MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association for 1955 was held during April 13–16 at University College, Leicester, under the presidency of Prof. W. V. D. Hodge, Lowndean professor of astronomy and geometry in the University of Cambridge. On April 14 the presidential address, entitled "Changing Views of Geometry", was delivered. Prof. Hodge referred to the late nineteenth-century view, expressed by Klein in the famous Erlanger Program, that geometry deals with properties invariant under a group of transformations, and pointed out that this formulation had been to some extent misleading and is by now certainly inadequate. By the 1920's, geometry had become separated from the main stream of mathematics and was indeed suffering from a temporary exhaustion, though the development of birational geometry had shown the need to break the tyranny of the Erlanger Program. Prof. Hodge suggested that a geometry to-day might be described as the study of a space with a structure; he analysed the meaning to be attached to the words 'space' and 'structure', and showed that this description would help to re-integrate geometry into the main fabric of mathematics. Whether the geometer works directly from axioms or through an algebraic representation is, Prof. Hodge thought, largely a matter of taste; but he declared that what is required from young people entering a university with the intention of studying geometry is not any great ingenuity in solving tricky problems, but a thorough understanding of what geometry is about, and a sound knowledge of the elementary techniques of the subject.

Mr. A. Prag (Westminster School) spoke to the meeting on "Mathematical Literature", mentioning some of the key developments to be found in the classical works of the early mathematicians, and illustrating these by reference to some of the bibliophile's treasures to be found in the Association's own Library. This is housed at University College, Leicester, and though chiefly used as a postal lending library, it was on show to members during the meetings. On April 15, the first item was a paper by Prof. R. L. Goodstein (University College, Leicester) on "The Definition of Number". He showed the logical difficulties which arise in attempting to give a definition of whole numbers, the Frege–Russell class theory leading to antinomies while the Peano axiomatic method fails to specify a unique set. The extension of the number concept to positive and negative integers, fractions and complex numbers was also critically described. Following this, the Association proceeded to a discussion of its recently issued report on "The Teaching of Mathematics in Technical Colleges"; those opening the discussion were Mr. F. W. Kellaway (North Hertfordshire Technical College), Dr. H. Frazer (Gateway School, Leicester) and Mr. A. J. L. Avery (Derby Technical College). The details of the report were commended; but members showed some anxiety about the general relations between education in the secondary modern schools and in the technical colleges, and with the alleged excessive wastage during the course of the normal five-year curriculum of technical education. The Association was glad to hear that an increasing number of technical students find their way to a university degree.

The first item in the afternoon session was a discussion of "The Disadvantages of a Mathematical Education", led by Mr. W. O. Storer (Department of Education, University of Birmingham); Mr. Storer thought that the logical training supposedly given by mathematics might be arid, and that mathematical insistence on accuracy might lead to intellectual arrogance. Some members were reluctant to accept these inferences. In the next paper, "High-Speed Computers and their Application to Lens Design", Mr. W. M. Wreathall (Taylor, Taylor and Hobson, Ltd., Leicester) outlined the methods of obtaining the optical formulæ required, and showed that the very laborious calculations needed in applying these formulæ could now be handled readily by modern high-speed computers. After tea, Dr. Paul White (University of Reading) asked "What is the Matter with Negative Mass?". Dr. White asserted that the young research student must be prepared to question and to analyse fundamental assumptions, and illustrated the attitude of mind required by suggesting that the consequences of supposing that a particle might have negative mass could be examined. Some of these consequences are surprising, and Dr. White concluded by exhibiting, not entirely seriously, plausible reasons for believing that the original state of the universe consisted of equal quantities of particles of positive and negative mass, but that fluctuations of distribution had ultimately driven the negative masses to great distances. The final paper, on April 16, "The Applications of Statistics to Industry", by Mr. M. J. Moroney (chief statistician, Unilever, Ltd.), assumed that members were familiar with the mathematical elements of statistics and discussed, with much wit and force, the means whereby works managers could be made to understand that many of their production and distribution problems are amenable to treatment by statistical methods which can be explained in simple terms.

The president of the Association for the year 1955–56 is Mr. G. L. Parsons, of the Merchant Taylors' School, Sandy Lodge.

HYDRAULIC CONVEYING OF SOLIDS

THE tendency of process industries to-day to change from batch-wise to continuous operation is reflected in a renewed interest in pneumatic and hydraulic transport and a wider application of these systems to the conveyance of materials of all kinds. In both cases, the underlying principle is the application of forces to the solid by a conveying fluid travelling through a pipe-line in turbulent flow, so that the solid is carried forward in suspension at approximately the same velocity as the fluid in the case of hydraulic conveying, and at a rather lower velocity in pneumatic conveying. The mechanism is complicated; but the parameters involved can be identified and investigated in comparatively simple plant.

Although hydraulic conveying has long been used for handling a variety of materials, including gravels,

mine tailings, china clay and coal, no theoretical treatment has been proposed upon which the size of an installation and the power consumption for a specific duty can safely be based. The design engineer is still forced to rely on such published data as are available, relating to a restricted range of materials and operating conditions.

