PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Introductory Remarks

M. J. Lighthill

Phil. Trans. R. Soc. Lond. A 1971 **269**, 323-326
doi: 10.1098/rsta.1971.0034

Phil. Trans. Roy. Soc. Lond. A. **269**, 323–326 (1971) [323]
Printed in Great Britain

Introductory remarks

By M. J. Lighthill, F.R.S.
Department of Applied Mathematics and Theoretical Physics, University of Cambridge

May I begin by extending the warmest possible welcome on behalf of the Royal Society to all of you, and a particular welcome to all those who have been so kind as to agree to speak at this meeting. I should like also to give especial greetings to our many visitors from abroad. We are delighted to see you here in London.

The Royal Society of London, in its fourth century of work to foster science and technology, is more than ever concerned to arrange discussions of those subjects that involve interactions between different specialist disciplines. Admittedly, during the third and fourth of those centuries, thousands of specialist societies have grown up, and have done excellent and distinguished work within particular disciplines. Nevertheless, there are many very complicated borderline areas, which specialized bodies are prone to ignore, and these are where a Society with a very broad field of interest and expertise can play an important part.

Recently the Royal Society has gone still farther, and taken particular interest in interactions with subjects somewhat outside the normal field of science and technology; subjects like demography and archaeology. Today and tomorrow we are concerned, not only with science and technology in the shape of aerodynamics and structural engineering, but also with both the arts *and* social studies, in the shape of one of the classical fine arts—architecture—and one of the characteristic systematizing fields of work of the twentieth century, that of socio-economic planning.

The very brief title of this Discussion Meeting is 'Architectural Aerodynamics', and obviously short snappy titles *have* great merit, and this one does put across the spirit of our Meeting rather well. Nevertheless, as the programme notes suggest, the material should be of interest not only to workers in architecture and aerodynamics but also to those in many fields of work that border on architecture and aerodynamics, and this prediction seems to have been borne out by the very numerous attendance.

To go into a little more detail, we are concerned here today and tomorrow with all problems of design of land-based structures and groups of structures as influenced by considerations of the action of the wind. I emphasize land-based here, because so much of the work of aerodynamicists in the past has been devoted to the problems of air-supported vehicles; but of course the presence of the ground makes all the aerodynamic problems still more difficult and interesting.... It is most desirable that the great body of knowledge that aerodynamicists have accumulated during the past thirty or forty years should now receive increasing application to these very important and difficult problems of airflow around land-based structures.

The structures include, of course, buildings, groups of buildings, and whole towns; exceptionally tall structures which pose special problems; similarly, exceptionally long structures such as bridges; and also roads, railways and everything involved in surface transport on land. They are to be discussed in the light of quantitative knowledge of the properties of airflows and the forces which they generate; of the structural deformations that are produced by those forces; of static deformations; of dynamic deformations, including vibrations, which may interact in a

complex way with the unsteady element in the surrounding airflow; and of the potentialities of new materials or new structural forms for combating these problems.

The Meeting begins with three accounts of the problems faced by designers. Perhaps I might appropriately mention in the first place the architectural contribution, in recognition of the fact that the word 'architectural' comes into our title and of the happy circumstance that the contribution in this field is to be made by the Royal Society's own architect, Lord Holford.

All of us that are enjoying the magnificent appearance and suitability of this building owe a profound debt to Lord Holford as the architect of the conversion of numbers 6 to 9 Carlton House Terrace for the purposes of the Royal Society. It is remarkable how the interior of these premises succeeds in combining to such a felicitous extent beauty and fitness for purpose, and above all fitness for large scientific meetings such as that in which we are involved today. I had the pleasure of working with him in the final stages of design and construction, and have myself enjoyed working in this building for the past three years. Thus, I am particularly in a position to appreciate the excellence of the architectural work, but Lord Holford is equally eminent as a town planner, and today he is to present a personal view of how problems resulting from airflow affect the work of both the architectural and the town-planning professions.

In the field of structural engineering we particularly welcome Dr Kerensky, an eminent member of the consulting firm Freeman, Fox and Partners, which has had such successes in many fields of civil engineering, including especially that of long suspension bridges, with their notable work on the Forth and more recently on the Severn and the very exciting work now in progress on the Bosphorus. Several of the many important new concepts in structural engineering that have been introduced for the first time in these projects are related to wind problems, and this makes Dr Kerensky particularly well qualified to speak on aerodynamic matters as they affect the civil engineer.

It is also a pleasure to look forward to the contribution by the Chief Scientist of the Ministry of Transport, Mr B. T. Price, who will speak first. His subject will be the special problems of wind action in relation to our roads and railways and the vehicles travelling on them, problems that have become much more severe with advanced methods of motorway construction and the present work on development of the high-speed passenger train.

This group of speakers on design problems is followed by the speakers on aerodynamics. Here I should like to refer to the extremely important work on the aerodynamics of architectural and engineering structures carried out in the Aerodynamics Division of the National Physical Laboratory. I am delighted that the Deputy Director of N.P.L. responsible for the Engineering Sciences Group of Divisions, Mr Alec Silverleaf, is my fellow organizer of this meeting. The first presentation on aerodynamics will be made by Mr Scruton, the head of the Industrial Aerodynamics Section at N.P.L., and by Dr Rogers. It is most desirable that this meeting may lead to the important work and the important facilities in architectural aerodynamics within that Section becoming still more widely known to those that can benefit from their application.

