THE MATHEMATICAL ASSOCIATION

ANNUAL CONFERENCE

FOR the first time Oxford was the venue of the Mathematical Association's annual conference, the largest ever, which was held during April. Members were accommodated at St. Hugh's (the College of this year's president, Dr. I. W. Busbridge), Somerville, Trinity and Wadham Colleges. They, with large numbers of non-resident members, attended the inaugural meeting in the Sheldonian Theatre and later lectures and meetings in the spacious new buildings of the Oxford College of Technology.

The Association was received on arrival by the Lord Mayor and Lady Mayoress at a civic reception, and later by the Vice-Chancellor and Mrs. Wheare at a University reception at Rhodes House. The Association's annual dinner was held in St. Catherine's College. One afternoon was devoted to group visits and tours. Parties visited the University Engineering Laboratory, the *Atlas* computer at Harwell, the Hydraulics Research Establishment, the University Press, and various other places of special interest in and around Oxford. The exhibition of working school computers was a special feature of the main conference. These computers, which were demonstrated by senior pupils from the eight schools exhibiting (Abingdon, Bedford, Exeter, Marlborough, Oundle, Rugby, St. Albans and Sherborne) were, with one exception, made by the schools concerned and included digital and analogue machines, together with some smaller 'games' machines.

The various official reports at the annual business meeting indicated that the Association is in a flourishing condition with many worth-while projects in hand and a membership of now more than 5,000. The Treasurer, however, sounded a clear note of warning that, with increasing costs, the normal rate of increase of membership will be insufficient to provide the necessary finance for all the projects to be completed. He set the Association a target of 7,000 members by its centenary year, 1971. The Schools and Industry Committee has been working on the £3,000 given by the British Petroleum Company, and has good hopes that further assistance will be available to enable it to continue work beyond present horizons. The Association's Diplomas (Teaching and Technology) are now well established and the Teaching Diploma is keeping abreast of modern trends of teaching.

Following the arithmetic, mechanics and statistics reports, the Teaching Committee is now taking a more general look at mathematics as a whole. In particular, the teaching of mathematics between the ages of eleven and sixteen is to receive special attention: an attempt will be made to synthesize the various 'mathematical projects' and form some conclusions. (Meanwhile, the Association is itself publishing a number of papers on selected 'modern' topics, written by individual members: these papers are not intended to represent the Association's considered views in these matters.) The Teaching Committee will also review its primary school and technical college reports with the view of rewriting them.

Mr. J. T. Combridge, reporting generally on "Current Affairs", spoke of the way in which the Association and the Institute of Mathematics and Its Applications are working closely together to the common good, each in its own field. He saw little danger that the advent of the Institute, which owed much to the Association for its inception and is now well established, would mean any diminution of the Mathematical Association.

The place of the computer in mathematical education is one topic in which the existence of a professional mathematical institution has helped the Association. They have both worked through the Joint Mathematical Council in deciding how best the computer needs of schools can be met, not only for class instructional purposes, but for familiarization courses for teachers. The present choice would seem to lie between the central computer based on a university or college of advanced technology, and the travelling computer. There is no support for individual computers for schools.

For the International Congress of Mathematicians at Moscow in 1966, the three topics to be discussed by the International Committee for Mathematics, and their United Kingdom sponsors, are: (*a*) the programme of university training in mathematics for the future physicist (the Institute of Physics and the Physical Society); (*b*) the use of the axiomatic method in secondary teaching (the Mathematical Association); (*c*) the development of mathematical activity in school children; the place of the problem in their development (the Association of Teachers of Mathematics).

Robbins and All That

Dr. I. W. Busbridge began her presidential address by directing the attention of the large audience in the Sheldonian Theatre to the building designed by a mathematician, Christopher Wren, and to Robert Streater's painted ceiling with its motif 'Truth descending upon the Arts and Sciences', and its mathematical significance.

