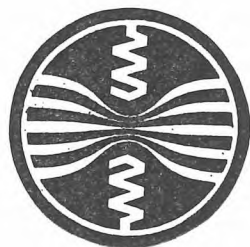


BULLETIN



BRITISH SOCIETY OF RHEOLOGY

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FOREWORD

From all reports the recent joint B.S.R./S.I.R. meeting at Shrivenham was a great success and members are already looking forward with eager anticipation to a similar meeting in the not too distant future. Two or three possible venues in Italy have already been mentioned during informal discussions, but has anyone ever considered a conference cruise? The warm tranquil waters of the Mediterranean would be most attractive for such an enterprise. Even the less expansive area of the Tyrrhenian sea includes a large number of attractive stopping places. The islands of Corsica, Sicily and Malta are conveniently grouped and even Tripoli and Tunis are within reach. Some of these places are not major tourist areas but offer the natural beauties of the countryside. Others, perhaps more popular, where a good evening's entertainment can be had offer beauties of a different kind.

At first sight this might seem to be an expensive venture and costs would need to be examined in detail. There would be some environmental compensations however in that during working sessions delegates would be away from the noise and distractions of a busy city. On the other hand time off could be spent in a variety of ways not always available in a single location.

OFFICERS AND MEMBERS OF COUNCIL 1974-75

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SIR GEOFFREY TAYLOR

All members of the Society will be saddened to learn of the death of Sir Geoffrey who was our first President from 1940 to 1942.

The following obituary is reprinted by courtesy of *The Times*.

Sir Geoffrey Ingram Taylor, O.M., F.R.S., who died on June 27th at the age of 89, was one of the most notable scientists of this century. Over a period of more than 50 years he produced a steady stream of contributions of the highest originality and importance to the mechanics of fluids and solids and to their application in meteorology, aeronautics, and many branches of engineering. He occupied a leading place in applied mathematics, in classical physics, and in engineering science, and was equally at home with the methods and attitudes of these three disciplines.

By a combination of penetrating insight, deceptively simple mathematical analysis, and correspondingly ingenious experiments, he was able to illuminate a large number of phenomena of different kinds. Many of his scientific contributions opened up whole new fields; he had the knack of being first. He was the personification of the peculiarly British tradition of applied mathematics, and carried forward the type of thought represented by Newton, Maxwell, Stokes and Rayleigh.

Profoundly original scientific thought came easily to him, and his character was entirely free from strain, artificiality or vanity.

He was born in London on March 7th, 1886, to a family in which genius had already appeared. His mother Margaret was the second daughter of George Boole, one of the pioneers of mathematical logic whose third daughter Alice also had remarkable mathematical ability but no formal training. His father was an artist. At University College School, Taylor had already been attracted to mathematics and science; and later at Cambridge, where he began a life-long association with Trinity College, he took first the Mathematical Tripos Part I and next the Natural Sciences Tripos Part II.

Embarking on research, he made his mark immediately by two successful pieces of work, one an experiment undertaken at J. J. Thomson's suggestion to test the new quantum theory, and the other a mathematical determination of the thickness of a shock wave. In 1910 he was elected into a Prize Fellowship at Trinity. A year later he was appointed Reader in Dynamical Meteorology at Cambridge, which was a temporary office founded to encourage the study of meteorology. Taylor's newly aroused interest in atmospheric motions was retained for many years and led to several important advances, including his pioneering work on turbulence. In 1913 he acted as meteorologist on the ship *Scotia* sent to initiate an ice patrol in the

North Atlantic, following the sinking of the *Titanic*; and in his spare time he flew kites from the mast head in order to get measurements of pressure, humidity and temperature at various heights above the sea surface, on which he based new theories about the vertical transfer of heat and water vapour by turbulent mixing of the air.

Soon after the outbreak of war in 1914 Taylor and a number of other Cambridge men joined the Royal Aircraft Factory at Farnborough to assist in experimental work in aeronautics. Characteristically adding adventure to his intellectual pursuits, Taylor decided that he should learn to fly as a part of this new work, and to parachute also, and did so. Aeronautics became another field of science in which he was to remain interested and to which he continued to make fundamental contributions.

After the war he returned to Trinity College as a lecturer in mathematics, and became a close friend of Rutherford. Rutherford gave him facilities for work in the Cavendish Laboratory, in a room alongside his own. This happy association with the Cavendish Laboratory and Taylor's appointment in 1923 to a Yarrow Research Professorship, newly-established by the Royal Society, opened up a tremendously productive phase of his research life which was to last until 1939.