Good facilities and expertise within this field are available also at the Universities of Bristol and Cambridge and at the Imperial College of Science and Technology, and we look forward to contributions from all these university groups. From Cambridge, Professor Mair and Dr Maull will be telling us about the special aerodynamic characteristics of various types of structures situated in the wakes of other structures.

From the aerodynamicists we shall pass to the aeroelasticians, and particularly to the study of structural vibrations that may interact with an unsteady airflow (which will include

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

unsteadinesses due to the vibrations themselves) so as to extract energy from it. At this point I should like to refer with particular pleasure to the fact that this is in a very real sense an Anglo-Canadian meeting. The Royal Society greatly values its role in reflecting the progress of Commonwealth science as a whole. We have the closest and most friendly relations with Canadian scientists, and we are delighted that the two speakers on aeroelasticity are from Canada. First, we will hear from Dr Davenport, from that fine university situated in London, Ontario, namely, the University of Western Ontario, and then from Professor Parkinson of the University of British Columbia. Furthermore, two later speakers are from Toronto. We greatly welcome the important Canadian contribution to this Meeting.

After the analysis of wind load problems, we shall hear an analysis of ways in which the structural engineer may respond to those problems, particularly in the case of tall structures and difficult structures of various kinds. We look forward to hearing Dr Chilver of the Cranfield Institute of Technology on this theme.

Tomorrow, after all this analysis of structural reaction to wind, we come to the question 'what are the winds which need to be designed against?'—including the statistical questions of extreme values of wind and the questions of how the mean wind and the turbulence are distributed in the neighbourhood of the ground. We are very fortunate that the knowledge on these matters will be presented to us by the Head of that very distinguished team within the Meteorological Office that is concerned with the airflows within the terrestrial boundary layer. Dr Pasquill will describe knowledge of winds relatively near the ground in general, and go on to questions of how they are modified by groups of buildings or by whole towns.

When we come on to this question, a certain change of emphasis in the meeting will occur, essentially from the problems of structural tolerance to aerodynamic effects to those of human tolerance to such effects. First of all we are concerned with the disagreeable characteristics of the distribution of the turbulence that is generated by interaction of the wind and certain buildings, as well as with human reactions to the mean winds found in particular locations around buildings and groups of buildings. We are pleased to have a speaker on these matters from the Central Electricity Research Laboratory at Leatherhead which has done such fine work on air pollution and its reduction; Dr Hunt will here be concentrating on the complicated distributions of mean wind and turbulence around a single building.

The Building Research Station is also deeply concerned with problems of architectural aerodynamics, and with advice to architects on the problems they may face, and we are glad that Mr Wise of B.R.S. will be giving us the benefit of his experience on many troublesome aspects of the distribution of flow in the neighbourhood of groups of buildings. His paper will be followed by that of Mr Lawson of the University of Bristol, which will highlight features of the wind as affected by local characteristics of the landscape, particularly in urban regions.

Continuing the theme of human tolerance to aerodynamic effects, we shall then go on to hear about aerodynamic aspects of pollution. We can say in the manner of Macbeth's porter that airflow is an 'equivocator' with pollution. In principle it can be rather effective in carrying pollutants and contaminants away from areas of human habitation, but all too often it works the other way and acts to produce local increases of concentration on the ground.

First, we shall hear about problems of pollution in towns as a whole, described by Dr Craxford of the Warren Spring Laboratory, which has devoted itself so effectively to problems of air pollution reduction. Next, we shall consider the special problems of distribution of pollutants and contaminants in the locality of a building. We are very grateful to Mr McCormick for having

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

crossed the Atlantic to speak to us on this important topic. We thank also the U.S. National Air Pollution Control Administration for allowing him to come and make this presentation.

The University of Toronto Institute of Aerospace Studies is an outstandingly fine centre of work in aerodynamics and related fields, and it is a pleasure to welcome a very distinguished aerodynamicist from U.T.I.A.S., Professor Etkin, who will speak on a quite different potential aspect of architectural aerodynamics, and this time one that would definitely involve air working for us. The idea of light roofs being supported by the action of internal air pressure is already familiar enough, of course. However, Professor Etkin, in collaboration with an architect Mr Goering, will speak on the much more revolutionary concept of air acting *as* the roof itself. This idea might be distinctly expensive to realize, but it could well prove worth the cost if it enabled a large sports stadium such as Wembley to function and receive maximum takings even in the pouring rain!....

The object of this Meeting is *not* to present a cut-and-dried account of a subject in something near to its final state. This survey is taking place, rather, near the beginning of architectural aerodynamics—the subject has only just taken off, to use an aerodynamic metaphor—and we envisage it as a rapidly growing new area of interaction of the scientist, the engineer, the artist, the planner; one where the inevitability of deeper and deeper involvement in all these problems is completely clear, but where the direction of the big further advances that are going to take place is not so clear. We want to encourage discussion—discussion inside the meeting to the maximum extent, and also discussion outside it. There is an opportunity here, in fact, to get hundreds of interacting views on the future, on questions such as how to use the facilities that are available; how to plan new facilities; how to take full account of all that is known in design; what new ideas are needed from the aerodynamicist, the aeroelastician, the structural engineer, the meteorologist, the architect, the town planner.

To assist in all this, we organizers have arranged a tailpiece, or perhaps I should say a Grand Finale, in which Professor Owen of the Imperial College of Science and Technology will seek to probe this future, in the light of his very wide experience, and suggest to us all what the future may hold. He will be influenced, I am sure, by the new ideas which we will by then have heard voiced in the papers and in discussion during the two days' proceedings; proceedings to which we can all look forward with the keenest interest and pleasure, and from which I shall no longer seek to detain you.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES