ICAS

The International
Council of the
Aeronautical Sciences

A BRIEF HISTORY

By
John J. Green,
Past-President

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TABLE OF CONTENTS

ICAS: A Brief History

By John J. Green, *Hon. F.C.A.S.I., F.R.Ae.S., F.A.I.A.A., K.M.D.G.L.R.*
Past-President of ICAS

Foreword

ICAS was founded some twenty-three years ago, and in the intervening time it has fulfilled the expectations of its founders in every way. So much so, that it now looks forward to the future confident that the importance of its role is not only undiminished but enhanced by the growing complexity and importance of the problems facing aviation today. ICAS believes it stands on the threshold of a new era in which the need for cooperation and collaboration will generate augmented support for its activities. With this in mind, the Executive Committee determined that ICAS should facilitate this growing support by preparing and disseminating an account of its own history, to reveal to those interested why and how it came into existence, its role and objectives, and how it has fared during the twenty-three years since its birth.

Dr. Theodore von Kármán—the first President of ICAS—with the author (Dr. J. J. Green)—"looking to the future"!

THE INTERNATIONAL COUNCIL OF THE AERONAUTICAL SCIENCES CREATES A WORLD FORUM FOR EXPLORING THE ARTS, SCIENCES, AND ISSUES OF AERONAUTICS

THE International Council of the Aeronautical Sciences (ICAS) provides a forum for discussing common problems in aeronautical science and technology. Its membership, open to all countries, now comprises the national associations dedicated to the advancement of aeronautics of twenty-six countries.

ICAS was founded in January 1957. At that time, the Institute of the Aeronautical Sciences (IAS: now the American Institute of Aeronautics and Astronautics, AIAA) had been expanding its international activities. An IAS patron and participant, Harry Guggenheim, the distinguished American industrialist and philanthropist, had a strong commitment to the fostering of a better understanding among all the nations of the world in all areas. He suggested that positive action should be taken to bring together, at regular intervals, all the scientific bodies of the aeronautical world for the discussion of common problems. Apart from the seeming political difficulties facing such an objective, economic problems stood in the way; it had been impossible to make any long-range plans without some positive assurance of continuing financial support. To overcome this difficulty Mr. Guggenheim generously offered the proceeds from the sale of the Guggenheim Estate at Sands Point, Long Island, as financial support for periodic international congresses in the aeronautical sciences, and suggested that a conference should be held, with representatives from other countries, to explore the practicality of his ideas.

Such a conference was held in New York on January 29, 1957, to which a number of persons were invited who represented the aeronautical societies of nine countries. Those attending were:

- AGARD: Theodore von Kármán, Chairman
Frank Wattendorf, Director
- Canada: J.J. Green, Past President, CAI
- England: E. T. Jones, President, R.Ae.S.
A. M. Ballantyne, Secretary, R.Ae.S.
- France: Maurice Roy, Director, ONERA
- The Netherlands: H. J. van der Maas, Professor of Aeronautics, Delft
- Spain: A. Perez-Marin, National Aeronautical Institute
- Switzerland: R. Greinacher, Service Technique
- Sweden: Bo K. O. Lundberg, Director, Aeronautical Research Institute
- West Germany: H. Blenk, President, WGL

- United States: M. I. Peale, President, IAS
  Harry F. Guggenheim, Honorary Fellow, IAS

  Hugh L. Dryden
  T. P. Wright
  C. J. McCarthy
  L. R. Richardson
  E. R. Sharp
  } Past-Presidents, IAS

  S. P. Johnston
  R. R. Dexter
  J. Maitan
  W. A. Shrader
  E. B. Robischon
  } IAS Staff

In an editorial in the *Aeronautical Engineering Review,* from which I have quoted extensively, Paul Johnston, Director of the IAS, wrote about this conference in these words: "One of the most important events of the Twenty-Fifth Annual Meeting of the Institute did not appear on the official program. At an informal dinner on Tuesday evening, January 29, in the Hotel Sheraton-Astor, representatives of scientific societies from overseas and a representation of IAS Council and Officers (including five past-presidents) considered ways and means of extending collaboration in the aeronautical sciences on a world-wide basis. The discussions of that evening will have far-reaching results." How true and prophetic these remarks were. For in the talks, which actually lasted several days, it was agreed that a series of international congresses in the aeronautical sciences would be initiated and they would encourage interchange of information on all phases of flight. Every country having a recognized national association dedicated to the advancement of the aeronautical sciences, technology, and engineering would be invited to participate without regard to immediate military or political interest. Moreover, every other appropriate means for effective interchange of scientific information, the participants agreed, should be exploited.

The International Congresses would be held at about two-year intervals, and it was proposed that these be in the years between the scheduled Anglo-American and Pan European meetings, i.e., in the even-numbered years, so as not to conflict with these events. At each General Assembly, a Council composed of one member from each participating society would meet to consider questions of policy and to appoint working subcommittees. The most important of these would be the Executive Committee, which might consist of five to seven members of the Council. It was believed at that time that the membership of this committee should be rotated, with each member serving four to five years in a staggered pattern for continuity. The IAS would serve as the general administrative agency, with the IAS Staff acting as a permanent Secretariat, coordinating all the activities of ICAS from selection of technical papers to publication of proceedings, etc. Logistical support would come from the "Daniel and Florence Guggenheim Memorial Fund for the Promotion of

International Collaboration in the Aeronautical Sciences," administered by the IAS.

The selection of the locale and the general subjects to be covered in any particular congress would be determined by the Council. Programs would be organized by international committees in the various fields of interest (aerodynamics, structures, propulsion, aeroelasticity, aeromedicine, flight-test engineering, etc.).

Further, in appreciation of the source of the funds which was to make these congresses possible, a suggestion was made that at each international congress a "state-of-the-art" lecture in some field of the aeronautical sciences be given by an outstanding scientific figure. These would be known as "The Daniel and Florence Guggenheim International Memorial Lectures in the Aeronautical Sciences."

Those persons who were present at this meeting in New York were invited to a second meeting, scheduled for Paris in the Spring of 1957, and it was decided that those attending would constitute the Provisional Council, for their task would be the formulation of plans for the First International Congress, to be held on a suitable date in 1958. This meeting was held on May 30, 1957, at the Association Française des Ingénieurs et Techniciens de l'Aéronautique (AFITA), 6 rue Cimarosa, Paris, with Professor Maurice Roy as Chairman. It was a most important meeting from the point of view of long-range planning for the new organization. The names, and the positions occupied at the time, of those members of the "Provisional Council" in attendance are as follows:

• A.M. Ballantyne:	Secretary, R.Ae.S., The United Kingdom
• H. Blenk:	President, Wissenschaftliche Gesellschaft für Luftfahrt, Federal Republic of Germany
• Hugh L. Dryden:	Director, National Advisory Committee for Aeronautics, United States
• G. de Faget:	Office National d'Études et de Recherches Aéronautiques, France
• G. Gabrielli:	Director, Divisione Aviazione, Fiat, Italy
• John J. Green:	Defence Research Member, Canadian Joint Staff, and Defence Research Attaché, Canadian Embassy, Washington, D.C., United States, Canada
• R. Greinacher:	Chief, Aviation Section, Service Technique Militaire, Switzerland
• Jules Jarry:	President, Association Française des Ingénieurs et Techniciens de l'Aéronautique, France
• S. Paul Johnston:	Director, Institute of the Aeronautical Sciences, United States
• E. T. Jones:	General Director of Technical Development, Ministry of Supply, The United Kingdom

- Theodore von Kármán: Chairman, Advisory Group for Aeronautical Research and Development (AGARD), United States
- Bo K. O. Lundberg: Director, Aeronautical Research Institute of Sweden
- H. J. van der Maas: Professor of Aeronautics, Delft Technical University, The Netherlands
- A. Perez-Marin: Secretario General, Institute Nacional de Tecnica Aeronautica, Spain
- Maurice Roy: Director, Office National d'Etudes et de Recherches Aéronautiques, France
- Frank L. Wattendorf: Director, AGARD, United States

The principal objective of the meeting was to set up a provisional organization to handle the arrangements for the First International Congress and to establish a time and place for it.

Although there was a firm determination on the part of those attending both the first and second meetings to proceed with the plans for these International Congresses, it appears in retrospect that there might have been some lingering caution. After all, in creating an activity which was to rely on the interest and cooperation of so many countries of the world, the certainty of success could not be taken for granted. It was for this reason, no doubt, that the early steps were still considered as exploratory and the organization to handle the first congress as "provisional."

The Chairman opened the meeting by restating the general purpose of the organization, to facilitate the free interchange of information among all countries of the world in order to advance the general knowledge of all phases of aeronautics and related subjects. To have drawn up a Constitution for the new organization would have been too courageous, if not presumptuous, at that date, and many years were to pass before the need for such a step became fully apparent. At the meeting in New York a tentative organization to handle successive international congresses was drafted, as described in Paul Johnston's editorial in the *Aeronautical Engineering Review*. Various changes were made to this draft by the IAS Staff between the two meetings, and in Paris Paul Johnston discussed these and invited further comments and suggestions.

The need for a Council, responsible for convening each Congress, was reaffirmed, and the two-year interval between congresses was adopted. Membership on the Council would be open to every country which had an association dedicated to the advancement of the aeronautical sciences and engineering, and every country, or rather association, considered by the Council to be eligible to participate would appoint one official delegate to the Council. An alternate could also be appointed, but in no case would any country (or association) have more than one vote in the Council.

Paul Johnston reviewed the offer made by Harry Guggenheim to provide funds, now in the possession of the IAS, from the sale of the Guggenheim Estate on Long Island. Approximately $20,000 would be available every two

years to underwrite some of the operating expenses of the proposed congresses.

In light of the way in which the ICAS Congresses have developed over the years, it is of interest to look back on the character they were expected to have at the time of this meeting. They were to be of the general nature of the annual meeting of the IAS, but with the scope and number of papers presented somewhat more limited. They would last for about one week, and some 30 to 35 papers might be presented. No more than two papers should be given at a session (morning or afternoon) and not more than two simultaneous sessions would be held in any one day. There would be no official evening sessions and no official field trips or visits to industrial or research establishments because of security problems. It was also recommended that official social functions be held to a minimum, including possibly a reception on the opening day and a banquet toward the end of each congress.

A congress, it was agreed, should open with a general assembly, and after the opening ceremonies the Daniel and Florence Guggenheim International Memorial Lecture in the Aeronautical Sciences would be presented. The distinguished lecturer would be selected by the Executive Committee and Council. However, the tradition has developed that the host country usually chooses the lecturer, subject to the final approval of the Executive Committee.

During each congress, the Council would meet, to carry out general business, hear reports of the committees, elect officers, deal with time and place for the next conference, and so on. The closing general assembly, in addition to providing a good opportunity for thanking those responsible for organizing the Congress, could serve as a forum for announcing the major decisions of the Council, such as the changes in elected officers and committee chairmen and place and date for the next congress.

Regarding publication of the proceedings of a congress, no translations were to be made; papers would be published in the language of origin. Format for proceedings would be decided later and would be determined largely by budgetary considerations.

It was believed that attendance at the congresses might run between 250 and 500 people. Each delegate would be responsible for his own travel and living arrangements and expenses. Social events, particularly the banquet, would, it was hoped, be self supporting through the sale of tickets to the delegates. The financial responsibility of the "host" country was discussed, and the apportioning of costs between the host and Council was set; it has remained substantially unchanged over the years. At the Paris meeting it was considered that the main responsibilities for the host association would be the provision of a suitable meeting place, with suitable administrative facilities and adequate transportation facilities or arrangements for delegates between hotels and the meeting place. Simultaneous translation services (two or three languages) were deemed to be part of the budget which should be supported by IAS funds.

With the approval of Dr. von Kármán, arrangements were made for Miss June Merker of the AGARD Staff to act as permanent secretarial representative for the Council in Europe. This provided the Council with a convenient mailing address and a focal point for its activities.

Regarding the time and place for the first International Congress, it was agreed that September 1958 was the most desirable period, with the final selection of the week to be made after the dates were known for the SBAC Show at Farnborough and the European Congress. It was decided that the three events should be contiguous, but whether the ICAS Congress should precede or follow the other two was left for a later decision by agreement between the Executive Committee of the Council, AFITA, and others concerned. It had previously been agreed that the first congress should be held in Europe, and if possible in a non-NATO country. Three suggestions were considered: Switzerland, Sweden, and Spain. Dr. von Kármán, from previous inquiries, had ascertained that Madrid would be a desirable location, and he was seconded in this by Col. Perez-Marin, who extended an official invitation to the Council to hold its congress there in September. This invitation was accepted.

The following appointments of members to the three main committees were made. Dr. von Kármán was elected Honorary President of the First International Congress and a permanent member of the Council in his own right, i.e., not representing any specific country or association.

In addition, Professor M. Roy was elected Chairman of the Executive Committee, with Dr. H. L. Dryden, Mr. E. T. Jones, Dr. H. Blenk, and Col. Perez-Marin as members. Paul Johnston, Director of the IAS, was to be an ex-officio member of the Executive Committee. To simplify the planning for the first congress it was decided that this Executive Committee would also function as the Technical Program Committee and be responsible for the selection of the topics and papers to be presented.