In that period he made his most substantial and significant contributions to continuum mechanics, two of which stand out for comment. While at Farnborough he had been concerned with calculations of the strength of aircraft spars, and this led him later to think about the mechanism of plastic deformation of metals under load. A series of papers led him in 1934 to the idea that plastic strain of a metal crystal occurs by the sliding of one plane of atoms over another, over a finite area of the slip-plane which is bounded by an irregularity, or "dislocation", in the arrangement of the atoms. The concept of a dislocation and the related theory of strain hardening have provided the basis of much of the subsequent research in metal physics. The other of the two major advances concerned the turbulent motion of fluids.

As early as 1921 he had realised that analysis of the eddying and irregular motion of a fluid involved the statistics of continuous functions, and that the current representation of the fluid as a collection of discrete lumps was not adequate. But he was far ahead of his contemporaries, and it was not until after he had consolidated and extended his statistical description of turbulence in a series of papers published between 1935 and 1938 that the full significance of his work was appreciated. Both these major advances opened up new fields of work which were taken up by many scientists, and this was Taylor's cue to move on to other problems; he preferred always the simple mathematics and experiments that are appropriate for initial discoveries.

During the Second World War his services were much in demand by government committees, and he worked on a wide variety of defence problems, including underwater explosions and their effects on structures, dispersal of fog from aeroplane runways by lines of burners, the fragmentation of bomb casings, the ranges of large rockets, shaped charges for piercing armour plating, spherically expanding blast waves due to release of a large amount of energy (an atomic bomb), and a host of others.

In the closing phase of his scientific life, from 1945 onwards he continued, with undiminished zest and enjoyment, to devise beautiful investigations of whatever new phenomena took his fancy. He retired from his research professorship in 1952, although the Royal Society continued to support him and there was no change whatever in his mode of life. His research in this phase followed no strategic plan, and to others he seemed sometimes to be equally interested in the trivial and the profound; but anything he touched turned to scientific gold and no longer looked trivial.

He studied the method of swimming of very small creatures such as spermatazoa, the movement of large gas bubbles through water, thin sheets of liquid in air, the hydrodynamics of paper-making machines, a novel form of cavitation bubble in viscous liquids, and many other bye-ways of fluid dynamics. All these problems were relatively untouched, they could be studied by experiments performed on a small table and by mathematics covering one or two sheets of paper, and he saw that they had potentialities.

Taylor wrote over 200 scientific papers, of uniformly high quality and value, which have been collected and republished by Cambridge University Press in four large volumes.

Taylor was honoured for his work by a host of universities and learned societies in many countries. He enjoyed being fêted, with the simple pleasure of one who never took it for granted that his work deserved recognition. He was appointed OM in 1969.

No account of Taylor's life would be complete without references to his non-scientific activities. One cannot say "recreations" or "leisure interests" for work was play to Taylor; even "non-scientific" is not wholly right, for he was inventive while he played. He was passionately fond of small boats and sailing from boyhood, and sailed with his wife in their 19-ton cutter to the Shetlands, to Norway and to the Lofoten Islands. The anchor of the boat was awkwardly heavy, so Taylor designed a new one with a blade like a ploughshare which buried itself to the right depth in the sea-bed when dragged along; the new anchor was subsequently used by the Admiralty, in particular for holding "Mulberry" harbours in position. Travel always appealed to him, especially if it took him to strange places unknown to tourists and "unspoiled" by material development. With his wife he explored Borneo in 1929 after attending a

Pacific Science Congress. He was a keen and perceptive botanist, and took great pleasure in the familiar plants of his well-stocked garden in Cambridge and in what he saw elsewhere in England and abroad. All these pleasures made no demands on other people, and were shared with a few only.

In 1925 he married Stephanie Ravenhill and began a happy and life-long partnership. They had no children. His wife died in 1967.

REPORT ON 1975 SPRING CONFERENCE, ROYAL MILITARY COLLEGE, SHRIVENHAM, April 8th-11th, 1975

Following our successful joint meeting with the Dutch Society, this meeting was held jointly with the Societa Italiana di Reologia. Dealing with "Rheometry: Methods of measurement and analysis of results", the conference attracted a registration of 122. Over a third of these were from overseas, Italian members predominating, which was not surprising, but participants from France, Germany, Holland, Belgium, Finland, Israel and Australia were also present.