In this age, if we are to achieve an educated nation, much "blood, toil, tears and sweat" lies ahead. Dr. Busbridge suggested that it was worth considering similar problems which must have faced Britain when the building of the Sheldonian was started in 1664. Galileo had died but twenty-two years before, the Royal Society had just been founded, Wren and Newton were young men, Halley a child, and, with the Commonwealth upheaval, the whole period was a ferment of ideas in many ways similar to our situation to-day. The Visitations at Oxford and Cambridge and their effect were paralleled to those of Robbins on the present university. It was of interest that the appointment in 1647 of John Wallis, for fifty years Savilian professor of geometry, was due to his predecessor being replaced by the Visitors for possessing Royalist sympathies. Both Wren and Halley must have been taught by him. The Visitors tried to impose new statutes on universities and colleges, but then, as now, Oxford demanded the right to take its own government into its own hands and to write its own statutes. Even then there were proposals for new universities, with London, York, Manchester and Durham all claiming consideration, and much outspoken criticism of the older universities. There were advocates for a university for every city, and suggestions for turning universities into scientific and technological institutes. With the Restoration came the reaction against science, and the dedication of the Sheldonian provided the popular preacher, Robert Smith, with an opportunity to damn the new philosophy.

In spite of this reaction, the golden age of British mathematics and mathematical physics blossomed: the time was ripe for Newton, whose *Principia* was initiated, and the printing paid for, by Edmund Halley, whose observatory is still to be seen in nearby New College Lane. This new learning found its way into the schools, and men such as Dr. Thomas Gale of St. Paul's School, later a Fellow and Secretary of the Royal Society, were firing the minds of boys like the young Halley. An important experiment in mathematical education was the foundation in 1673 of the Royal Mathematical School at Christ's Hospital to provide navigators for the Royal

Navy and merchant marine—an early technical section of a comprehensive school. The foundation had the benefit of advice and help from Sir Jonas Moore, inspector general of Ordnance, and one of the best practical mathematicians of the day, and the continuing interest of Newton, Flamsteed, Wren and Pepys, all governors of the school. Halley, who lived nearby, helped with the publication of the text-book on navigation. Unfortunately there was—just as now—a shortage of teachers of mathematics, and, in 100 years, no eminent mathematicians were produced by this School.

Before coming to the problems of the present day, Dr. Busbridge referred to a later 'Robbins Report'—the Royal Commission on the Universities of 1850. Although some steps had been taken before 1850 to establish degrees in science at Oxford and Cambridge and the setting up of laboratories at Balliol and Christ Church, the Commissioners made enlightened proposals regarding the provision of a School of Mathematics and Physical Sciences with two departments: (*a*) Pure and Applied Mathematics; (*b*) Mechanical Philosophy, Chemistry and Physiology, together with subordinate science. They also proposed that proficiency in mathematics might compensate for weakness in Latin in a new matriculation examination. The reactions at Oxford were violent, but reforms came steadily.

Turning to the Robbins Report itself, Dr. Busbridge considered the recommendations for a two- or three-subject degree to include mathematics, since "the great majority of undergraduate students of mathematics have neither the aim nor the ability to become mathematicians of the front rank, and, for them, somewhat less concentration would be appropriate, in order to make way for the study of some other suitable subject such as physics or chemistry". Dr. Busbridge, while completely in favour of two-subject courses involving mathematics provided such a course is well integrated, was concerned at the definition of 'front-rank' mathematicians. Assuming that such a mathematician is one capable of profiting from a postgraduate course in advanced mathematics, that is, those with first and top seconds in Finals, she disagreed profoundly with the suggestion that all the rest would be better doing two-subject degrees. It is well known that almost one-third of the students entering mathematics courses fall by the way. The proposals were: (*a*) more help and guidance to be given to first-year mathematics students—the year which even quite able students find difficult; (*b*) grants should be extended to allow mathematics honours failures to transfer to a double-subject honours course (this policy is understood to be now accepted in principle); (*c*) a lowering of the standard of the first-year course. However, she appreciated that each university must solve the problem for itself.