An Arrangements Committee was appointed consisting of Col. Perez-Marin as Chairman, with Dr. Wattendorf, Dr. Ballantyne, and Mr. de Faget as members, and with the Controller of the IAS as an ex-officio member. Finally, a publicity release was prepared for distribution to the newspapers and the aeronautical press.

THE FIRST CONGRESS

THE first congress was held September 8-13, 1958, in Madrid, Spain with an attendance of about 500 delegates from some 23 countries. Forty-four papers were presented, including the first Daniel and Florence Guggenheim International Memorial Lecture, which was delivered by Dr. von Kármán on the subject of "Some Significant Developments in Aerodynamics Since 1946." (A complete list of the subjects and lecturers of all the Guggenheim Memorial Lectures over the past 22 years is tabulated in this history.) The program included sessions on most subjects which were then of importance, or destined to become so within the next decade: aerodynamics (boundary layer control; hypersonic flow; supersonic aircraft design), structures and aeroelasticity, heat transfer, jet engines and noise, navigation and guidance, VTOL and STOL, heat resistant materials, human factors, and telecommand and telemetering.

At the Council meeting held during this first congress, the membership of the Council was reviewed and confirmed, and the "Provisional" designation which had been given to the Council was removed. Perhaps a willingness to accept some distinction for being members of this group which had worked so carefully to bring about this new venture in international cooperation led to the adoption of a suggestion that all members of this Provisional Council should become "Life Members" of ICAS. More particularly, this move was seen as essential for guaranteeing the continuation of ICAS and its evolution along the lines laid down by its founders in the two meetings in New York and Paris. It was both a declaration of faith in the survival of the new "baby" and an insurance policy to give it the best chance possible to do so.

Succeeding congresses were held during the "even" years in Zurich, Stockholm, Paris, London, Munich, Rome, Amsterdam, Haifa, Ottawa, and Lisbon. Dr. von Kármán presided over the second and third congresses, but his death in 1963, just four days before his eighty-second birthday, deprived ICAS of his wisdom and leadership into the future. At the fourth congress, in Paris, Maurice Roy presided, having been elected to succeed von Kármán as ICAS President. He also delivered the Daniel and Florence Guggenheim Memorial Lecture, on the evolution of the scientific spirit of Theodore von Kármán.

THE SECOND CONGRESS

IT is unfair, I am sure, to pick out for special mention some of the papers presented at the biennial congresses. After all, the very careful process of selection of the papers is supposed to ensure that all papers have a meaningful relevance to the basic problems in aeronautics in their particular time frames. However, some of the papers are so obviously important to current or anticipated developments, or problems, that I have been brave enough to refer to them in reviewing the activities at past congresses. For instance, the second congress, in 1960, took place at a time when commercial aviation was on the threshold of considerable expansion based on gas turbine powered aircraft. The prospect of commercial operations at supersonic speeds seemed to be feasible, and the Space Age, with all its challenges to technology, had only barely arrived. In a very real way the papers given at the congress reflected this situation in their relevance to operational problems and to aircraft developments yet to come.

Franklin Kolk, of American Airlines, delivered a paper on airline economy in the turbine era, and Walter Georgii, of the Deutsche Forschungsanstalt für Segelflug, spoke on the physics of the jet stream—a meteorological phenomenon which would become of increasing interest with the expansion of long range, high altitude operations. There were five papers which dealt with the fatigue of materials and aircraft structures, including Bo Lundberg's on a statistical method for fail-safe design. D. Küchemann's paper on aircraft shapes for flight at supersonic speeds is of considerable significance in view of his close association, later, with the "Concorde" development program. There were other aerodynamic papers of relevance to transonic and supersonic flight by authors from the NPL (U.K.) and NASA Langley; and Holt Ashley, of MIT, and coauthors gave a paper on the prediction of lifting surface flutter at supersonic speeds. Papers on aerothermodynamic problems of re-entry were presented, and several others discussed the biological and physiological problems to be encountered in a space environment. The paper by A. R. M. Noton, of Jet Propulsion Laboratory, California Institute of Technology, dealt with the guidance of space vehicles by radio measurement and command, surely of interest in the light of subsequent developments in that field.

THE THIRD CONGRESS

THE growing interest in supersonic flight continued to be expressed at the third congress in 1962, with some nine or ten papers dealing with the subject. Many of these were of predominantly scientific interest, but several dealt with design aspects of the SST. One of these, by Maurice D. White and coauthors from NASA Ames, considered design limitations of SST's as identified in piloted-simulator studies, while a second paper by L. F. Nicholson of the Ministry of Aviation (U.K.) was addressed to some of the problems of SST's in the climb and descent phases of flight. A third paper, by G. A. Hoffman, of the RAND Corporation, looked into the pros and cons of using beryllium in the SST aircraft. Perhaps the most challenging of the papers was Bo Lundberg's Guggenheim Memorial Lecture on speed and safety in civil aviation. This was to become just the prelude to a courageous but controversial debate, conducted both in public and at the political level, on the pros and cons of supersonic commercial aviation.

In retrospect it must be admitted, I think, that aeronautical engineers failed to do very much about reducing aircraft noise, until a clamor for action arose within communities everywhere. Yet at the 1962 congress, Professor E. J. Richards delivered an important lecture on airplane noise in the 1970's in which he prophesied that noise would become the limiting factor in the design of transport aircraft, including particularly the SST, and VTOL aircraft.

The possibilities of easier access to air transportation from urban communities, inherent in V/STOL developments, were the inspiration for several papers in the field of high lift. One by Professor Elie Carafoli and N. N. Patraulea, of the Institute of Applied Mechanics, Bucharest, dealt with the influence of lateral jets alone, or in combination with longitudinal jets, on wing lifting characteristics. Another, by Professor H. Schlichting, of the Institute of Fluid Mechanics, Braunschweig, considered the aerodynamic problems of high lift, and a paper by F. J. Drinkwater III and his coauthors, from NASA Ames, was an important contribution to studies of the handling characteristics of V/STOL aircraft, undertaken through flight tests and simulator techniques of investigation.

Third ICAS Congress—Stockholm 1962. Bo Lundberg (from the 'floor') speaks to Dr. von Kármán.

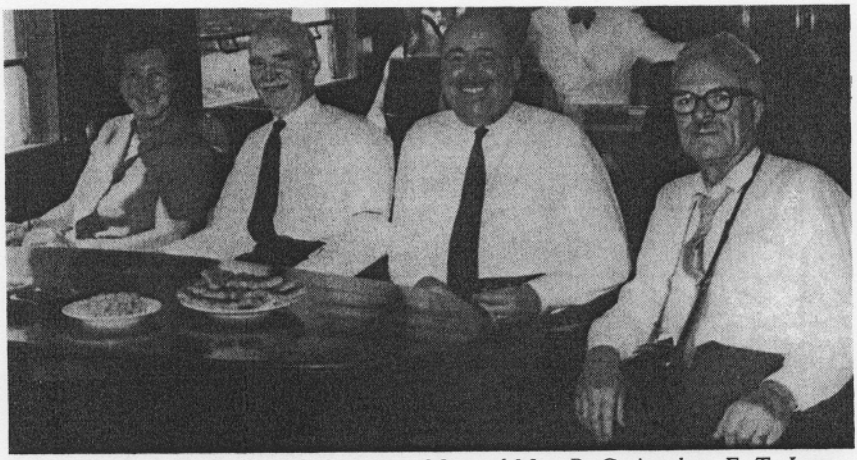
THE FOURTH CONGRESS

AT the 1964 congress, in Paris, both ends of the speed range received attention. Supersonic transports dominated the meeting, with some ten papers relating thereto, with V/STOL running second, with six papers. Sparked no doubt by the concerns expressed in Bo Lundberg's paper at the previous congress, the subject of noise, and particularly that of the SST, received considerable attention. A lead-off paper by H. S. Ribner, of the University of Toronto Institute of Aerospace Studies, discussed noise in general and the then current concepts regarding its generation.

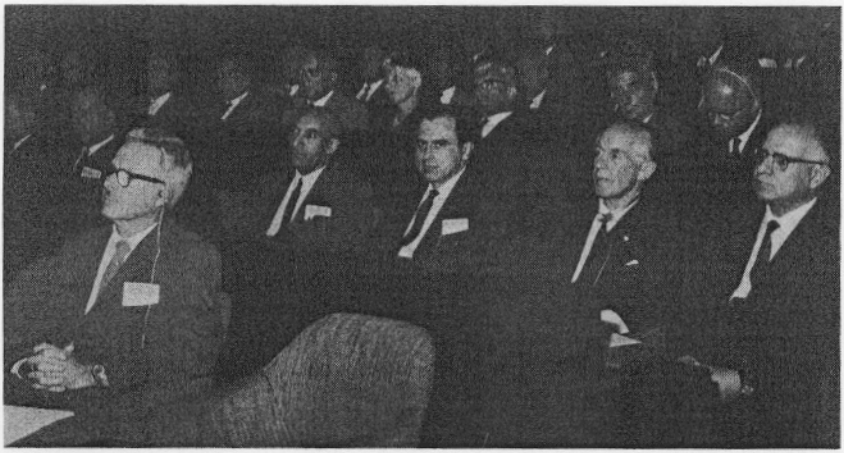
Three papers dealt with the influence of atmospheric variables and nonhomogeneity on the propagation of sonic booms. These were by C. H. E. Warren of the RAE, Farnborough; Harvey Hubbard and Domenic Maglieri of NASA Langley; and Robert Dressler and Nils Fredholm of FFA, Sweden. Five of the SST papers discussed design factors. One of these, by Ignacio Da-Riva and two coauthors, of the Institute Nacional de Tecnica Aerospacial, Spain, discussed results from supersonic combustion studies. Another, by R. J. Atkinson, of the RAE, dealt with the testing of SST structures in fatigue, and a third, by R. Richard Heppe and two coauthors, of Lockheed Aircraft

Mr. Robert Dexter enjoys a talk with Dr. A. M. Ballantyne and daughter Caroline, while the author looks on. Fourth Congress boat trip.

Fourth Congress. Prof. H. ~~Blenk~~ Schlichting and Dr. G. ~~Bok~~ Bock—a relaxed discussion with two other delegates.



Boat trip—Paris 1964—Fourth Congress. Mr. and Mrs. R. Greinacher, E. T. Jones (between them), J. J. Green.



At the Fourth Congress—Paris. At extreme right—Dr. Frank Wattendorf and Dr. Bo Lundberg.

Fourth Congress—Prof. M. Roy, in great form. At table with Prof. Alex Baxter, Bo Lundberg (back of his head) and Charles Tilgner.

Corporation, was concerned with the structural design philosophy adopted by Lockheed for its SST project. Two papers, by W. T. Kehler of the Boeing Company and H. A. Goldsmith of the British Aircraft Corporation, treated the stability and control of the SST at low speeds. Finally, a paper by R. Ceresuela and coauthors, of ONERA, France, dealt with the kinetic heating of the SST.

Looking beyond the SST, three papers considered the hypersonic aircraft. John V. Becker, of NASA Langley, discussed his studies of high lift/drag ratio hypersonic configurations; Charles A. Lindley, of Aerospace Corporation, Los Angeles, talked about air-breathing and rocket engines for hypervelocity aircraft; and Richard J. Weber, of NASA Langley, spoke on propulsion for hypersonic transport aircraft.

Turning to the question of V/STOL, the problems of dynamics and control of VTOL aircraft and the quest for optimal control and stability were investigated and reported in a paper by T. Hacker, of the Institute of Applied Mechanics, Bucharest. D. C. Whittley, of DeHavilland, Canada, presented a paper on the augmentor-wing, a new means of engine airframe integration for STOL aircraft.

For the more down-to-earth engineer, and of particular interest to aircraft fleet operators, there were three papers devoted to mechanical reliability, and the reliability of systems and equipment in aerospace operations.

THE FIFTH CONGRESS

THE fifth congress, in London, in 1966, was held conjointly with The Royal Aeronautical Society's Centenary Congress. At the opening session, H.R.H. The Prince Philip, Duke of Edinburgh, delivered the Centenary Address. The program contained only three papers having relevance to supersonic flight, and the emphasis seemed to have shifted somewhat to hypersonic flight, with five papers devoted to it. Professor Elie Carafoli, of the Institute of Fluid Mechanics, Bucharest, described his linearized theoretical studies of simple and cruciform wing-body configurations in supersonic and hypersonic flow regimes. Arvel Gentry of the Douglas Aircraft Company dealt with techniques for the aerodynamic analysis of complex shapes in hypersonic flow and demonstrated the use of this analysis in design studies. Professor L. F. Crabtree and D. A. Treadgold, of the RAE (U.K.), discussed wind tunnel results on simple delta-like shapes of lifting bodies as the basis for future hypersonic aircraft, concentrating in general on wave-rider shapes and including low speed studies of handling qualities and stability for typical landing conditions. Finally, Ph. Poisson Quinton and R. Ceresuela, of ONERA, France, reported on wind tunnel tests on the efficiency and heating of control surfaces and spoilers at hypersonic speeds. At an even more practical level, R. R. Heldenfels, of NASA Langley, talked about structural prospects for hypersonic air vehicles and the selection of configurations and materials to meet the requirements. G. Y. Nieuwland, of NLR, Amsterdam, contributed a significant paper on the theoretical design of shock-free transonic flow around airfoil sections.