With nearly thirty papers to be digested, the dedicated conference-goer found that he (or she) had a great deal of hard work ahead of him (or her). The B.S.R. President, Professor K. Walters, took the Chair for the pre-coffee part of the Wednesday morning session which dealt with "Stretching and compressive flows". C. J. S. Petrie, University of Newcastle-upon-Tyne, opened the programme with "On stretching Maxwell Models". The transient responses of various Maxwell Models to uniaxial elongation under different conditions were calculated, and the results both serve as a basis for the design and interpretation of experiments in elongational viscometry and enable work on simple flows of simple models to help understand more complex flows. Professor D. Acierno, University of Palermo, then presented a paper co-authored with G. Titomanlio, G. Rizzo and G. Marrucci on "Molecular structure and elongational stresses in polymers". Dilute and concentrated polymer solutions were both considered. With concentrated solutions or melts the elongational viscosity agreed with the Trouton value, but dilute solutions, especially in highly viscous solvents, the extensional viscosity may be very large compared with the zero-shear viscosity. The results were explained on the basis of macro-molecular physics and the mechanics of polymer entanglement; theory and experiment showed satisfactory agreement. In the third paper, Dr. H. Muenstedt, B.A.S.F., Ludwigshafen, spoke on "Measurements of the elongational flow of polystyrene melts in creep experiments". Here the sample was held in an oil bath, which heated the sample, under a system of loading in which the actual weight of the sample was compensated for. A generalised Kelvin model was used to explain creep curves for polyethylene of various molecular weights and molecular weight distributions. Shift factors agreed well with those obtained by capillary and oscillatory methods and the master curves presented fitted the data excellently. Viscous and viscoelastic parts of the deformation both had the same temperature dependence, while elongational velocity was shown to be a direct function of molecular weight.

Professor Walters was one of the authors for the latter half of the session, so the chair here was occupied by Professor J. R. A. Pearson. Dr. N. E. Hudson (University of Strathclyde) co-authored a paper with J. Ferguson entitled "Elongational flow and the wet spinning

of polymer solutions". Residual stresses "frozen" in a filament formed by wet spinning were determined from studies in the pre-coagulation state using an elongational viscometer described by the authors at a previous conference. The transient tensile stress was shown to be a function of the shear history, and the results related to the wet spinning process as a whole. This was followed by Dr. D. R. Oliver, University of Birmingham, with "Combined shear and extension of polymer solutions". An aircraft safety fuel was examined with a triple jet system, which stretched it as it flowed from a capillary tube. Inserts in the capillary, or a change of tube length, enabled a varied shear history to be applied to the sample before elongation; pre-shearing greatly influenced the elongational viscosity and could raise it by an order of magnitude. This interplay should prove highly significant in the fields of lubrication and turbulence suppression. The last paper before lunch was given by Professor K. Walters, University College of Wales, Aberystwyth, in conjunction with G. Brindley and J. W. Davies. "An investigation of viscoelastic effects in squeeze films using a Weissenberg Rheogoniometer" was the subject. Here, a rheo was modified to perform in a squeeze film mode. With Newtonian liquids, the theory of the process gave excellent agreement with experiment, as was the case for elastico-viscous liquids at low Deborah numbers. With the latter, however, elastic effects had to be taken into account at high Deborah numbers, and when applied to lubrication performance, the results implied that the presence of viscoelasticity in the lubricant improved its performance.

So to lunch, which was of the very high standard that springs to the mind of B.S.R. members whenever the word "Shrivenham" is mentioned. For the afternoon session, Professor Acierno took the chair; the session now turned its attention to "Thixotropic systems". Presented by the former, J. C. Godfrey and K. Hemingway (University of Bradford) spoke on "Rheological measurement and interpretation for thixotropic fluids". The paper set out to show how to obtain useful data for applications from commercial viscometers and dealt with stress decay and recovery under steady shear conditions. Decay appeared to be a two component experimental decay. Next, Dr. C. E. Chaffey co-authored a paper with D. W. J. Osmond and F. A. Waite (I.C.I. Paints, Slough), entitled "Shear thinning and thickening in dispersions". Some concentrated non-aqueous colloidal dispersions of rigid spheres are shear thinning at low shear rates, but often thicken abruptly at high shear rates. Data were presented for suspensions of polymethyl methacrylate spheres in organic vehicles and variations with shear rate, particle size and free volume fraction investigated. The results—obtained on a rheogoniometer—were interpreted in terms of micro scale processes and allowed the interaction between particles to be estimated. This was followed by "Measurement and characterization of the flow properties of high solids vinyl dispersions in cone and plate viscometers" by D. C.-H. Cheng

(Warren Spring Laboratory) and B. Roberts (Pafra Ltd.); the paper was read by Mr. Roberts. Here, results taken on a Ferranti-Shirley were comparable to those measured with a rheogoniometer. Results could be fitted to either a "power law" equation (e.g. Ostwald, or Herschel and Bulkley equation, or a "sigmoidal" type (Cross; or Reed Eyring equations).

