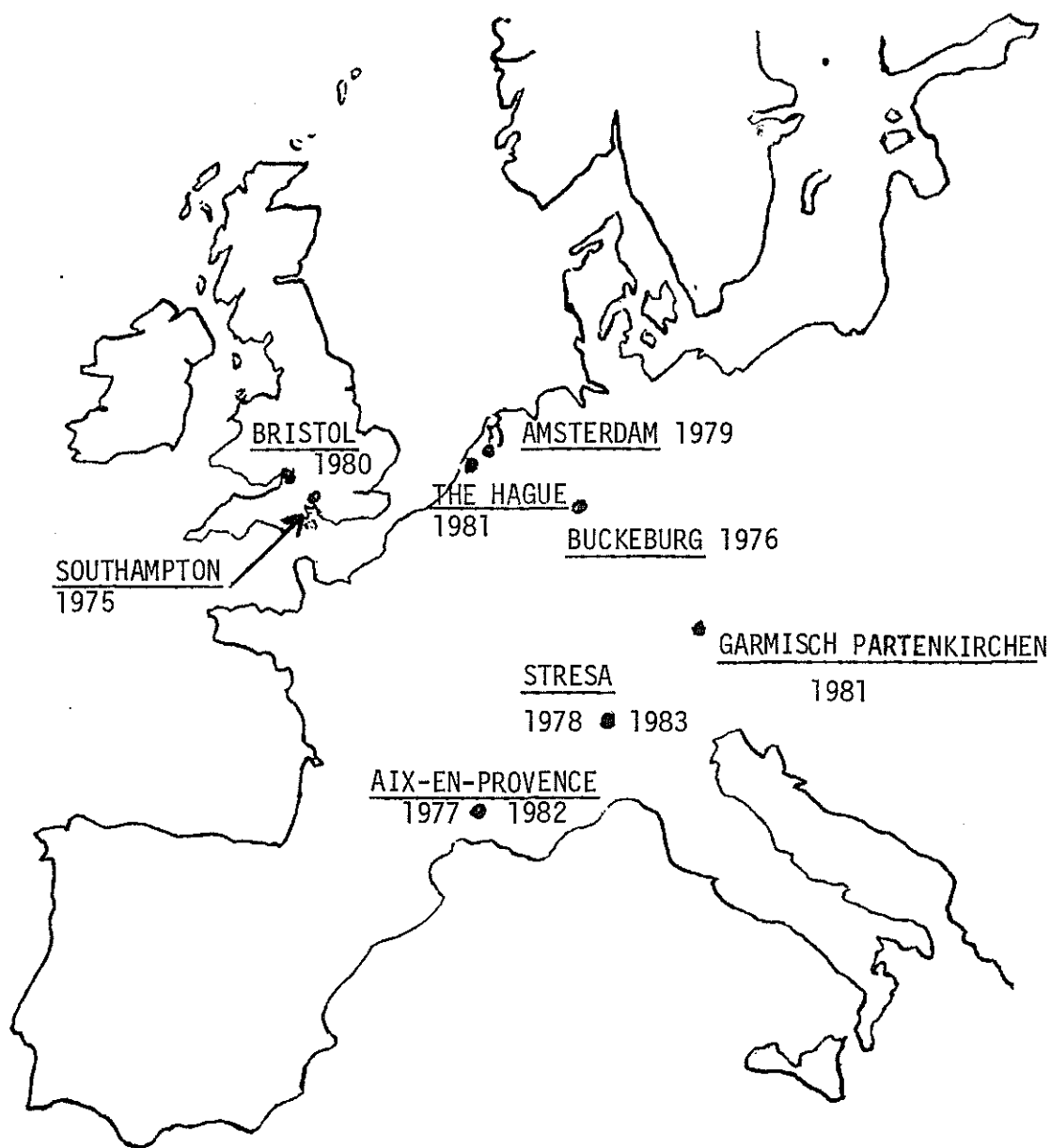
TABLE VI

INTERNATIONAL ORGANISING COMMITTEE FOR EACH FORUM

(Chairman shown by underlining)