Since ICAS itself is dedicated to international cooperation, a paper by Sir George Edwards on Anglo-French collaboration, which discussed the present position and gave some thoughts on the future, was a welcome and instructive addition to our deliberations. It is significant that, in the congresses which followed this one, there was a growing number of papers which discussed similar international projects, sometimes involving more than two countries.

Also of particular significance at this congress were several papers which dealt with highly important operational problems or developments in commercial aviation. First I would mention John C. Houbolt's paper (Aeronautical Research Associates of Princeton, Inc.) on the development of power spectral techniques for the design of aircraft to gusts. Also, there was the paper by Abe Silverstein, of NASA Lewis, on progress in aircraft gas turbine engine development, which drew attention to the future design potentials and summarized some of the work in progress. There was a paper by O. B. St. John, of the RAE, Bedford, and R. C. Morgan, of British European Airways, on all-weather landing in the U.K. Of all possible future developments in commercial aviation, this is, to my mind, one of the most pressing. Yet despite the good work done at the RAE and elsewhere, the solution to this problem, in a manner completely acceptable to the regulatory agencies, eludes us.

The paper by J. E. Pateman, of Elliott Flight Automation Ltd.; Rochester, U.K., on the place of inertial navigation in the navigation of transport aircraft, was both important and timely. This system of long-range, over-ocean

navigation was, at that date, the only practicable system to provide the accuracy and, in due course, the reliability which could safely permit a greatly increased exploitation of the air space available on such routes.

There were only two papers on VTOL and none on STOL aircraft at this congress. Of major significance, however, was the attention given to human pilot factors, with four papers devoted to this important subject, as follows. Group Captain A. J. Barwood, of the RAF Institute of Aviation Medicine, spoke on the medical aspects of skill, and H. Schmidtlein, of the Technische Hochschule, Darmstadt, gave a paper dealing with the problems of the human pilot transfer function at "anticipative" disturbances of flight motion. D. E. Beeler, of NASA Edwards, discussed the optimization of aircraft performance and mission completion through research on the pilot and aircraft as an overall system. In the same vein, H. Frohlich and two coauthors, of Dornier Werke, Friedrichshafen, gave a paper on new techniques in investigating handling qualities based on the "pilot-aircraft" system.

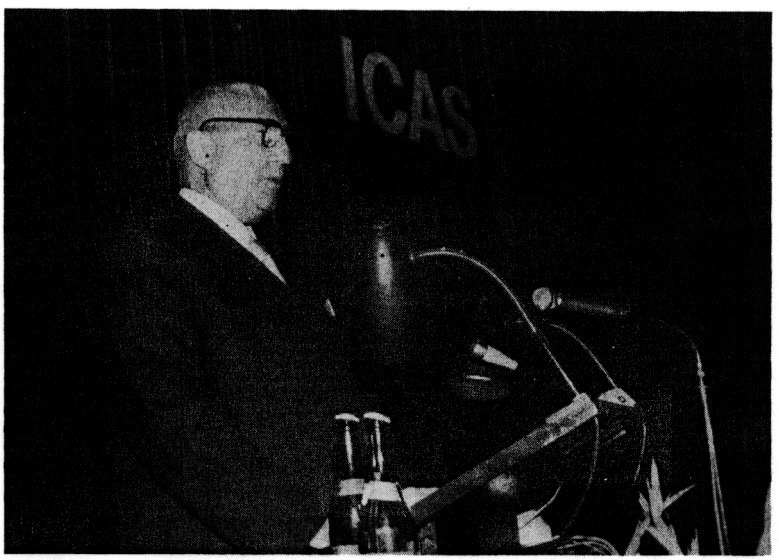
COMMENTARY

LOOKING back on these first five congresses, the number of papers presented jumped from 44 at the first to 56 at the second, declining thereafter to 49 at the fourth and fifth congresses. Since then, the number has climbed to 59 or 60 at each congress, with the exception of 1972, when it was 56, and 1978, the eleventh congress, when a record of 67 papers were submitted.

In analyzing the programs of past congresses, I have attempted to single out a number of papers which show an easily recognizable relationship to the pathway of aeronautical development over the years. Some of these were particularly "newsworthy" in this regard and quite obviously would have attracted the interests of a broader audience of professional people. My analysis has, of necessity, done less than justice to the many authors who delivered specialist papers of less general interest, or less obvious relevance to the scientific and engineering problems of the day. Nevertheless, it must be said that at every congress there has been a large number of excellent papers which were of very considerable interest to specialists in the same field. Speaking generally, these papers represented an advance in our knowledge of specific subjects and have thereby contributed to understanding and development in aeronautics. Always of significance is the appearance of a number of papers in each subject which deal with slightly different facets of the same problems, thereby mutually enhancing their value, and "rounding out" the picture presented to the audience for its understanding and assessment. My remarks are particularly directed to the many papers on structures and their behavior under various loading conditions, to those on materials and their properties in operational environments, and to those numerous papers which dealt with new and advanced research equipment or techniques for experimental investigation of problems new and old.

THE SIXTH CONGRESS

AT the sixth congress there were two main themes, noise and VTOL/STOL, with some eight or nine papers directed to each of these subjects. In a paper by Friedrich R. Grosche, of AVA, Göttingen, experiments were described on the shielding of noise from air jets issuing from slot nozzles. An analysis of jet noise and boundary layer noise was given in the paper presented by O. Bschorr, of Entwicklungsring Süd, G.m.b.H., Munich. In another paper, on the problem of noise in the civil gas turbine aero engine, Michael J. T. Smith, of Rolls Royce, Nottingham, gave attention to turbine noise, in the context of other component noise sources. He discussed its generation and propagation and related the question of its suppression to current research activity. Hermann Oberst, of Farbwerke Hoechst, Frankfurt, read a paper on the reduction of noise by the use of optimized vibration damping materials which seemed to offer the promise of improved sound insulation, a reduction in the noise generated, and a diminution of acoustic fatigue. The paper from Robert L. Miller and John B. Large, of the Boeing Company, Seattle, considered the question of aircraft noise propagation and the ability of various methods to predict accurately the exposure to such noise for communities adjacent to airports. The results of recent NASA research on aircraft noise and sonic boom alleviation were given in the paper by Harvey H. Hubbard and his two coauthors, of NASA Langley. This dealt with the design of engine components to minimize noise generation and radiation, and the operation of aircraft to alleviate noise exposure on the ground. Finally, there were two papers which dealt with sonic boom propagation, one by Antoni Tar-



Prof. Maurice Roy—opening session—Sixth ICAS Congress— Munich 1968.

Opening session—Sixth ICAS Congress—Munich 1968.

nogrodzki, of the Technical University of Warsaw, which treated real atmospheres (nonhomogeneous, non-still), and the other by Robert F. Dressler, of the Aeronautical Research Institute of Sweden, which examined cut-off booms and random winds, both experimentally and theoretically.

Of the VTOL/STOL papers, with only one exception they all dealt either with practical applications or development problems. The exception was the paper by Zbyněk Jaňour and Vilém Kočka of the Aeronautical Research and Test Institute, Prague, which discussed the results of wind tunnel research on the effects of boundary layer control by blowing, for wings with flaps, and flight test results for an experimental aircraft designed on the basis of the wind tunnel research. Rudolf Jenny, of the Eidgenössische Technische Hochschule, Zurich, considered the exhaust gas recirculation problem with VTOL aircraft, and Barry Laight, of Hawker Siddeley Aviation, Surrey, presented a paper on the development problems of V/STOL aircraft. R. A. Tyler and R. G. Williamson, of the National Research Council, Canada, discussed a vectored thrust powerplant for commercial V/STOL operations, describing the system design considerations and the results of preliminary model tests, while R. M.

Lucas and J. H. Dale, of Rolls Royce, Derby, gave another paper on combined lift and propulsion which indicated the benefit of vectoring at least part of the installed thrust. A paper describing research and development of advanced rotorcraft concepts was presented by Evan A. Fradenburgh of the Sikorsky Division of United Aircraft Corporation, Connecticut. Turning to the question of the application of V/STOL to operations, there were three papers which were relevant to this aspect of the subject. S. Bernstein, of Canadair, Montreal, gave a paper which examined the characteristics of the CL-84 Tilt Wing aircraft and its general suitability for operational roles as utility transport and close support. Short haul commercial transport applications were also examined.

Researches on the use of STOL aircraft in civil transport were also reported in a paper by A. Salvetti, of the Institute of Aeronautics, University of Pisa, specifically for short-haul roles in Western European countries. The study evaluated an appropriate configuration of aircraft and was to be followed by the design and development of a powered flying model to investigate low speed flight behavior. Finally, Norman W. Boorer and Bernard J. Davey, of British Aircraft Corporation, delivered a paper based on general studies of the characteristics and problems associated with V/STOL operations of civil aircraft. It looked at the parameters favorable to performance and meeting the certification rules for this type of aircraft, examined the role of electronics in all-weather operations, and discussed competition from surface transport, and the V/STOL airport requirements.

There were some four papers dealing with supersonic flow, covering such matters as the computation of wing-body interference effects, the calculation of the flow around blunt bodies, and a discussion of variable geometry requirements for inlets and exhaust nozzles at high Mach numbers.

An important paper by B. M. Spee and R. Uijlenhoet, of the National Aerospace Laboratory, Amsterdam, gave experimental confirmation of the shock-free transonic flow around quasi-elliptical airfoil sections, the theoretical possibility of which had been suggested in G. Y. Nieuwland's paper delivered at the fifth congress.

Six papers were devoted to fatigue, several of which dealt with the operational situation, under such titles as "Inspection Intervals for Fail-Safe Structures," "Damage Tolerance and Logistic Transport Design," and "Allowable Fatigue Stresses for a Given Lifetime."

Progress of NASA programs for the development of high-temperature alloys for advanced engines was reported in a paper by John Freche and Robert Hall, of NASA Lewis.

Finally, Jerome Lederer, of NASA, gave a lecture forecasting air transport safety problems in the 1970-1980 decade.

THE SEVENTH CONGRESS

THE seventh congress, in Rome, celebrated the 50th anniversary of the establishment of the Associazione Italiana di Aerotecnica. By this time, 1970, ICAS itself was well into its second decade of existence, securely established and with its biennial congresses functioning smoothly and successfully, and the organization itself operating satisfactorily within its financial constraints. The papers at this congress grouped more clearly into a few themes than had perhaps been the case at earlier congresses. Typical themes were V/STOL (9 papers), transonic and supersonic flight (9 papers), hypersonic flight (9 papers), fatigue (7 papers), aircraft design (7 papers), and noise (4 papers). In addition, there was a paper, from Eurocontrol, on automatic conflict detection and resolution in the planning of air traffic control, and a paper which discussed comparative studies of international aerospace management.

Of the V/STOL papers, one was concerned with the achievement of increased wing lift coefficients through the use of air jets, blowing in a spanwise direction. Two of them dealt with helicopter rotors, one of which described rotor tests in the large wind tunnel at Modane, and the other considered the design problems of five types of low-disk-loading, high speed VTOL aircraft. Presented by Robert Lichter, of Bell Helicopter Company, Fort Worth, it concluded, from the success of the helicopter, that future high speed VTOL aircraft would utilize such rotors in the vertical lift mode, with several options for their use or disposition in the level flight mode. His paper analyzed these at length and examined the pros and cons. Two of the papers dealt with design aspects of VTOL aircraft dictated by space limitations. The paper by J. W. Fozard, of Hawker Siddeley Aviation, revealed how the space configuration requirements for vectored thrust conflict with those for transonic performance in the case of a fighter aircraft. D. C. Whittley, of DeHavilland, Canada, similarly revealed that ejector powered VTOL aircraft require most of the useful fuselage space for the ejector system. In his paper he described new configurations in which the ejector system is contained within the root section of the wing. In a paper by E. D. Foy, of LTV Aerospace Corporation, Dallas, which discussed descent capability, landing performance, and impact criteria for V/STOL, the interplay and trade-offs between these design objectives were examined, with particular regard to STOL landings in less than 1000 feet.

Four of the transonic-supersonic papers dealt with transonic flow. The paper by H. H. Pearcey and J. Osborne, of the NPL, Teddington, was a good general review of the various features and problems of transonic aerodynamics. Two of the papers described methods for the calculation of transonic flowfields, while the fourth, by J. W. Boestoel and R. Uijlenhoet, was yet another paper from the National Aerospace Laboratory, Amsterdam, on lifting airfoils with supercritical shockless flow, utilizing the hodograph theory for quasi-elliptical airfoils expounded in Nieuwland's original paper at the 1966 congress. Three of the supersonic flight papers dealt with aspects of propulsion. A paper by D. Zonars, of USAF Systems Command, Wright-Patterson AFB, focussed on inlet and nozzle problems which reflect adversely on flight performance. Similarly a paper from RAE, Bedford, considered the

Canadians at Seventh ICAS Congress—Rome 1970.

external drag of fuselage-side intakes for a strike fighter aircraft at subsonic and supersonic speeds. The third paper, by W. G. E. Lewis and F. W. Armstrong, of the National Gas Turbine Establishment (NGTE), U.K., described experiments on two-stream propelling nozzles for supersonic aircraft, a high level of propulsion efficiency for such nozzles being essential for a successful SST. One paper, by Paolo Santini, of the University of Rome, discussed his researches on the structural nonlinearity of aeroelasticity in problems of supersonic flight, and another, by John Swihart, of the Boeing Company, was devoted to the operation and economics of the SST, based on Boeing's SST design project.