Dr. Busbridge was next concerned with the shortage of teachers of mathematics and, with the increased requirements of the universities and other colleges of further education, she feared a shortage in the schools for some time to come. The Oxford system of lectures to perhaps 150 undergraduates, with a wide range of abilities, made it desirable that there should be an adequate backing of tutorials; but this again created a staffing problem, though without two-way traffic at all levels, lectures cannot expect to be successful. The tutorial system is equally good for the "embryo Newton", the steady-going second-class man, and for the man at the bottom of the list. Dr. Busbridge did not advocate the abolition of the Oxford entrance and scholarship system. Her experience showed that among her most able students were those who on the results of the Advanced Level Examination for the General Certificate of Education would never have been selected.

The new school mathematics courses are bound to create problems over the next few years, and universities will have to design their first-year courses over that period so that all students arrive at the second year with a common basis of knowledge. This must be done without boring "modernists" who have been stimulated in their schools or confusing the "traditionalists" by not laying a true foundation for the new work. The Association's Universities and Schools Committee is trying to compile a basic syllabus which would be common to all Advanced Level courses for the General Certificate of Education and without which a first-year university course would be unintelligible. This basic syllabus would also be the backbone of the one-subject Advanced Level course, thus facilitating the transfer from science courses to mathematics.

Dr. Busbridge appealed for more experimentation in schools. She did not expect them to go all the way with some of the new projects, but hoped teachers would endeavour, whenever appropriate, to make injections of modern mathematics into the traditional system. This would stimulate both teacher and pupil. Syllabuses were never intended to be adhered to rigidly. Every teacher of mathematics has two objects: (*a*) to give to every student the opportunity of developing his or her mathematical powers to the full; (*b*) to foster those of special ability for the sake of the country as a whole and for the advancement of knowledge. Dr. Busbridge criticized the Leicestershire form of comprehensive schooling (with its junior and senior high schools) as it is likely to affect the fulfilment of these objects. The years twelve to fifteen are the most important in the production of the mathematician, yet, under the Leicestershire scheme, experience is showing that few qualified mathematicians are opting to teach in the junior high schools. For Britain to survive we have to increase the supply of mathematicians, and yet many local authorities are turning to the Leicestershire plan as the solution to all their difficulties. In the true comprehensive school no such difficulty is created. She considered that the Mathematical Association should press for a dovetailing of time-tables between the junior and senior high schools under the Leicestershire plan so that at least the 'A' streams would be taught by fully qualified mathematicians. In the universities the process of levelling up or levelling down is also working. Whatever happens, this must be a levelling up, since Britain needs the best mathematicians that she can produce if the 'brain drain' is ever to be slowed and a reverse flow stimulated. Eminent research schools must be built up which will provide such intellectual and material attractions that many of the ablest young mathematicians and scientists will choose to study in them.

In conclusion, Dr. Busbridge, viewing all the difficulties ahead, took heart from the past surrounding her audience. Life under the Puritans must have been pretty grim, and yet it was the continuing effort of men with vision and faith that brought in the golden age of British mathematics. Now, as in 1665, we need the vision of Christopher Wren and Robert Streater when they chose 'Truth descending upon the Arts and Sciences' as the subject for their great painted ceiling.

The Mathematical Association, the Institute of Mathematics and the Joint Mathematical Council

The first discussion of the conference was on what the foregoing bodies do for the teacher of mathematics, and was opened by Prof. T. A. A. Broadbent on the Mathematical Association, and Prof. J. G. Semple on the Institute of Mathematics and Its Applications and the Joint Mathematical Council.

Prof. Broadbent challenged members as to whether they were accepting their individual responsibility to see that things which needed to be done were done. In his view, the Association to-day offered very good value to members for their subscriptions, with a first-class *Gazette*, frequent reports, ample branches, diplomas, etc.

The Association's primary purpose is the teaching of mathematics, but we must appreciate that the mathe-

matics is at least as important as the teaching. We must teach good mathematics in a good way.