A. Auriol (Fr)									VIII	
P. Bellavita (I)			III	<u>IV</u>	V	VI	VII	VIII	IX	X
J. Boulet (Fr)			III	IV						
Dr. R.M. Carlson (USA)	I									
Prof. I.C. Cheeseman (UK)	<u>I</u>	II	III	IV	V	VI	VII	VIII	IX	X
Prof. L.F. Crabtree (UK)						VI				
R. Dat (Fr)		II	III	IV	V	VI	VII			
B. Gmelin (FRG)		II					VII			
Prof. X. Hafer (FRG)		II	III	IV	V	VI	VII	VIII	IX	
R.J. Van der Harten (Ne)					V	VI	VII	VIII	IX	
Dr. M.V. Lowson (UK)	I	II	III	IV	V	<u>VI</u>	VII	VIII	IX	X
L.R. Lucassen (Ne)		II	III							
R.L. Maltby (UK)	I					VI				
C. Petit (Fr)	I	II	<u>III</u>	IV	V	VI	VII	<u>VIII</u>	IX	X
P.H. Poisson-Quinton (Fr)	I									
Prof. G. Reichert (FRG)	I	<u>II</u>	III	IV	V	VI	<u>VII</u>	VIII	IX	X
J.S. Shapiro (UK)	I									
J.C. Sieffer (Fr)								VIII	IX	X
A. Sunden (Sw)	I									
Dr. E.T. Thomas (UK)						VI				
H.J.G.C. Vodegel (We)				IV	V	VI	VII	VIII	IX	X
V. Von Tein (FRG)										X
Prof. J. Wittenberg (Ne)	I				<u>V</u>					<u>X</u>

FIG. 1: LOCATIONS OF THE FIRST TEN EUROPEAN ROTORCRAFT FORUM



## **APPENDIX**

**Letter addressed initially to distinguished persons  
regarding the initial Forum**

### Addressees

Dr. R. M. Carlson (USA)

Dr. M.V. Lowson (UK)

M. C. Petit (FR)

M. Poisson-Quinton (FR)

Dr. C. Reichert (FRG)

Mr. A. Sunden (SW)

Prof. H. Wittenberg (NE)

Reference: A/A 22/7

9th September 1974

Dear Monsieur Petit,

European Rotorcraft and Powered Lift Aircraft Forum  
September 22nd - 24th 1975

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The need for a regular meeting in Europe to discuss the important developments that are taking place in the Rotorcraft and Powered Lift Aircraft field has no doubt occurred to you. In an effort to initiate such a series of meetings we propose to hold a Forum at Southampton from September 22nd to 24th 1975.

The objective of the meeting is to provide an opportunity for researchers, designers, flight personnel, experimenters and operation personnel to meet to discuss their achievements and problems. Attached is a tentative programme which illustrates more clearly the way in which we hope to achieve this objective. The subjects chosen should not be considered as fixed but purely an indication of the topics which might be considered. The actual programme will be determined by the organising committee.

The length of the conference has been restricted to three days in the hope that delegates will be able to be present for the whole time. Two days are devoted to papers and it is proposed that a visit will be arranged to a suitable centre(s) in conjunction with the conference on the third day. We have further made a restricted, but topical choice of subjects for formal contributions. If further conferences follow, hopefully in other centres in Europe, then subjects not discussed this year could well be given pride of place on their agendas. To overcome this selective aspect it is planned to invite a distinguished speaker to review the field at the opening of the conference.

Finally, in suggesting that the word European be included in the title, we are not seeking to exclude American or other participation. It is hoped that such participation will take place in exactly the same way as European contributions are made to the American Helicopter Society and A.I.A.A. meetings.

Your distinguished contributions to these fields are recognised and we hope that you will feel that the objective that we are seeking is sufficiently important for you to accept our invitation to join the organising committee. Similar invitations have been extended to persons listed overleaf. Although the conference is one year away the timetable is already very tight. A tentative schedule is attached. I envisage that the committee's business will be largely conducted by post. I do hope that I shall receive an early and favourable reply from you to this invitation.

Yours sincerely,

I.C. CHEESEMAN

Monsieur G. Petit,  
Le Directeur des Etudes Helicopter,  
Societe Nationale Industrielle Aerospatiale,  
Usine de Marignane BP 888,  
Division Helicopters,  
13 Marseilles,  
France.