Of the hypersonic flight papers, four of them dealt with re-entry vehicles. Of these, two were concerned with the aerodynamic and other problems of re-entry, and the other two were devoted to studies of the configuration of re-entry vehicles using wind tunnel tests to develop satisfactory characteristics. Three of the hypersonic papers considered the heat transfer problem, and one of these examined the fundamental aspects of using ceramic composite materials in the structure. In a paper from ONERA, France, R. Ceresuela described a wind tunnel program to investigate the stability and control of various configurations of hypersonic aircraft. Finally, John Becker, of NASA Langley, in a broad, general lecture, discussed new approaches to hypersonic aircraft and the strongly interacting requirements in the aerodynamic, structures, and propulsion systems which offer the potential for improved vehicles. The use of hydrogen fuel for cooling of the entire airframe was considered in detail.

Of the seven papers devoted to fatigue, two of them dealt with the comparison of methods and conclusions between tests on small specimens and on large scale components. Another paper investigated the fatigue properties of alloys as affected by temperature, while a fourth, by L. Lazzarino and A. Salvetti, of the University of Pisa, described theoretical and experimental research on the fatigue behavior of reinforced sheets. This work has enabled both the causes of fatigue cracks and their subsequent effects on the behavior of such structures under load to be studied.

Turning to the aircraft design papers, two of these were concerned with the application of flight simulation to aircraft design—a powerful technique which also reduces development time and costs. Two more papers described the application of modern computer techniques in aircraft design problems, and a fifth paper reviewed stability augmentation in aircraft design and its potential benefits to performance, handling, and operations. Professor F. C. Haus, of the Universities of Ghent and Liege, reviewed the evolution of handling qualities requirements and the modern method of assessment which depends on both practical (test pilots' evaluations) and theoretical (transfer functions of system elements) approaches.

Two of the "noise" group of papers considered the sonic boom, one being theoretical and the other concerned with the practical aspects and approaches to minimize the boom intensities. The other two papers dealt, respectively, with the silencing of jets and an experimental method for analyzing the source of compressor noise and jet noise.

THE EIGHTH CONGRESS

THE eighth congress, in Amsterdam, was under the distinguished patronage of H.R.H. Bernhard, The Prince of the Netherlands. At the Council meeting during this congress, Professor Roy was elected Honorary President of ICAS, and he was succeeded in the Presidency by the writer, who had, since 1966, been Chairman of the Executive Board. Dr. Raymond L. Bisplinghoff, of the U.S., succeeded me in this latter position. The papers at this congress again tended to group themselves into a relatively small number of themes—e.g., V/STOL (6 papers), noise (7 papers), transonic flow (2 papers), supersonic-hypersonic flight (13 papers), materials (8 papers), flying qualities (3 papers). It was significant of the times, perhaps, that a number of the papers were concerned with the "community aspects" of aviation developments.

Of the six V/STOL papers, four of them dealt with noise, and all four considered community aspects of the noise. The paper by W. Z. Stepniewski,

Amsterdam 1972—Eighth Congress of ICAS. Opening by Prof. M. Roy.

of Boeing/Vertol, and Fredric Schmitz, of the U.S. Army, discussed the possibilities and problems of achieving community acceptance of VTOL noise, based on noise reduction at the source by design considerations and trade-offs, and flight path management in the terminal area. It proposed a method for evaluating "total community annoyance."

The paper by Donald L. Button, of the Ministry of Transport, Ottawa, described a prototype demonstration system established between specially constructed STOL-ports in Ottawa and Montreal to assess passenger and nonpassenger public acceptance of STOL operations, and to develop standards, criteria, and regulations for STOL. Harvey Hubbard, of NASA Langley, and two co-authors gave a paper on noise control technology for jet-powered STOL vehicles which, again, was a mix of sophisticated design features for noise reduction at source and a study of the subjective reactions of people to noise exposure of various characteristics.

The paper by Martin V. Lowson, of Loughborough University, U.K., discussed noise reduction from V/STOL aircraft, with methods of computing the combined noise radiated from the various sources for a variety of V/STOL aircraft. It then gave a brief review of community acceptance factors, leading to an overall evaluation of potential community response to the various systems.

In addition to these four papers, there were three other papers on noise. That by J. D. Voce and J. Simson, of Rolls Royce, Bristol, was a contribution to our understanding of "jet noise," with a careful analysis of the internal noise, which revealed the greater complexity than would be suggested by classical theory. On the same subject, J. Taillet, of ONERA, France, gave a paper which described work done on a method for defining the sources of noise in jets based on the measurement of infrared emissions. NASA engine noise research was discussed by James J. Kramer and Robert G. Dorsch, of NASA, Washington, D.C., with emphasis on fan noise suppression from the NASA Quiet Engine program.

Of the transonic flow papers, one by Lars Ohman and two coauthors, of the NAE, Canada, gave the results from two-dimensional, high R.N. pressure distributions, force measurements, and wake surveys for "shockless" and other airfoils. Comparisons were made with theoretical pressure distributions and other experimental results. The other, by W. Stahl and two coauthors, of DFVLR, AVA Göttingen, examined whether it was possible for the flowfield of a very slender delta wing, with all its favorable properties, to be retained in a wing-body combination over a speed range from subsonic to supersonic. Forces and pressure distributions were measured, and flow visualization techniques were utilized.

Considering the super-hypersonic flight papers, a general lecture based on the work of Richard H. Petersen and Mark H. Waters, of NASA Moffett Field, gave an economic analysis of hypersonic transports (direct and indirect operating costs and return on investment) for a range of assumptions and also discussed their environmental effects, including noise and sonic boom, in comparison with current transports. Bo Lundberg gave a paper on the economic and social aspects of commercial aviation at supersonic and hypersonic speeds, which followed by ten years his previous paper on the SST.

This paper provided a lively discussion because of its controversial treatment of the economics and social effects of SST's and even more pessimistic views of HST aircraft operations.

There were three papers devoted to the propulsion aspects. One of these, by Jean Surugue and Jean Fabri, of ONERA, France, was a contribution to the experimental study of a somewhat poorly understood subject, the nature and configuration of the flowfield in supersonic compressors. The other two papers, by Pierre Contensou and two coauthors, from ONERA, France, and E. Krause and two coauthors, of DFVLR, Porz-Wahn, Germany, considered aspects of combustion. The former examined a mixed combustion engine (subsonic combustion followed by supersonic combustion in the same chamber) for hypersonic vehicles. The latter dealt with problems of combustion at supersonic and hypersonic speeds.

Four of the papers treated the space shuttle, or re-entry vehicles, one of which reported on the boundary layer characteristics; two others discussed aerodynamic heating investigations of re-entry; and the fourth dealt with the discontinuity stresses in the main propellant tankage of a space shuttle orbiter.

Of the papers which considered structural materials, five were directed to composites. The stage was set for a discussion of this most important subject by a general lecture on weight saving by composite primary structures,

Eighth ICAS Congress—Amsterdam 1972. Visit to NLR supersonic wind tunnel (SST).

delivered by Professor U. Hütter, of the University of Stuttgart. He spoke about fiber/matrix composites and how the optimum weight saving depends not only on component strength/weight ratio, but also on sophisticated design configurations. Cost-effectiveness was also discussed. Alan M. Lovelace and two coauthors, of USAF Systems Command, Wright-Patterson AFB, reviewed the need for much broadened application of advanced composite technology to systems and discussed the barriers which inhibit this transition from technology to application.

J. J. Choury, of the European Society of Propulsion, France, discussed heated re-impregnated materials (carbon-carbon), a new family of composites having good mechanical strength and thermal shock resistance, dimensional stability at high temperatures, and low thermal conductivity. Fabrication of them is complex. A fourth paper, in two parts, by Z. Hashin (Part I) and S. R. Bodner (Part II), of Technion, Israel, discussed the dynamic inelastic properties of materials. Part I dealt with the damping characteristics of fiber composites, and Part II with time-dependent characteristics of metals, such as strain-hardening, strain rate effects, and inelasticity. The fifth paper, by C. N. Owston, of Cranfield Institute of Technology, U.K., described the work at Cranfield to reveal the defects which caused fiber reinforced polymer composite materials for components to fail below their design performance, and methods for the nondestructive location and assessment of such defects.

Other papers dealt with holographic methods for assessing the quality of adhesive bonded metal joints, the determination of creep characteristics, and fatigue crack propagation in stiffened panels.

It is of interest that all three papers on flying qualities dealt with low speed control. A paper by W. J. G. Pinsker, of RAE, Bedford, discussed low speed control, focussed mainly on the approach and landing, where the most severe demands on low speed control are met. Another, by H. A. Mooij and W. P. de Boer, of NLR, Amsterdam, envisaged the development of much larger aircraft than the present jumbo jets, and, considering that the approach and landing phase will be the most demanding, they estimated characteristic parameters for the handling qualities of two aircraft of twice and eight times the weight of current jumbo jets and discussed these in the light of contemporary regulations. They felt that they had clearly demonstrated the need for command augmentation flight control systems and direct lift control.

The third paper, by Irving L. Ashkenas and Samuel J. Craig, of Systems Technology Inc., California, analyzed the multiloop piloting aspects of low speed flying qualities to show the conditions under which air speed and climb rate are "coupled," and used a simple simulator technique to illustrate the effect of pilot technique and background on tolerable coupling.

There were three papers on propulsion, one of which dealt with inlet and engine compatibility, and another with the development of inlet flow distortion in multistage compressors of high hub-tip ratio. The third paper considered basically the same subject from the point of view of technological advances in airframe-propulsion integration.

The program also contained two papers on air-traffic control which focussed on future advances and methods for improved performance of ATC systems.

THE CONSTITUTION OF ICAS

FOLLOWING the eighth congress, the Council decided that ICAS needed a constitution. A draft constitution was prepared by the President and the Executive Secretary with the assistance of a small group: H. C. Luttman, secretary of CASI, A. M. Ballantyne, secretary of the R.Ae.S., and W. Schulz, of the DGLR. This was tabled at the meeting of the Council in Haifa during the ninth congress, but received the required approval by two-thirds of the member associations in June 1975.

The constitution regularized a number of actions and activities which had become almost traditional for the smooth functioning of the organization and its biennial congresses. Changes were also made in past practice, the most important being as follows: Under the constitution, Council members would be appointed by their respective member associations for a term normally of four years and be eligible for one additional term. Most officers would normally serve a term of two years and be eligible for re-election. The President and Chairman of the Program Committee would be restricted to two terms of office.

The intention was to keep ICAS a vital organization through infusion of new blood and ideas. Since the Executive Board had never functioned as a true executive committee, but rather as a program committee, the constitution called for the formation of an Executive Committee consisting of the officers plus two to four additional members elected by the Council and a Program Committee of not fewer than seven members. Under the constitution, member associations were to pay annual subscriptions in amounts determined from time to time by the Council.

In 1974, for the first time, ICAS fulfilled one of the prime functions suggested for it at the founding meeting in New York and spelled out in Paul Johnston's editorial in the *Aeronautical Engineering Review*—"to bring together groups of specialists...to discuss particular programs or projects." After receiving an invitation to do so, it sponsored the Second International Symposium on Air Breathing Engines, held in Sheffield, England, March 24-29, 1974. Subsequently, ICAS also sponsored the third and fourth of these symposia, in Munich (March 1976) and in Orlando, Florida (April 1979).

THE NINTH CONGRESS

AT the ninth congress, in Haifa, Israel, ICAS joined with Technion—Israel's oldest institution of higher learning—in celebrating "Technion Jubilee Year" (the academic year of 1973-74). Major General (Res.) Amos Horev, President of Technion, participated in the opening session of the congress. At first glance, the program for this congress might have appeared to be too esoteric, and far removed from the problems of aircraft designers or operators. Gone were the speculative papers on supersonic and hypersonic transports and V/STOL aircraft. Even conjectures about community acceptance of this or that kind of development were missing from this program. A closer look, however, would have revealed that the majority of papers were aimed at immediate or near future prospects for beneficial developments and advances in aviation. Moreover the papers seemed to take due cognizance of the problems facing the aircraft designer in extrapolating the results from wind tunnels and structural laboratories to actual aircraft, where the conditions often present important differences. Such papers really fell into only five groupings. There were 21 papers on aerodynamics, 13 dealing with structures and materials, 15 papers directed to operational problems (including noise), and 5 papers on propulsion.