He was sorry to note how few of the younger university dons and lecturers were members. This he felt to be a bad thing on a number of counts, but particularly for the inevitable widening which must result in the gap between the universities and the schools, a gap which only the Association is qualified to fill.

Prof. Broadbent hoped to see more young men and women playing their full part in the activities of the Association, and charged the older members to see that this was possible and encouraged. This is not a matter of what 'they' should do; it is a 'do-it-yourself' problem.

Prof. Semple, secretary of the Joint Mathematical Council, outlined the steps which have led in the past two or three years to the setting up of a Joint Mathematical Council of the United Kingdom, and of an Institute of Mathematics and Its Applications. He paid tribute to the part which the Mathematical Association, and in particular Mr. J. T. Combridge, had played in their inauguration.

In addition to setting up the Institute of Mathematics and dealing with international conference matters, the Joint Mathematical Council has been mainly involved with two projects which both affect the teacher: (*a*) the setting up, under the Organization for Economic Co-operation and Development, of a national committee, under the chairmanship of Dr. E. Kerr (Salford Royal College of Advanced Technology), to report on mathematics as a component of the training of engineers to first-degree level in Great Britain; (*b*) the formulation of plans for improving the standard of mathematical instruction in schools and increasing the supply of trained mathematicians.

Dr. Kerr's committee has worked out a 'core' syllabus in mathematics for engineers which contains a substantial section on numerical analysis and computer programming science. It has also prepared a suggested Advanced Level syllabus which would provide the kind of school mathematical training most useful to engineers.

Discussions are now proceeding with the appropriate institute on how time for this core syllabus can be found from that at present allocated to other engineering subjects, and how mathematics departments generally are to equip themselves to teach in the spirit envisaged in the report from the Organization for Economic Co-operation and Development.

The Joint Mathematical Council's most difficult project has been that of the present complex of problems relating to mathematical instruction in general, and particularly in schools, both primary and secondary. The Council's approach to this problem has been taken under three main heads: (*a*) the possible danger of the threatened proliferation of General Certificate of Education syllabuses, and the possibility or desirability of some degree of control, for example, by means of agreed minimal core syllabuses at the various levels; (*b*) the provision of a regular and effective information service for all teachers of mathematics; (*c*) the expansion, both for the present emergency and on a permanent basis, of facilities for the in-service training of teachers of mathematics in schools.

To try to reach a decision on (*a*), the Joint Mathematical Council has charged all its constituent member associations, covering the university-level to the primary school, to examine this problem independently and to report back to the Education Committee of the Council on which selected Her Majesty's Inspectors of Schools are attending members.

The foregoing items (*b*) and (*c*) have not posed the initial problems that (*a*) has done and is likely to do. Recommendations for the in-service training of teachers and for the setting up of an information service for teachers have already been welcomed by the Minister of State for Education and are now under his consideration. These proposals include the setting up for the development of in-service training of teachers of: (*a*) local mathematics centres (each located in a school and covering a considerable group of primary and secondary schools in a local education authority neighbourhood); (*b*) regional advisory units (based on institutes of education); (*c*) a national committee. In addition, it is proposed that a national information centre should be established, located possibly in one of the larger institutes of education.

The subsequent discussion showed that the Association was very conscious of its failure to make an impact in the primary field and that the fault lay in the first instance with the members, who had failed to accept their responsibility as mathematicians to help to bridge the gap. Courses and lectures were arranged, but secondary and university teachers were all too conspicuous by their absence.

Mechanics Report and Other Discussions

The second and third discussions of the conference were on the Association's recently issued second reports on the teaching of mechanics and arithmetic in schools.

The Mechanics Report was described by the president as one of the Association's outstanding reports and a great addition to its literature.

Mr. J. T. Combridge, chairman of the Report Sub-Committee, outlined some of the thoughts which had guided its preparation. While applied mathematics is tending to disappear from the examination syllabuses, there is still plenty of applied mathematics which needs to be taught. It is a suitable subject for all secondary pupils whatever the age or ability, and it should provide the opportunity for co-operation with teachers of science subjects. It is most certainly not a dead subject: it is indeed a live and developing subject and teachers should endeavour to make it a live subject in keeping with modern times, whether by experiment or other means. The report endeavours to lead.