A break for tea, and then a further four papers on the more solid-like type of thixotropic material. Dr. G. R. Dobson (B.P. Research Centre) spoke on "The interconversion of grease flow curves between rheometers". For a Newtonian fluid, rotary viscometers give adequate data to predict pipe line flow characteristics of such fluids, but for non-Newtonian fluids, especially greases, corrections must be made for the distribution of velocity gradients within the viscometer (on which the predictions are based) arising from the non-Newtonian nature. The authors used numerical techniques to do this, and compared the results with exact solutions for certain model fluids. Numerical solutions were adequate for grease-like fluids, but were in error for materials possessing a yield stress. Results from pipe, concentric cylinder and cone/plate rheometers were successfully interconverted by these techniques. Next, J. F. Hutton (Shell Research, Chester) dealt with "On using the Weissenberg Rheogoniometer to measure normal stresses in materials which have a yield stress", and showed that at low shear rates, unusual effects could occur with this instrument when used with a cone/plate head, ascribed to interactions between the instrument and the yield stress property. At high rates of shear, normal stresses were encountered, but the presence of a yield stress was an interfering factor in the measurements. This paper was followed by one on "Comparison of nonlinear viscoelastic behaviour of dispersions under steady state and oscillatory flow as measured on the Weissenberg Rheogoniometer" by G. Schoukens, J. Mewis (Catholic University of Louvain) and A. J. B. Spaul (Brunel University); Professor Mewis presented the paper. The authors used carbon black in oil dispersions, aimed to characterise the variable structure of the dispersion by its viscoelastic spectrum, and succeeded in doing so. Additionally, transient non-linear behaviour under large amplitude vibrations was analysed, and interpreted. It was noted that these systems behave like a polymer chain system, even though no polymer is present. Finally, Miss P. T. Oittinen (Helsinki University of Technology) spoke on "Measurements of the viscoelastic properties of printing inks on a rheogoniometer". The diminutive, fair-haired figure of the B.S.R.s only Finnish member added a touch of gentleness to the proceedings as she talked of studies in which commercial inks had been used, together with suspensions of various carbon black grades and a TiO_2 pigment in typical printing ink media. Simple shear and oscillatory tests were made, and a flow curve model derived to describe samples having an apparent yield value. Normal stress results were given;

in all cases, efforts were made to relate rheological parameters to the structure of the suspensions.

So ended the first day's session, and after dinner, some delegates may have felt that after a twelve-hour stint involving three square meals and thirteen papers, they had plenty of ammunition to answer critics who greeted them on their return from a conference with the words "And did you enjoy your holiday?"

The Thursday session was chaired by Dr. K. M. Beazley. Dr. Plochocki of Warsaw was unable to attend the meeting, and his paper had to be withdrawn, resulting in a modest re-arrangement of the advertised programme. The sessions dealt with "Polymer melts" and "Instrumentation", and the first paper was "Thermal measurements and the dissipative mechanism in flowing polymers" by G. Astarita and G. C. Sarti of the University of Naples. Dr. Sarti described experiments where the total work done on a flowing polymer, and the accompanying temperature rise, were measured simultaneously. The temperature rise measured agreed with the value expected if the work done were completely converted to heat; thermodynamic analysis showed that the polymer melts studied behaved as viscoelastic materials with entropic elasticity. Dr. G. C. Locati, of S.N.A.M. Progetti SpA then took us on to the problem of "Die swell in molten polymers". A theory based on flow in short capillaries was derived on the assumption that the deformation experienced by the melt as it enters the capillary is essentially elastic, and as it passes through the capillary essentially viscous. The derived equation contained a relaxation time characteristic of the material; experimental measurements on molten high density polyethylene agreed well with the theory, provided this characteristic relaxation time was properly evaluated. J. L. Leblanc of the University of Liege then spoke on "A new slot die rheometer; some results on butadiene-styrene block copolymers". The instrument described was a modification of the extrusion part of a Zwick rheometer, which is a piston apparatus with a constant applied pressure. Results obtained from the instrument using butadienestyrene block copolymers—materials which resemble rubber without having to undergo vulcanisation—were presented.