Considering aerodynamics, its most striking application at that time was in the SST, with the "Concorde" already flying, but still in question on the score of economics and general acceptability. For the distant future there were the possibilities of hypersonic flight. As for the present, the world's airlines and

Haifa, Israel—Ninth Congress 1974. Mr. G. Yaacobi, Minister of Transport, addressing the opening session. Prof. Josef Singer is amused.
General Horev

public had accepted jet travel, and its growth had been phenomenal. Between the performance of current jet transports and that of the SST lay a great gulf. Surely this could be closed somewhat, to improve both the economics and the convenience of jet travel. Even a modest delay in the drag rise which accompanies the approach of the flight speed to the speed of sound would be a very real gain. It was Prof. Nieuwland's paper which first discussed the possibility of "shockless" transonic airfoils at an ICAS congress in 1966. The theme was continued, albeit by only one or two papers, at each succeeding congress. But at the Haifa congress, eight years after Professor Nieuwland's paper was presented, there were some six papers which discussed research on "supercritical" airfoils, revealing that four other countries (U.K., U.S., Japan, and Canada) had active research programs in this field.

A good lead-off paper by Richard T. Whitcomb, of NASA Langley, reviewed the work done on NASA supercritical airfoils, discussing the basic phenomena and typical wind tunnel results, which showed a 10% delay in drag rise Mach numbers compared with a comparable "conventional" series airfoil. He also summarized the flight demonstration programs, which were using three test-bed aircraft with supercritical airfoil wings. From the National Aerospace Laboratory, Tokyo, came a paper by Takashi Shigemi, on recent studies of the flow over transonic airfoil sections, comparing the results with theoretical computations using a modified hodograph theory to give exact solutions, with good agreement with test results.

M. G. Hall and M. C. P. Firmin, of the RAE, Farnborough, gave a paper which first described recent work on the development of a finite difference method for computing the inviscid three-dimensional, transonic flows about wings. A second part of the paper was devoted to an estimation of the viscous effects in flows about two-dimensional airfoils. J. J. Kacprzynski, of the NRC, Canada, delivered a paper which dealt entirely with the viscous effects on transonic flow, to which supercritical airfoils are very sensitive. Even at very high Reynolds numbers wind tunnel results show large differences from inviscid flow. He discussed methods of calculating viscous transonic flow and revealed the difficulties in reconciling wind tunnel results.

Yet another paper, a joint effort between David J. Peake and two coauthors, of NRC, Canada, and Hideo Yoshihara, of General Dynamics, Convair Division, San Diego, described an experimental program on transonic lift augmentation of two-dimensional supercritical airfoils by aft camber, slot blowing, and jet flaps, in high Reynolds number flow. It showed the superiority of the jet flap with slot blowing. The knowledge that Reynolds number effects are of major importance was the basis of another NRC, Canada paper by E. Atraghji and H. Sorenson, which investigated these effects for a swept-wing-body configuration with high lift devices, at speeds up to supercritical Mach numbers.

Attention to the importance of viscosity and Reynolds number effects was also underlined in two papers from Sweden, although not concerned in these cases with supercritical airfoils. Bjorn L. G. Ljungstrom, of FFA, discussed experiments on the viscous flow effects for high-lift-producing multielement airfoils. The study concentrated on the interaction of the different viscous layers (the conditions being varied by suction) and compared the results with

an appropriate viscous multielement method of calculation. The other paper, by Sven-Olof Ridder, of the Royal Institute of Technology, Stockholm, was concerned with the leading edge suction force, including the maximum attainable suction force with variation of Reynolds number, and the induced suction force distributions on various wing planforms, wing-body configurations, and air intakes, in the R.N. range where the laminar flow separation bubble strongly influences the flow.

Two of the aerodynamic papers were directed to an operational problem—ice deposition on wings. The first, by J. W. Flower, of the University of Bristol, investigated ice deposition on the upper surfaces of slender wings, which cannot be easily reproduced in icing tunnels. He first developed a novel experimental technique, using small glass beads in a water tunnel to simulate supercooled water droplets entrained in the space above the wings. A simplified theory was then developed for the case of low icing rates in which the water tunnel technique is difficult to apply. The other paper, by Boris Laschka and Rudolf Jesse, of Messerschmitt-Bolkow-Blohm, Munich, determined the ice accretion shapes and their effect on aerodynamic characteristics for the unprotected tail of the Airbus A-300 B aircraft. The most severe icing conditions to be expected were investigated; theoretical calculations and analysis of ice shapes, based on impingement analysis, were made; icing tunnel tests were conducted; and aerodynamic data with ice accretion were established.

Turning to "structures," one of the most significant papers to which my opening remarks about the program apply was presented by Josef Singer and Avin Rosen, of Technion, and it concerned the development of design criteria for buckling and vibration of imperfect stiffened shells. Classical theories for buckling and vibration based on "ideal" materials devoid of imperfections, and with "ideal" boundaries, are suspect in their application to the world of real materials. This paper reviewed recent advances in methods for predicting buckling of stiffened shells, together with the influence of imperfections, boundary conditions, and inelastic effects, correlated with test results. From these, realistic design criteria were developed for the buckling of loaded stiffened shells. Similarly, realistic design criteria were developed for the vibration analysis of such shells. The use of vibration testing as a nondestructive method for checking actual boundary conditions and for predicting buckling loads was also discussed and compared with tests.

Another such paper, by A. van der Neut, of Delft University of Technology, discussed the influence of imperfections on the interaction of the two modes of buckling (from local buckling loads, and from Euler buckling loads), considered to be optimal when coincident. Imperfections cause failure below the smaller of the two pure buckling loads. The paper described the use of a simplified model to demonstrate the significance of the interaction for real panels and when the two pure buckling loads were close to equality.

Yet another paper of immediate utility was concerned with the fail-safe characteristics of built-up sheet structures, typical of aircraft construction. This paper, by H. Vlieger, of NLR, Amsterdam, discussed the need for reliable inspection procedures and a thorough knowledge of fatigue crack propagation and residual strength characteristics, if the concept of fail-safe structures is to be acceptable in aircraft operations. The literature gives much

data on crack propagation and residual strength for unstiffened sheets, but not for built-up structures. NLR has done much work on these problems, and this paper presented some of the computational results for stiffened panels using unstiffened sheet data and accounting for the stiffener interaction. Results were compared with experimental data.

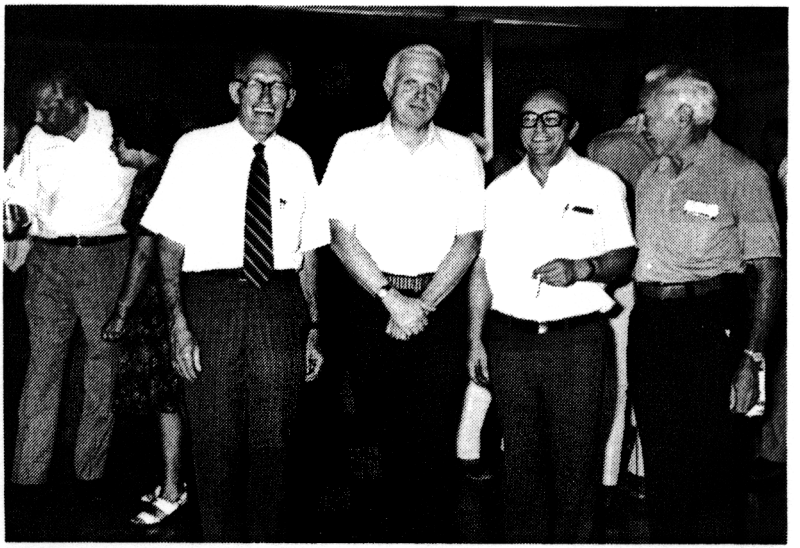
A paper by G. Cavallini and A. Salvetti, of the University of Pisa, discussed the problem of the natural modes of vibration of thin-walled stiffened structures, and the results of their study of them by both theoretical and experimental procedures. The theoretical method took into account rigid displacements and also distortions of the stringer cross section. Satisfactory agreement with experimental results was obtained which underlined the importance of cross-section distortion insofar as the stress state in the stringer was concerned.

An interesting practical problem is the influence exerted by the sloshing of liquid in tanks at the extremeties of wings on the natural vibration modes. This was examined in a paper by R. Valid and R. Ohayon, of ONERA, France, using a method of calculation based either on the fluid finite elements or using a step-by-step method, or simply from the perturbations of the vibration modes selected initially.

Of the aeroelasticity papers, two of them were related to the Saab Viggen aircraft. The first, by Valter J. E. Stark, of Saab-Scania, Sweden, described the development of a Fortran program, based on the so-called polar coordinate method for calculating the aerodynamic forces on oscillating wing configurations in subsonic flow. The paper gave the results from an application of this program to the Viggen aircraft. The second paper, by J. Kloos and S. G. L. Elmeland, of Saab-Scania, presented the methods for computing static aeroelastic effects on the aerodynamics of the canard configuration of the Viggen, for subsonic and supersonic speeds. Wind tunnel tests were used as a check on the method and for interpolating through the transonic range. Finally, flight test results were given and compared with those from the theoretical and wind tunnel work. The third paper, by Paolo Santini and two coauthors, of the University of Rome, Italy, discussed the structural optimization, under constraints of whatever kind, first for the case of conservative forces and then taking nonconservative forces into consideration. Applications to aeroelasticity were presented.

Of major interest were the papers on new materials and structures. William R. Johnston, of the USAF Flight Dynamics Laboratory, Wright-Patterson AFB, discussed advances in the reduction of the effects of fatigue. Guided by refinements in the subject of fracture mechanics and crack propagation theory, new metals have emerged with slower crack growth rates, and new design concepts for metals which avoid past problems. Additionally, new advanced composites are here which show different properties and damage characteristics. The application of these, particularly the composites, calls for new design techniques which for the composites has added a new dimension —the designing of the material.

A similarly important paper was given by Donald G. Smillie and David M. Purdy, of Douglas Aircraft Company, which considered advanced material applications to subsonic transport aircraft. They stated categorically that this



Ninth ICAS Congress—Haifa 1974.
Prof. and Mrs. Thieleman, Dr. R. L. Bisplinghoff, Dr. R. T. Whitcomb, Dr. Roth—Senior V.P. Israel Aircraft Industry, Dr. Rosen (United Aircraft).

was the technology area which offered the greatest potential for aircraft system improvements, and they defined and evaluated this role for the new materials. The effects, in terms of system economics and vehicle performance, were quantitatively examined for commercial and military aircraft systems, including the impact on contributing engineering and other disciplines. Plans for incorporating such materials were discussed, and an R&D program for developing the technology was outlined.

Two papers considered high temperature materials. The paper by Wolfgang Bunk, of DFVLR, Porz-Wahn, discussed composites for gas turbine blades, with the promise of higher efficiencies from higher operating temperatures. The paper by Luigi Broglio, of Centro Ricerche Aerospaziali, Rome, studied the thermal transient and the thermoelastic stresses due to kinetic heating and radiation for a re-entry body of composite structure, assuming variation with temperature of both the thermal and the elastic coefficients.

In his paper on the automation of the design process, R. R. Heldenfels, of NASA Langley, reviewed what had been done in this development, with emphasis on structural analysis and design, but concluded that current computer hardware and software technology could be exploited more fully to create advanced aircraft designs better, faster, and cheaper than with current procedures.

In the group of papers which dealt with operating problems, three of them considered the emission of pollutants, especially NO, by aircraft engines and concluded that the problem was amenable to solution. Three of the papers

were directed at noise research. The first, by F. W. Armstrong, of the NGTE, U.K., described the evolution of noise research at NGTE since the 1950's and gave results from recent work on jet and associated exhaust system noise, fan noise, and the behavior of absorbent linings for powerplant ducts. Gunnar Helstrom, of Saab-Scania, discussed noise shielding configuration tests (engine positioned above wings or tail-planes) to reduce the forward and rearward arc noise during fly-over, and to verify a prediction method mainly applicable to internal noise sources of high bypass fan engines. The third paper, by John S. Gibson, of Lockheed-Georgia, reviewed developments in the non-engine noise field, related to aerodynamic noise created by structural components, unsteady aerodynamic forces, trailing vortices, and wakes. The lecturer concluded that the prospects for reducing this noise were good, even in the light of noise requirements of the 1980's.

A general lecture by Gabriel Coupry, of ONERA, was devoted to the problems arising from flight in turbulence. The speaker began with a description of the mathematical models which are able to provide a representation of the environment encountered by the aircraft. After discussing the classical models he turned to the new approaches, both British and French, and examined the response of a non-rigid aircraft to such an environment, showing the need to take into account the isotropy of the turbulence. The speaker concluded by demonstrating how active control systems in the next generation of aircraft will be less sensitive to rough weather, and described actual systems under test.

The discovery that the vortex wakes behind aircraft could be a hazard to other, following aircraft has inspired extensive examination of the nature of such vortices. Six papers at this congress were directed to this subject. One of these, by engineers of Alitalia Airlines, was concerned mainly with wake vortex calculations and the correct computation of lift and wing-tail interference. A second paper, from Technion, was directed to the calculation of vortex distribution over the wing planform and the trailing vortex wake. A third paper, from McGill University, Montreal, discussed experiments on the decay of tangential velocity in a vortex, enhanced by the superposition of a longitudinal jet, or wake. The deformation of a vortex sheet behind a swept back wing was the subject of a theoretical and experimental report from NLR, Amsterdam; and from Texas A&M University an experimental study of aircraft trailing vortex instabilities was the theme of another paper. A technique for inducing earlier than normal breakdown and dissipation of the vortices was described.