Mr. S. L. Parsonson (Harrow School) described the report as a spirited plea for the retention of a subject which surely must be needed in times when the demand for technologists, applied mathematicians, and scientists capable of doing applied research is so great. He blamed the examination system of the past twenty or thirty years for the subject's present disrepute. It has removed the subject from the real world into that of unreal problems, and any questions set involving a test of the principles of mechanics soon showed the students have a serious lack of understanding of the basic principles.

The only major criticisms of the report from the floor emphasized that frames of reference were not sufficiently stressed and that insufficient attention was directed to the needs of the teachers at the Certificate of Secondary Education level who need more guidance than their more highly mathematically qualified colleagues.

The problem of the mathematical model and the difficulty of setting examination questions which are both sensible and soluble at the appropriate level was one to which no ready answer was given. All were agreed on the early introduction of the use of vectors.

The Arithmetic Report (a completely new report to replace the previous 1931 report) was described by Mr. C. G. Nobbs, a member of the Report Sub-Committee, as one based on the concept that computation, seen as a mechanical process, is being left increasingly to the machine, and that the time thus saved allows a more informal approach leading to better understanding.

Mr. Ellerby (St. Dunstan's, Catford), speaking as a junior school master, felt that the report should have given more guidance, though this view was not supported from the floor. Many felt that teachers must be prepared to consider alternative methods which may seem equally desirable, weigh them and make up their own minds.

Some speakers would have liked to see statistics, as a branch of arithmetic, receiving even greater emphasis in the report.

The final discussion of the conference was on school mathematical societies. The main speakers were Mr. D. Hobbs (Exeter School) and Mr. A. R. Tammadge (Abingdon). Mr. Hobbs outlined the activities of an essentially practical society which thrived on the making of mathematical machines and models of all types, working computers being demonstrated. Mr. Tammadge spoke of the more culturally inclined senior society the *modus vivendi* of which was based socially and intellectually on that of the university society.

General Lectures

Dr. J. F. Scott, deputizing for Prof. McKie, gave the Association a most absorbing account of the early history of the Royal Society up to the early eighteenth century.

Prof. M. F. Atiyah, Savilian professor of geometry in the University of Oxford, speaking on "Linear and Non-Linear Mathematics", took members to some of the frontiers of mathematics to-day, indicating the unity and simplicity of the subject. He showed the significance of linear methods in various parts of mathematics and the advantages in translating certain kinds of non-linear problems into linear form: in this, one does not restrict oneself to finite dimensional linear problems but allows infinite dimensions.

Dr. K. Austwick, Department of Education, University of Sheffield, in an illustrated lecture entitled "Automation in the Classroom", gave a balanced idea of the way in which teaching machines can be used as an aid in the teaching of mathematics. The present machines, which are relatively unsophisticated, are mainly effective in the teaching of motor skills and are more useful for revision, remedial and self-tutoring work with students capable of constructing responses. Conventional teaching cannot fail to benefit. In this respect his concluding remark was very pertinent: "Any human teacher who can be replaced by a machine ought to be".

Mr. J. H. Durran (Winchester College), speaking under the title "Do-it-yourself χ^2", delightfully demonstrated how the testing of goodness of fit in statistical work can be approached in an intuitive and experienced way.

The final lecture and film of the conference was "I Do and I Understand—a New Look at Primary School Mathematics", by Mr. J. W. G. Boucher, a former primary school teacher, and now a Fellow of the Nuffield Research Foundation. The attendance and interest shown by members at this final lecture showed that there is an increasing awareness among mathematicians that, using as practical an approach as possible with young children, mathematics can become the favourite subject for all children.