A pause for coffee, and back to business. Dr. N. S. Parker (C.S.I.R.O. Division of Food Research, North Ryde, N.S.W. Australia) presented a paper co-authored with G. E. Hibberd (Bread Research Institute of Australia) on "Interpretation of the results of dynamic measurements on non-linear viscoelastic materials". A method was presented for characterising the dynamic mechanical behaviour of non-linear viscoelastic materials in terms of two frequency dependent moduli and two functions of the strain amplitude; the method is independent of sample dimensions. The authors continued by describing a method for determining the strain dependent functions from observations of the forces and the corresponding displacement

on a sample and applied the technique to bread dough sheared between concentric cylinders. Simple equipment here gave way to the more complex, when Dr. R. Stenson (E.R.D.E., Waltham Abbey), described "Experiments with the Rheometrics mechanical spectrometer". An appraisal of this instrument, which can characterise the behaviour of liquids and solids under steady state, transient and oscillatory conditions was given. Three divisions of I.C.I. joined forces to provide the last paper of the morning. This was "On the dynamic response of viscoelastic fluids" by J. J. Benbow (Agricultural), F. N. Cogswell (Plastics) and M. M. Cross (Organics), and was given by Malcolm Cross. The paper described the interrelation between the Maxwell and Voigt models of viscoelastic behaviour, and concluded that the Maxwell model was the more practicable.

The afternoon was left free for works visits and delegates had a choice of trips to Oxford, Stonehenge, or to the Great Western Railway Museum at Swindon, or the excellent sporting facilities were a temptation to the energetic, while yet others found a shopping trip helpful. Whatever the choice, not one vacant chair was to be seen at the Conference Dinner, which was the social highlight of the conference. Good food and wine are an excellent basis for good speeches, and these were certainly had. The President, Professor Walters, spoke briefly, and then handed the proceedings over into the capable hands of Professor Charlesby and Professor Astarita, whose witticisms brought another day to a very pleasant close.

The Friday morning session was chaired by Professor J. Smith (Delft), and the topic now was "Solids, pastes and composites". Opening the session were G. F. Battiatto and G. Ronca of S.N.A.M. Progetti SpA with "The influence of geometrical parameters on the mechanical behaviour of cylindrical specimens of bitumen subjected to axial loading". Loading tests carried out on cylinders subjected to uniaxial tension or compression can only be used to derive viscoelastic parameters when the cylinder is long, according to St. Venant's principle. The authors showed how to correct for the deviations experienced when short cylinders were used, and compared the theoretical predictions with experimental results for a soft bitumen. This was followed by "The glass transition temperature of semi-crystalline polymers from mechanical measurements" by G. Greco, L. Nicodemo and G. Migliaresi (University of Naples). Dr. Greco reported work using nylon-6 and nylon 6-6, in which it was shown that measurements made by differential scanning calorimetry gave results best interpreted from changes in the state of molecular bonding of the material, whereas mechanical methods, which seemed to be preferable, gave the glass transition temperature in terms of its classical meaning as due to the change in chain mobility of the amorphous regions of the sample. Our Italian colleagues carried on the good work as Professor L. Nicolais spoke of work done by himself and his University of Naples colleagues, D. Acierno, E. Bianchi, A.

Ciferi and B. de Cindio. This dealt with "The rheological properties of salted Nylon-6". Here, the melt viscosity and glass transition of derivatives of stabilised nylon-6 with LiCl, LiBr and KCl (up to 7 per cent weight/weight) were investigated. The glass transition was not affected by salt type and contact, whereas the rheological properties above that temperature were measurably affected. The results were interpreted in terms of ionic and molecular processes. Finally, the last paper before coffee considered "Flexural creep characterisation of rigid polymers: technique improvements and data handling" by A. Pavan, M. Rink and W. Lubert of Milan Polytechnic; Dr. Pavan presented the paper. Creep characterisation of rigid polymers in the low creep region is becoming of increasing importance. A simple method, based on three point bending, was developed. Viscoelastic parameters can readily be obtained with it, and the sensitivity is such that creep at times less than 0.1 sec. can be recorded. The customary method of superposing creep curves according to time-temperature superposition is questionable because the reduction factors are assumed to follow specific forms of temperature dependence, not necessarily true. A computer technique was developed by the authors which makes no such assumptions.