In a paper by S. W. Yuan and A. M. Bloom, of George Washington University, a detailed experimental investigation in the NASA Langley V/STOL wind tunnel of a vortex abatement device was reported. The results indicated not only a greatly reduced size of wing tip vortices and core strengths, but also a considerable increase in lift and decrease in drag.

The modern application of electronics technology in civil aviation, dictated by stringent requirements in navigation accuracy, all-weather flying, air traffic environment, quality of radio communication, operational safety, etc., was discussed in a general lecture by Ernesto Eula, of Alitalia, Rome. The impact of these developments on the operational, maintenance, and engineering areas

of an airline, and the response thereto were examined. The lecturer concluded with a look into the future based on current trends and the areas not yet explored.

An important paper on matched propulsion for advanced vehicles was presented by George Rosen, of United Aircraft Corporation. He described the very high bypass variable pitch fan as a new and effective means of meeting the increasing demands for improved transportation in the face of today's fuel and environmental constraints. It offers good low-speed performance, low fuel consumption, and low noise level in a compact, light-weight propulsion package.

THE TENTH CONGRESS

AT the Council meeting in Haifa it was decided to hold the tenth congress outside Europe, for the first time, and an offer from the Canadian Aeronautics and Space Institute to host this congress in Ottawa, in early October 1976, was accepted.

The papers for the tenth congress were apportioned as follows: aerodynamics 15, structures and materials 13, propulsion 5, STOL 2, aircraft design 4, ground and flight testing (and facilities) 8, operations (including noise) 8, air traffic control 4.

In view of my remarks about the ninth congress program and the potential role of transonic aerodynamics in increasing the speed and efficiency of subsonic transport aircraft, it will not be surprising that eight of the fifteen papers in aerodynamics were devoted to that subject. The paper by John R. Spreiter, of Stanford University, and Stephen S. Stahara, of Nielsen Engineering and Research, Inc., California, reviewed some of the great strides which have been made in recent years in the theoretical analysis of steady and unsteady transonic flows past wings and bodies, and the first extension to wing-body combinations, helicopter rotors, and within rotating turbomachinery. Remarks were also offered on the direction of future advances.

Wolfgang Schmidt, of Dornier, G.m.b.H., and Sven Hedman, of FFA, Sweden, discussed recent explorations in relaxation methods for three-dimensional transonic potential flow, presenting a method for analysis and design for wing-bodies. The method was applicable to real aircraft design, and such a wing-body combination was configured and tested in the FFA wind tunnel. In the paper by H. Sobieczky and E. Stanewsky, of DFVLR-AVA, the hodograph transformation method for the design of shock-free airfoils was extended to include weak shocks, and the displacements due to boundary layers with and without separation. Shock boundary layer interaction measurements were made and the results compared with the theory. Boundary layer computations were also made and compared with boundary layer measurements. The extended hodograph method, combined with boundary layer computations, was found to be well suited to the design of transonic airfoils.

Morris W. Rubesin and four coauthors, of NASA Ames, reported on an extensive theoretical and experimental program related to turbulence modeling of shock wave induced boundary layer separation on airfoils at supercritical speeds. A summary of recent advances, obtained both theoretically and experimentally, in the aerodynamics for transonic flight was given by A. Eberle and two coauthors, of M-B-B, Munich. Results were shown which demonstrated the high efficiency of new computational and semi-empirical methods for the design of fighter-type aircraft maneuvering at transonic speeds.

The Franco-German experimental program for evaluating a supercritical wing for a combat aircraft was described in a paper by Michael Lotz, of Dornier, G.m.b.H., and Bernard Monnerie, of ONERA. The investigations used the Alpha Jet as a flight test vehicle, following theoretical and experimental work. The main interests lay in three-dimensional effects on

moderate aspect-ratio wings, supercritical wing performance in a broad region of lift coefficient/Mach number, the effectiveness of maneuver flaps on a supercritical wing, and behavior beyond the buffet boundary and at the maneuver limit. The results of the first design cycle and the resulting improvements in performance were given.

In the paper by Bert Arlinger, of Saab-Scania, he developed a computational method for the two-dimensional, inviscid transonic flow around a two-element system (an airfoil with leading-edge slat or trailing-edge flap), for various configurations.

The papers on supersonic and hypersonic flow were similarly esoteric. There were two on supersonics, one from FFA, Sweden, which dealt with theory and experiment for wing-body interference to determine the resulting load distribution on the body from a triangular wing, and the other from Cranfield Institute of Technology, describing a detailed experimental survey of the supersonic flow around a slender (70°) delta wing and comparing the results with thin shock-layer theory. Of the two papers on hypersonic flow, one of them used the thin shock-layer theory to examine the steady and unsteady aerodynamic forces on slender delta wings, and the other was concerned with a theoretical and experimental study of the flow over long, slender bodies in a conical nozzle.

In the two preceding congresses, the importance of the new composite materials was beginning to emerge. At this congress there were five papers devoted to this subject, and most of them underlined the very real advances in structural efficiency which such materials will bring. The paper by D. M. Purdy and C. G. Dietz, of the McDonnell Douglas Corporation, must have

Tenth ICAS Congress—Ottawa, Canada. CASI President, Mr. J. P. Beauregard, welcoming the delegates.

been of major importance to all aircraft structural design engineers. To begin with, it reiterated the remarks made by Professor U. Hütter at the eighth congress, and William Johnston at the ninth, to the effect that the optimum weight saving with composites as primary structural materials is dependent on sophisticated design configurations, and new approaches to the design task. Purdy and Dietz went a step further and devoted their entire paper to the optimum design of composite primary structure components, ranging from the optimum configuration layout patterns down to the "nitty gritty" of appropriate sizes, shapes, and spacing of stiffeners. Further, they discussed the various constraints imposed on the optimization process and their influence on structural weight, and compared the optimized structures with existing metal structures.

J. J. Cools, of Fokker-VFW, and G. Bartelds, of NLR, Netherlands, reported on an evaluation of HTS carbon-epoxy composite material in hybrid laminates and as reinforcement in aluminum wing panel construction. Weight saving of 20% to 30% seemed possible. They also examined the promising use of such composites to improve the fail-safe characteristics of stiffened and sandwich panels, and noted the improvement in crack arrest and residual strength. The application of advanced composites to military aircraft was discussed by Richard N. Hadcock, of Grumman Aerospace Corporation, who reviewed a ten-year evolutionary program which saw the commitment to boron/epoxy for the horizontal stabilizer of the F-14A in 1968 and current developments of large, complex, mixed fiber composite structures. He also referred to the future benefits from extensive application of advanced composites.

An example of the sophisticated design approaches needed with composites was given in a paper by R. Kochendorfer, of the Institut für Bauweisen-und Konstruktionsforschung, Stuttgart, which dealt with the limitations on the advantages of composites imposed by the solution of the attachment problem. The author was here discussing the attachment of compressor blades fabricated in boron/aluminum, for which a novel design method was developed whereby the blades were fabricated in pairs, with the fibers forming a loop running from tip to tip, with bolts to attach each twinblade to the disk.

The program contained two papers on fatigue. One by Jozsef Gedeon, of the Technical University of Budapest, dealt mainly with computer oriented methods for arriving at a low failure probability for fatigue life prediction. The other, by E. Antona, of the Politecnico di Torino, Italy, and three coauthors, was directed to the role of fracture mechanics and acoustic fatigue in the design of advanced aerospace vehicles. Pressurized aerospace structures often contain small flaws or defects in the material. Such defects can grow under environmental conditions, including noise-induced vibrations, to an extent that explosive failure occurs. Spacecraft carried into orbit by the space shuttle would be particularly prone to this hazard. The paper reported on the results of a coordinated research effort among university, industry, and the National Research Council, summarizing the results and their impact on the design of pressurized spacecraft structures.

The paper by P. Santini and R. Barboni, of the University of Rome, was concerned with a general approach to supersonic aeroelastic vibration

problems. Not since the second congress, sixteen years earlier, had there been a paper on this subject in an ICAS program. In the earlier paper, Holt Ashley and his coauthors pointed out that flutter at supersonic speeds could be a more serious design problem than at transonic speeds. The paper by Santini and Barboni, in discussing the flutter of plates, noted that flutter amplitudes are limited in experiments by the nonlinear behavior of the structure, a most important source of which is the occurrence of tensile stresses in the middle surface, influenced strongly by the boundary conditions. The paper presented a new mathematical approach, adapted specifically to three-dimensional panel flutter which included the cross-coupling of out-of-plane bending and in-plane stretching.

A second paper, by L. Balis-Crema and P. Santini, of the University of Rome, was aimed at providing a substantial contribution to the needs of the industry in predicting aeroelastic properties of aircraft, by means of a computational program, which is a part of a larger one, which also includes consideration of vibration modes to be used in flutter prediction.

Two of the propulsion group of papers were concerned with the nature of the transonic flow through turbo-machinery and its influence on such design features as powerplant nozzle and afterbody systems and compressor blade contours. A third paper dealt with the performance of variable-pitch fan stages, applicable to short-haul aircraft, and a fourth with the determination of engine thrust in flight from a reading of engine parameters preferably calibrated in an altitude test facility.

The two STOL papers included Richard Hiscock's Guggenheim lecture on the dynamics of STOL, which discussed the factors which influenced design of STOL utility aircraft in Canada, its public acceptance, and the technical areas needing more advanced development. The other paper, by H. P. Rosewarne and D. D. Spruston, of the Canadian Air Transportation Administration, gave the results of the STOL demonstration service described in a paper given at the eighth congress, and their applicability to future Canadian STOL systems.

An important paper in the aircraft design group was given as a general lecture by John M. Klineberg, of NASA Headquarters, on the NASA Aircraft Energy Efficiency Program. This covered five areas—improved engine components for existing engines, advanced materials and cooling concepts for higher efficiency in future engines, improved aerodynamic design and active controls technology for derivative or new aircraft, laminar flow control for drag reduction in future transport aircraft, and composite materials for weight saving in structural components. Another design paper, by Oskar Friedrich, of M-B-B, Munich, and Brian Young, of BAC, U.K., dealt with the major advanced design features of the Tornado, advanced STOL fighter-bomber aircraft. It gave the highlights of the design philosophy, with emphasis on the overall integrated function and performance of the airframe achieved by synthesis of all systems.

For helicopters having auxiliary wings, the interference between wing and rotor is the most important problem to be solved. This was discussed in a paper by Kazimierz Szumanski, of the Aeronautical Institute, Warsaw, on optimization of the rotor-wing system from the point of view of performance.

Rounding out this attention to STOL and V/STOL flight, an important paper giving a resume of steep gradient research at the RAE, Bedford, was presented in a general lecture by A. D. Brown and covered a four-year period of research with a wide range of different aircraft and approach aids, plus piloted simulation tests. Emphasis was given to all-weather aspects and, more recently, noise abatement techniques.

This congress program had more papers devoted to ground and flight testing than perhaps any previous congress. Four of these papers concerned wind tunnels, which should not be surprising since the wind tunnel, in its service to aeronautics, has had a longer existence than aviation itself. It remains today as the premier and most powerful tool in aircraft development. Its evolution over the years in adapting to the changing demands placed on it by each new advance in aviation has kept it in the forefront of development aids.

Two of the papers were concerned with wind tunnel wall interference effects, and how to reduce or remove these in specific cases was discussed. A third paper described the proposed U.S. 2.5-meter cryogenic high Reynolds number transonic tunnel at NASA Langley, which will be known as the National Transonic Tunnel. The paper was authored by Robert R. Howell and I. Wayne McKinney. The fourth paper examined the influence of turbulence in the external flow of a wind tunnel on the development of turbulent boundary layers on the side walls.

There were two good papers on flight testing. D. Lean, of RAE, Bedford, gave his personal view of the art and science of modern flight testing. He reviewed some of the R&D programs in the U.K. and showed that, although the science of flight testing had been advanced by improvement in instrumentation, data recording, and processing, the art of devising economic and productive flight tests and interpreting the unique data is flourishing too, and will continue to be required.

In the other paper, H. L. Jonkers and J. A. Mulder, of Delft University, discussed new developments and accuracy limits in aircraft flight testing. The authors' concern here was for the extraction of accurate aerodynamic data from the results of flight tests. This is limited by measurement errors, atmospheric disturbances, and mathematical modeling errors. The effect of these error sources on the maximum achievable accuracy was examined, and the conclusions were compared with actual flight test results. The effect of different flight test techniques on the maximum achievable accuracies was discussed.

Perhaps the paper of greatest general interest at this congress was that on the operational experience on Concorde, by R. M. McKinley, of BAC, U.K., J. Franchi, of SNIAS, Toulouse, and G. R. I. Heaton, of BAC. At the time of this lecture, Concorde was in service with British Airways and Air France, and it was possible at least to start to assess the real operational behavior of the aircraft. The paper gave an outline of the experience with the aircraft to date, both in the hands of the manufacturers and the airlines, described how Concorde is operated normally, selected a few features highlighted as a result of its route flying, and gave an operational assessment from the particular viewpoint of the flight deck crew.

Turning to the subject of noise, we had five papers at this congress. Two of these dealt with internal engine noise, one paper investigating the unsteady pressure distribution and noise propagation in turbo-machinery intake ducts, and the other related to noise generated wave-like eddies in turbulent jets.