During recent years, however, systematic research has been in progress, notably in Britain and in France, in an effort towards obtaining a better understanding of the mechanisms involved. The results of some of this work were described in three papers read before the Institution of Chemical Engineers on March 15.

The first paper, by D. M. Newitt, J. F. Richardson, M. Abbott and R. B. Turtle (Department of Chemical Engineering of the Imperial College of Science and Technology, London), gave a brief summary of previous work and included an account of an experimental investigation into the behaviour of a wide variety of materials conveyed in a pipe of 1 in. diameter in a circulating system. Data were given for suspensions of graded solids from 0·0008 to 0·15 in. in diameter, specific gravities in the range 1·18–4·6, and volumetric concentrations up to 33 per cent.

It was shown that, over the range of velocities attainable in the system, five distinct modes of flow can occur, varying from fully suspended flow at high velocities to flow with a bed of solid moving at a uniform rate in the lower part of the tube, at low velocities. When pressure drop is plotted against velocity for a given concentration of suspended solid, a curve is obtained showing a minimum pressure drop at some critical value of velocity not far removed from that at which deposition occurs with subsequent choking. Some interesting observations were also made on the flow characteristics of suspensions of solids of mixed sizes. It appears that the transport of a coarse material may be facilitated by the admixture of a small proportion of fines, resulting in an increase in the overall carrying capacity of the system for a given pressure drop.

The results obtained with a 1-in. pipe can be correlated with reasonable accuracy by an equation based on simple theory. It is interesting to note that the equations are similar to the empirical relationships obtained by Durant, the only important difference being in the index of the pipe diameter term.

The second paper, by R. A. Smith, related to work carried out at the Billingham Division of Imperial Chemical Industries, Ltd., on the pumping of suspensions of sand in water through horizontal pipes of 2 and 3 in. in diameter. Measurements were made with closely sized and with mixed materials, and it was found that the pressure drop is always greater than that which would be obtained with a true fluid of the same density and viscosity as the suspension. With the non-uniform materials, the experimental results can be correlated with those for particles of a single size, by using a mean particle size, giving the same surface/volume ratio as for the mixture. The selection of a suitable pump, which will handle the suspension without serious risk of blocking and, at the same time, will have a reasonably high efficiency, is an important feature in the design of an installation. The pump used in the present work was of the centrifugal type, and was found to operate at an almost constant efficiency for volumetric concentrations up to 24 per cent.

In the third paper, by K. E. Spells (formerly with Imperial Chemical Industries, Ltd., Widnes, and now at the R.A.F. Institute of Aviation Medicine, Farnborough, Hants), the experimental results of a number of workers were discussed, and a dimensional analysis of the variables of the process was attempted. It was shown that, in all cases, there is a minimum velocity at which transport can safely be effected, corresponding to the condition where particles start to fall out of suspension. As the velocity is increased, the pressure gradient tends towards that obtained with a true fluid of the same density and viscosity as the homogeneous suspension. Although this condition is approached asymptotically, Mr. Spells claims that it is generally possible to assess fairly accurately the 'standard' velocity at which the two pressure gradients coincide. The correlations are obtained with both vertical and horizontal pipe-lines, but are limited to conditions where the particle size is small compared with the pipe diameter.

D. M. Newitt
J. F. Richardson

EMBRYOLOGY OF MAMMALS

In 1914, "Contributions to Embryology" was started to cater for those studies of the Carnegie Institution's Department of Embryology as were likely to prove too long and too lavishly illustrated for ordinary technical journals. Few ventures in scientific publication can ever have been better justified. The "Contributions" have become—what they promised to be at the beginning—the major single source of our information about mammalian embryonic development. The earlier volumes were devoted chiefly to descriptions of human embryos, and to accounts of placentation and the development of the systems of the body. Franklin P. Mall, who initiated the publication, and who was the Department's first director, was also keenly interested in the study of the mammalian reproductive cycle. The "Contributions" have, therefore, also had a profound influence on the development of experimental endocrinology. Vol. 2, published in 1915, carried an article by G. W. Corner, the present director, on the corpus luteum of gestation. Corner's analysis of the phases of the menstrual cycle in the rhesus monkey appeared in 1923, and in 1927 the "Contributions" published the first major experimental study, by the late Edgar Allen, of the hormonal basis of the primate reproductive cycle. The study of primate reproduction was taken an important step forward in 1933 with a description, by Lewis and Hartman, of the segmenting human ovum. Then, in 1941, side-by-side in the same volume, there appeared an account by Hartman and Corner of the first segmentation division of the fertilized egg of a monkey, and a description, by Hertig and Rock, of segmenting human ova no older than eleven to twelve days.

Vol. 35, which has recently been published*, goes yet further. In addition to a series of distinguished monographs that deal with regional embryological studies (among which is one by Bartelmez and Blount on the formation of the neural crest in man), as well as several of a more experimental kind (including one by Wells and van Wagenen on the induction of pseudo-hermaphroditism in monkeys), the volume provides a further description, by Corner and Bartelmez, of early embryos of the rhesus

* Contributions to Embryology, 35, Publication No. 603, Nos. 231–241 (1954). Pp. 237 + 54 plates + 57 figs. 12 dollars paper bound, 13 dollars cloth.