Elections and Future Conferences

At the annual general meeting, Mrs. E. M. Williams was elected president for 1965–66. The following honorary officers were re-elected. *Treasurer*, Mr. R. E. Green; *Secretaries*, Mr. F. W. Kellaway and Miss R. K. Tobias; *Editor*, Dr. E. A. Maxwell; *Librarian*, Prof. R. L. Goodstein; *Assistant Secretaries*, Mr. K. J. Backhouse, Instructor Captain R. G. Cross, Mr. B. J. F. Dorrington, Miss E. M. Holman, Dr. E. Kerr and Mr. C. Steele; *Assistant Treasurer*, Mr. N. Q. Dodds.

The 1966 meeting will be held in the University of North Staffordshire during April 13–16, 1966. The centenary meeting (1971) is being planned for University College, London, where the inaugural meeting of the Association for the Improvement of Geometrical Teaching (now the Mathematical Association) was held in 1871.

R. G. Cross

SIXTY THOUSAND PERIODICALS

THE *World List of Scientific Periodicals** was initiated late in 1920, when Sir Sidney F. Harmer, director of the Natural History departments of the British Museum, wrote to Sir Peter Chalmers Mitchell, secretary of the Zoological Society of London, asking him to direct the attention of the Conjoint Board of Scientific Studies to the problems of what is now referred to as information retrieval. The multiplicity of periodicals, issued in various languages throughout the world, was already confusing. No single library held more than a fraction of the total number, and the Board was invited to consider the preparation of a list of scientific periodicals with an indication of the libraries where they were kept.

The Board adopted the suggestion, and work began late in 1921, under the guidance of the World List Association, incorporated as a limited company. The first edition concerned the years 1900–21; it was issued in two volumes of which the first, published in 1925, listed 24,128 titles, while the second volume, published in 1927, gave standard abbreviations and library locations. The second edition was issued in one volume in 1934, and covered the years 1900–33; the third edition, covering 1900–50, was issued in 1952 and reprinted in 1958. The present edition covers the years 1900–60 so that, like its predecessors, it attempts to include every periodical which survived into the present century. About a quarter of the entries are titles published since 1950 and the total number is now more than 60,000, and the *List* is now issued in three volumes. In spite of the inconvenience in handling which is inevitable in a multi-volume work of reference, this edition is even more generally useful, and readily consulted, than its predecessors. A new type-face has been employed, words used in the alphabetical arrangement are in bold type, and the number of cross-references has been increased. The transliteration of Cyrillic and Greek alphabets is in accordance with the recommendation of the Royal Society, modified and published as British Standard 2979 : 1958.

The abbreviation of titles of scientific periodicals according to a carefully considered system, which has been a feature of the *World List* since its inception, has been instrumental in effecting a degree of uniformity in bibliographic usage throughout the scientific world. The abbreviations in this edition follow a forthcoming British Standard, not greatly different from the system followed in previous editions.

This is to be the last edition of the *World List* compiled and produced in this way, by an Association which has no permanent staff and by editors whose main occupation is elsewhere. The first three editions were prepared under the supervision of the late Mr. W. A. Smith, of the British Museum. After his death, before work on the fourth edition was begun, Mr. Peter Brown, also of the British Museum, undertook the editorship with Mr. G. B. Stratton, of the Zoological Society, who has been associated with the *World List* from its earliest days. The Association has had four successive chairmen: Sir Peter Chalmers Mitchell, Dr. A. S. Neave, Dr. E. J. Holmyard, and the present chairman, Dr. L. Harrison Matthews. In future, it is proposed to continue the *List* in the form of an annual cumulation of the material published quarterly by *Bucop*, the British Union Catalogue of

* *World List of Scientific Periodicals Published in the Years* 1900–1960 Edited by Peter Brown and George Burder Stratton. Vol. 1: *A–E*. Pp. xxv + 1–532. Vol. 2: *F–P*. Pp. xx + 533–1186. Vol. 3: *Q–Z and Periodic International Congresses*. Pp. 1187–1824. (London: Butterworths, 1963, 1964 and 1965.) 500*s*. per set of three volumes.