John Gibson, of Lockheed Georgia, discussed new developments in blown-flap noise technology which involve noise reduction concepts, structural geometry and shielding modifications, passive and active local flow field modifications, and the absorption of noise. There is still much to be learned, and the need is to use better application of low noise principles at the design stage. A paper on the opportunities for future improvement in aircraft noise was given by Robert P. Gerend, of the Boeing Commercial Airplane Company, Seattle. This gave a broad review of current theoretical understanding, experimental techniques, and potential future reductions of noise for all noise sources. While there are some interesting possibilities for advancement of noise technology, the author concluded that energy, emissions, and cost constraints will limit future noise reduction to relatively modest increments below the current wide-body fleet. Another paper, from Delft University, investigated the external sound characteristics of light propeller-driven aircraft.

On environmental effects, Alan J. Grobecker, of the U.S. Department of Transportation, gave a paper assessing the impact of climatic changes which may occur from the operation of aircraft in the stratosphere. The effects considered involved the geophysics of the atmosphere, the propulsion effluents, the impact of climatic change on the biosphere, and the economic and social measures of biological and climatic changes. He concluded with a discussion of technical measures for improving aircraft engines and fuels by which adverse environmental effects may be avoided.

There were four papers on air traffic control, all of which dealt with somewhat sophisticated approaches to the problem, so important in light of today's traffic congestion in the terminal area. A paper by J. M. Ten Have and C. G. H. Scholten, of NLR, Amsterdam, focussed on two conflict detection methods developed for overflying aircraft in Netherlands airspace, in the Sarp II, ATC system, based on long-term trajectory prediction. The aim was to produce few "false alarms" from the conflict detection systems, with minimum on-line processing time. This is met by the so-called "block method" described in the paper. A more complicated method, "the critical-distance method," will reduce uncertainties in the trajectory predictions in the ATC computer system and the lateral deviations from the track of the aircraft. V. Adam and Reiner Onken, of DFVLR, Braunschweig, reported on an evaluation of a new flight path digital command control concept, which follows independent commands in change of glide slope angle and speed in the sense of 4-D guidance. The introduction of digital electric flight control systems, and new theoretical techniques of multivariable control synthesis, enabled such advances as the design of this new concept, which has been evaluated in simulator tests. The commands are fed in by the pilot.

Charles L. Britt Jr., of Research Triangle Institute, North Carolina, and L. Credeur, of NASA Langley, described work on advanced, ground-based near terminal area 4-D guidance and control aimed at automated metering and

spacing. The all-digital, real-time air traffic simulation model was described. So were the facilities for aircraft tracking and interfacing with the digital simulation, and possible application to other types of experiments. A paper from the Swiss Federal Aircraft Factory, by Pierre A. Studer, discussed the predictive adaptive control of a nonlinear, time-varying aircraft system. An aircraft described by such a system is transferred from an initial state to a final state in a certain number of discrete steps applied to its optimized trajectory, the sequence of points defining elementary trajectories. The aircraft is guided from point to point by a finite-time control vector. At the end of control interval the state is measured, which allows determination of the control vector, provided the difference between the aircraft's state and the predetermined state lies inside a tolerable error window. If not, a parameter identification is carried out. The method was applied to the case of the accelerated climb of a hypothetical supersonic aircraft.

At the Council meeting, held during the tenth congress in Ottawa, the decision was made to return to Europe for the eleventh congress, when the Council accepted an invitation from the Grupo Português de Aeronáutica to hold the next congress in Lisbon, in September 1978.

THE ICAS SECRETARIAT

FROM 1957-77, the American Institute of Aeronautics and Astronautics provided the ICAS secretariat function, as well as substantial financial support for its activities. Robert R. Dexter of the AIAA staff served as the Executive Secretary of ICAS almost from the beginning. While the support of the AIAA has been of inestimable importance to the survival of ICAS, the new constitution introduced the possibility of broader support from the member associations in its functions and financial requirements.

Following Robert Dexter's retirement from the AIAA in 1973, and his subsequent resignation as Executive Secretary of ICAS in 1976, the Council sought a change of location for the ICAS secretariat in order to spread the responsibility and financial burden, which the AIAA had shouldered for so long. The Deutsche Gesellschaft für Luft- und Raumfahrt e.V. (DGLR) offered to take over the ICAS secretariat functions in 1977, in good time for the eleventh congress in Lisbon. Professor Dr.-Ing. Rolf W. Staufenbiel, who occupies the Chair of Aerospace Engineering at the Technical University of Aachen, was appointed ICAS Executive Secretary in September 1977. The success and smooth functioning of the eleventh congress demonstrated the soundness of the new arrangements.

At the tenth congress, in Ottawa, Ray Bisplinghoff retired as the chairman of the Program Committee. Josef Singer of Israel succeeded him. This was also the last Council meeting for Dexter as Executive Secretary, but he remained a life member of the Council.

Presentation of wristwatch to R. R. Dexter by J. J. Green, September 1977, Cologne. ICAS honors Mr. R. R. Dexter on his retirement as Executive Secretary after 20 years of service.

THE ELEVENTH CONGRESS

THE eleventh congress was held from September 10-15, 1978, under the distinguished patronage of the President of the Republic of Portugal, General Antonio Ramalho Eanes. The papers presented mostly fell into three main groupings and four smaller groups. Nine papers were devoted to wind tunnels or wind tunnel testing techniques; twenty-one papers were concerned with aerodynamics, and twenty-one with materials and structures; four papers dealt with propulsion, four with noise, three with environmental aspects, and three with flight and ground testing. One paper discussed a flight control system, and one examined some aspects of bird flight.

My remarks about the significance of papers dealing with wind tunnels, in discussing the tenth congress, seem to be generously reinforced by all the attention devoted to wind tunnels at the eleventh congress. It was, of course, a happy arrangement to have the Guggenheim Memorial lecture by Ronald Smelt examine the role of wind tunnels in future aircraft development, and then to follow that with eight other lectures in the program directed to aspects of the same subject. The ever-present problem with the wind tunnel has been a striving to reproduce in the tunnel the same air flow characteristics as exist in free flight, mainly defined by the Reynolds number, the ratio of inertial to viscous fluid forces. A second concern, of course, has been the influence of the tunnel walls, or boundary, on the flow characteristics.

These demands have challenged the ingenuity of aerodynamicists and are reflected in the evolutionary developments which have taken place in wind tunnel facilities, typified by the subject matter of the nine papers presented at Lisbon. Ronald Smelt's lecture set the stage and indicated the changes required in wind tunnel performance to meet the needs of advanced aircraft developments. A joint USAF/NASA paper reviewed the technical capabilities of the National Aeronautical Facility Program and other test facilities, and emphasized the need for increased national and international cooperation for better use of aeronautical test facilities and better results from them.

In a paper by J. P. Hartzuiker, of NLR, Amsterdam, a description was given of the European transonic wind tunnel for high Reynolds number testing, a joint program between the governments of France, West Germany, the Netherlands, and the U.K. It will be a fan-driven facility using nitrogen at low temperature as the working gas. A. Spence and four coauthors, of RAE, Farnborough, described the RAE 5-meter pressurized low speed tunnel, which will give more accurate and reliable results for the low-speed aerodynamics of aircraft and their high-lift systems. Full-scale Reynolds numbers on complete models of combat aircraft and values up to a quarter of full scale for transport aircraft of the size of the Airbus A-300 B would be possible. The pressurized subsonic wind tunnel F-1, of the Fauga-Mauzac ONERA center, was described by Marcel Pierre, of ONERA. This, also, allows studies of high-lift devices on aircraft wings at high Reynolds numbers (6 million). An intermittent high Reynolds number cryogenic tunnel concept was described in another paper which gave the sizes of tunnels required to meet the European and American specifications for running time of 10 seconds. Also a proposal for a more

modest National or university facility, with a one-second test time, was discussed.

The German-Dutch wind tunnel, a cooperative effort between DFVLR and NLR, was described by Freerk Jaarsma and Manfred Seidel. It will be one of the largest and most efficient of the low-speed tunnels in Europe and will be aimed principally at the aerodynamic design and development of selected components. Aeroacoustic work will be possible with one of the test sections (open section), and tests will also be possible with real engines. Finally, John Williams and T. A. Holbeche, of the RAE, Farnborough, discussed advances in aeroacoustic wind tunnel testing techniques for aircraft noise research. Here, models are mounted in a quiet test-section airstream, surrounded by an anechoic working chamber. The paper discussed the evolution, over several years, of the requirements for such specialized wind tunnels, the special techniques required for measurement and analysis and the method for simulating, at model scale, the noise from engine and airframe.

In aerodynamics, the potential gain from achieving laminar flow over aircraft surfaces has been a tantalizing goal. John S. Gibson, of Lockheed-Georgia, reviewed how noise has been a problem in the triggering of transition from laminar to turbulent flow in the boundary layer of the X-21A laminar flow control (LFC) research aircraft. A more detailed review was given for a recent design study LFC passenger transport aircraft, looking into noise sources, prediction of the effects on LFC surfaces, and the needs for further research.

There were a large number of papers dealing with computation methods for lifting surfaces and single or multisurface airfoil design, especially at high lift. E. Labrujère, of NLR, described a method for multielement airfoil design, by optimization, to fulfil approximately à priori specified aerodynamic and geometric requirements. A paper from Technion, Israel, introduced a method for calculating the non-linear longitudinal aerodynamic characteristics of wings of various shapes (including multielement) at high angles of attack, and a third paper used other computations to solve the problem of unsteady lifting-surface problems with edge separations. From Bristol University came a report on separated and unsteady flows in aeronautics covering a range of problems of the type which are now arising more and more frequently. A paper by G. F. Marsters, of Queen's University, Canada, discussed various jet flow interactions arising in the type of jet configurations utilized in powered lift devices for STOL aircraft.

The beneficial high-lift effects of spanwise blowing had been discussed at previous congresses, and two papers at this congress were devoted to it. A joint paper, by authors from M-B-B, Munich, and ONERA, France, described a Franco-German program to investigate the beneficial effects of spanwise blowing on stability, control, and buffet for a number of configurations. They concluded that it is a simple means to increase aircraft maneuver performance at high angles of attack. The benefits of spanwise blowing at transonic speeds were revealed in another joint paper from Lockheed, Georgia, and ONERA, which used a 40° swept wing-body at speeds of $M = 0.9$. Low levels of blowing controlled the shock-induced separation, giving reduced buffet intensity and improved longitudinal characteristics.

A considerable number of theoretical and experimental investigations of transonic flow were reported at this congress and, in several cases, their application to the design of aircraft. Francis Manie, of ONERA, described experimental and theoretical work on the three-dimensional flow around a variable sweep wing at subsonic and transonic speeds. Similarly, scientists at FFA, Sweden, reported on a theoretical and experimental investigation of the transonic drag characteristics of non-slender wing-bodies and their equivalent axisymmetric bodies at zero lift. In another paper, Yngve C.-J. Sedin, of Saab-Scania, presented a theoretical study, using the classical transonic equivalence rule, of the zero-lift transonic drag rise for a configuration with moderate spanwise extensions, with some preliminary calculations of drag rise due to lift. Bert Arlinger, of Saab-Scania, and Wolfgang Schmidt, of Dornier, G.m.b.H., gave a paper on the design and analysis of slat systems for transonic flow using a numerical method for the analysis of the two-dimensional flow around a two-element airfoil. Georg Drougge and three coauthors, of FFA Sweden, presented a paper which extended the work reported at the tenth congress by Wolfgang Schmidt and Sven Hedman. This was the application of the transonic small disturbance relaxation method for the design of a wing-body combination. The encouraging analysis of the previous results and comparisons with measurement led to modifications in the use of the numerical method and also in the wing-body design, which was then retested and the results analyzed. It was concluded that the numerical method is a powerful design tool.

A paper which again underlined the importance of Reynolds number was delivered by James A. Blackwell Jr., of Lockheed, Georgia. It surveyed the R.N. scale effects on supercritical airfoils and concluded that low R.N. drag data could be extrapolated to flight conditions only when the flow was "attached" and the pressure distribution did not change appreciably. But airfoil lift and pitching moment data cannot be extrapolated with confidence to full-scale conditions. The paper also evaluated the ability of theoretical methods to predict scale effects and the accuracy of low R.N. simulation of high R.N. conditions.

There were two papers on the application of aerodynamic computational methods to the design and analysis of transport aircraft, one presented by A. Larry da Costa, of the Boeing Company, and the other by Frank T. Lynch, of the Douglas Aircraft Company. The first established the validity of several methods of computation and then assessed more recently developed methods for three-dimensional viscous transonic flow and boundary layers on wings. The second paper combined an improved version of a three-dimensional finite-difference boundary layer program for arbitrary wings with a full potential transonic flow method in order to predict the combined viscous/inviscid flow characteristics for three-dimensional swept wings at transonic conditions. The calculations for two advanced transport wing configurations were compared with experimental results, and limitations of the current method were discussed.

Two of the papers were related to supersonic flow. One of these, by G. P. Voskresensky, of the Academy of Sciences of the USSR, was concerned with a numerical study of the supersonic flow around wings, while the second, by P.

I. Chushkin, also of the USSR Academy of Sciences, considered the numerical study of supersonic flows around large-angle wedges and cones. A paper by Eli Reshotko, of Case Western Reserve University, dealt with drag reductions possible in cryo-fueled aircraft, if the fuel is used to cool selected aerodynamic surfaces on its way to the engines. This is because cooled laminar boundary layers at subsonic and low supersonic speeds are more stable than adiabatic boundary layers and therefore more resistant to transition to turbulence. For a hydrogen fueled transport aircraft at $M=0.85$, drag reductions in cruise of about 20% are reasonable. The weight of fuel saved is well in excess of the inert weight of the required cooling system. Prospects are even better as Mach number and wing sweep angles are reduced.

Another paper, from the Technical University of Berlin, examined the airflow characteristics of hypersonic cruise vehicles under off-design conditions. Delta wings with sharp leading edges were examined at supersonic speeds over a range of angles of attack, and two wave-rider configurations were examined at subsonic and low supersonic speeds.

In the materials and structures grouping, there were eight papers dealing with composites. No longer were these papers directed to the "selling" of such materials for their potential benefits in weight saving, but rather to their performance under operating conditions. A paper by R. Prabhakaran, of the Indian Institute of Technology, and A. Rajamani, of Bharat Heavy Electricals Ltd., New Delhi, discussed theoretical and experimental studies on the free vibration characteristics of a number of simply supported plates, each made of different composite materials, with circular holes and square cut-outs. A second paper, by N. G. R. Iyengar and M. K. Patra, of the Indian Institute of Technology, Kanpur, devoted to the optimum design of composite plates, employed the finite-element displacement method to determine the free vibration and static analysis characteristics of such plates. The influence of fiber orientation and square cut-outs on the natural frequencies and corresponding mode shapes was also determined. A third paper, by J. J. McKeown, of the Hatfield Polytechnic, U.K., offered a new approach to optimization of the design of multilaminar composite sheets, by first seeking the deflection pattern associated with the optimal structure, and then inferring the optimal design from this. From the FFA, Sweden, came a paper which examined the buckling and post-buckling characteristics of flat carbon fiber reinforced plastic panels, subjected to compression or shear loads.

Three papers were presented on the effect of environmental exposure on the mechanical properties of composite materials. One of these, from NASA Langley, evaluated the results of flight service experience for 142 advanced composite aircraft components after five years and one million successful component flight hours. Ground-based outdoor exposures of other specimens related the influence of moisture pick-up and solar ultraviolet-induced material loss to the residual strength of both stressed and unstressed specimens. Richard A. Pride was the author of this paper. A second paper, by Christer Lundemo, of FFA, Sweden, reported on static and fatigue tests on carbon reinforced plastic specimens exposed to environmental cycling conditions simulating the temperature and humidity conditions an aircraft might experience in actual service. The third paper, by Denis J. Zigrang, of Rockwell

International Corporation, Tulsa, and Heinrich W. Bergmann, of DFVLR, Braunschweig, investigated the influence of moisture loss during re-entry on the strength of the graphite/epoxy face sheets of the payload bay door of the shuttle Orbiter.

Fatigue and fracture mechanics were the subjects of eight papers. Marco Borri, of the Milan Polytechnic, and Georgio Cavallini, of the University of Pisa, gave a paper on the assessment of acoustic fatigue in the design of aerospace vehicles, and pointed out that the problem is bound to grow worse, since the trend is toward more powerful multimission reusable vehicles. In coping with the problems, both safe-life and damage-tolerant design criteria may be followed, and their paper described approaches based on both. They discussed acoustic field characteristics (the input data), damping, fatigue and crack growth data, and the reliability of service life evaluation.

In a paper by P. R. Edwards and R. Cook, of RAE, Farnborough, a fracture mechanics model incorporating measured data on friction between fretted surfaces was used to predict fretting fatigue under both constant and variable amplitude loading. E. Antona, of the Turin Polytechnic, and three coauthors also reported on fracture mechanics approaches to the design of aerospace vehicles, sponsored by the Italian National Research Council as a joint research among university institutes and the aerospace industry.

While the concept of damage tolerant structures is currently used in structural design to guarantee freedom from the catastrophic growth of small cracks or flaws, fracture mechanics has become a fundamental tool in designing damage tolerant structures, a discipline aimed at evaluating the growth of flaws under the influence of operating loading and environment. Further advances will require more extensive researches aimed at improving and orienting existing knowledge toward reliable design methodologies. The paper recalled the problems with the structure of the module of the Spacelab, to illustrate a typical application to an advanced space structure design.

Roger Labourdette, of ONERA, delivered a paper which synthesized research at ONERA related to the coupling of the mechanical behavior of materials and the damage they sustain, under mechanical and thermomechanical loadings, and distinguishing between two main domains of research—the generalized elastoviscoplastic behavior and small scale yielding.

Aeroelasticity was the subject of three papers. A good review of the subject was given by Roland Dat, of ONERA, which considered wing flutter, compressor blade cascade instabilities, aeroelastic vibration of blunt structures, helicopter instabilities, and periodic vibrations. The mechanisms involved in all these were described, and the methods used to predict and prevent them were evaluated.

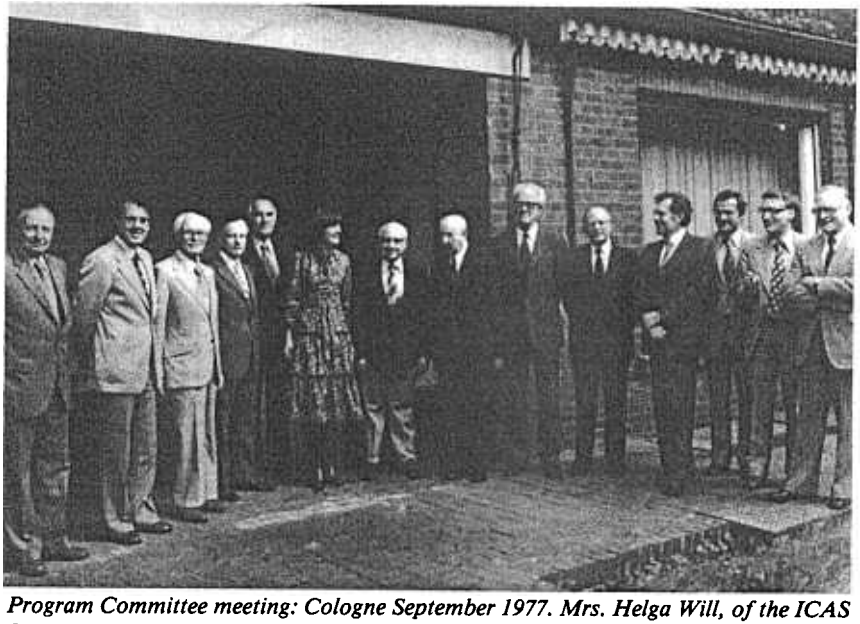
The other two papers dealt with the use of active controls to suppress flutter. E. Nissim, of Technion, Israel, presented a state-of-the-art of the aerodynamic energy concept and the latest applications of the relaxed energy concept for flutter suppression and gust alleviation. These applications include the suppression of external-store flutter of three configurations and some initial results for a 1/20 scale low speed wind tunnel model of the Boeing 2707-300 supersonic transport. The paper by Heinz Hönlinger and Albert Lotz, of M-B-B, Munich, described the design and flight testing of active control

systems for the suppression of flutter and store vibrations. The first system utilized additional control surfaces mounted on the store itself and was flight tested. It proved useful also as a mode excitation method for improved flight flutter testing of aircraft with wing mounted stores.

The second control system used the already existing control surfaces of the aircraft to suppress wing-store flutter and was to be flight tested on an F-4 Phantom.

Two papers, one from Japan and one from the Federal Republic of Germany, were devoted to the optimum design of structures. The former was based on extended reliability theory and took account of statistical variations in material strength, applied loads, fabrication processes, etc., and subjective uncertainties associated with engineering judgments. The latter utilized the finite-element method for minimum structural weight design.

The papers which were concerned with propulsion covered a wide spectrum. Wolfgang Bunk, of DFVLR, discussed the importance of ceramic materials in gas turbines to enable higher operating temperatures (and efficiencies), lower fuel consumptions, and more flexibility in choice of fuels. Another paper on the NASA Aircraft Energy Efficiency Program was given by Donald Nored, who discussed three main approaches: 1) engine component improvement for current engines; 2) energy efficient engines for new turbo-fan engines; and 3) advanced turbo-prop powerplants. A somewhat different approach to the



Program Committee meeting: Cologne September 1977. Mrs. Helga Will, of the ICAS Secretariat, is in the middle (coordinator for ICAS, within DGLR). Prof. Dr.-Ing. Rolf Staufenbiel, Executive Secretary of ICAS, is fourth from the right—next to Mr. R. R. Dexter.

same goal was given in a paper by Reinhard Hilbig and three coauthors, of VFW-Fokker, G.m.b.H., Bremen. They considered the application of advanced technology for improving the integration of engine and airframe for future transport aircraft, thereby improving the performance, energy efficiency, and noise radiation. They took into account existing experience with airframe integration of modern high bypass ratio engines and the benefits of positive engine-airframe interference and showed the potential for further improvements from different configurations.

Two of the papers were concerned with hypersonic flight. Robert A. Jones and Paul W. Huber, of NASA Langley, discussed research now underway on a new, hydrogen burning, air-breathing engine concept with extensive engine-airframe integration, offering good potential for efficient hypersonic cruise vehicles. The second paper, by H. Neale Kelly and three coauthors, also from NASA Langley, dealt with research on convectively cooled engine and airframe structures, with the engine section focussed on a hydrogen-cooled structure for a fixed geometry, airframe-integrated scramjet. However, the concepts in the paper were applicable to a broad range of engines.

An important paper by Hanno H. Heller and Werner M. Dobrzynski, of DFVLR, Braunschweig, presented a comprehensive review of the state of airframe noise research, the so-called "noise barrier" which cannot be reduced without major redesign configurations. Particular emphasis was given to work in Germany, but that done in the U.S., U.K., and France was also discussed to reveal the breadth of current efforts. With the possibility that future noise specifications might call for an ultimate need to reduce airframe noise itself, current efforts to develop the requisite techniques to affect the relevant source mechanisms for less noise generation were discussed, as well as future research needs. Two papers were concerned with helicopter noise. One, from Boeing Vertol Company, discussed recent developments in helicopter noise reduction, and the other used an adaptation of an aircraft noise assessment procedure to assess the noise exposure around heliports. A European joint research program into light aircraft noise and its possible reduction was also discussed in a third paper.

In the flight testing group of papers, Heinz Winter and Bernhard Stieler, of DFVLR, dealt with the new and advanced sensors available in flight testing, both ground-based and on-board, and also discussed the advanced data evaluation techniques available today. The application of both the hardware and software opens new domains for accuracy in flight test reference systems and insight into the complex systems under test. J. H. Breeman and J. L. Simons, of NLR, Amsterdam, described a very accurate measurement system and a data reduction method to extract performance data from a single dynamic maneuver, thereby reducing the large number of hours of flight time needed by the conventional steady flight procedure. The new method was tested and proven for the case of a modern jet transport aircraft.

CONCLUSION

AT the Council meeting in Lisbon, the writer retired as President of ICAS and assumed the newly established Council position of Past-President. He was succeeded as President by Raymond Bisplinghoff. At that time, Frank L. Wattendorf resigned as Honorary Treasurer and was succeeded by Barry Laight of the U.K.

Over the years ICAS has striven to have the world's prominent aeronautical scientists and engineers participate in its congresses, both in the role of lecturers, presenting papers of the highest quality, and as participants in lively and fruitful discussions which ICAS has endeavoured to stimulate at all congress sessions. The Program Committee has been successful over the years in gradually increasing the number of papers delivered at the congresses from the rather modest early intentions. The eleventh congress heard nearly seventy. The review of congress programs undertaken in this history will, it is hoped, be of some value to the reader in enabling him to judge whether ICAS has been, on the whole, successful in providing good quality programs, which have dealt with problems of timely importance, and in attracting participants of recognized stature in the aeronautical world.

THE DANIEL AND FLORENCE GUGGENHEIM INTERNATIONAL MEMORIAL LECTURES IN THE AERONAUTICAL SCIENCES

1. Theodore von Kármán 1958	"Some Significant Developments in Aerodynamics Since 1946"
2. Jacob Ackeret 1960	"The Role of Entropy in the Aero/Space Sciences"
3. Bo K. O. Lundberg 1962	"Speed and Safety in Civil Aviation"
4. Maurice Roy 1964	"Generation and Gradual Evolution of the Scientific Spirit Through the Initial Works of Theodore von Kármán"
5. M. B. Morgan 1966	"Some Aspects of Aircraft Evolution"
6. A. W. Quick 1968	"Some New Research Results in the Field of Flows with Energy Input"
7. Carlo Ferrari 1970	"Aerodynamic Problems of Re-Entry"
8. G. Y. Nieuwland 1972	"Choice and Balance. A Research Program in Aerodynamics in Perspective"
9. Arthur Kantrowitz 1974	"Lasers in Space and Aeronautics"
10. Richard Hiscocks 1976	"The Dynamics of STOL"
11. Ronald Smelt 1978	"The Role of Wind Tunnels in Future Aircraft Development"

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