After coffee, the first paper was given by Dr. K. M. Beazley, co-authored with R. G. S. Stewart (English China Clays, St. Austell) on "Some observations on the tensile behaviour of paper". Results were reported on Instron measurements of paper formed of pulps beaten to different degrees, and in sheets of varying basis weights. It was shown that above a certain weight, paper could no longer be considered a two-dimensional network, but had to be treated as three dimensional. A method of estimating the relative bonded area of the fibres from the stress-strain curve was given, and shown to correlate with values of this parameter measured directly. Next, Dr. J. J. Benbow (I.C.I. Agricultural Division) spoke on "The measurement and interpretation of frictional effects during catalyst paste extrusion". A technique was described enabling the frictional behaviour of catalyst paste to be measured as a function of velocity and pressure under conditions comparable to those in a screw extruder. The results provided a link between the rheological behaviours in the barrel and die regions, and their variation with paste formulation was described. The last paper of the morning was "Dynamometric measurements on vulcanized rubbers with very small annular samples" by A. C. Bassi and C. Sganzerla, Pirelli SpA. Dr. Bassi gave the paper.

Lunch, and then the final session of the conference, with John Hutton (Shell Research) in the chair. "Temperature distribution in cone-plate and biconical viscometers" by R. W. Whorlow and P. T. Galvin, University of Surrey, was the first paper. Here, Dick Whorlow considered various combinations of elements with conducting or insulating cones and plates. The thermal distributions were calculated and the calculations checked with thermocouple measurements; agree-

ment was good. In one case cited a temperature rise of 15°C was found, which is clearly considerable. From here we moved on to "Handling normal stress data" by P. L. Langborne and Mrs. S. C. McKay, of N.E.L., East Kilbride. Both normal and shear stress data were considered for a liquid obeying the Oldroyd model. This work included an analysis in which the effect of experimental errors on the Oldroyd viscosity functions were examined. The authors also outlined a method for predicting fluid behaviour at shear rates outside the normal experimental range. This was followed by "Stress growth in shear flow" by D. Acierno, F. La Mantia, G. Titomanlio and G. Marrucci, University of Palermo. A generalised Maxwell model with a set of relaxation times was used to describe the behaviour of polymer melts and concentrated polymer solutions. In classical non-linear viscoelastic theory, the associated rheological parameters are made to depend on deformation or deformation rate; here the parameters are made to depend on structural variables which in turn are determined by rate equations. The process is used to examine stress growth in shear; the results compare well with existing data. And so to the last paper of the conference—"An instrument for the measurement of the rheological properties of soft solids in simple shear" by N. S. Parker and G. E. Hibberd, C.S.I.R.O., Australia. Dr. Parker described an instrument where the sample was subjected to uniform shear between parallel plates, and illustrated its use by the results of some measurements on wheat dough.

The notes on this meeting are necessarily brief, since it is not easy to give a concise summary of 29 papers. Twenty-nine papers is also quite a lot of lecturing time, and one could be excused for thinking that discussion was limited. Not a bit of it. Timekeeping was as good as the present writer can remember, either at a B.S.R. or another meeting, and ample time was available for discussion. It says a great deal for the high level of this meeting that discussion was never stinted (and often had to be curtailed, to enable the next speaker to give his or her paper) and added materially to the value of the proceedings.

There is no doubt that this was a very good conference (comments made to the writer after the meeting confirmed this), but good conferences don't just happen by chance. Warm thanks are therefore due to Neil Cogswell and David Cheng, who between them organised papers, domestic arrangements and visits. But we ought also to thank our friends of the Italian Society for suggesting that the meeting be a joint meeting, for supporting the meeting so magnificently, and enhancing a Spring Conference in these ways. It is to be hoped that a similar meeting may one day be held in Italy—At the Istituto Universitario Navale, Napoli, perhaps?

K. M. BEAZLEY

PUBLICATIONS

Factors influencing the performance of polyolefin mouldings A. C. Morris B.Sc. F.P.R.I.

14 pages 23 figures £1.20 post free Cash with order

A new P.R.I. booklet with the above title by Mr. A. C. Morris was published in March. The book is intended to assist designers and engineers in developing a better understanding of the properties of polyolefins, particularly in injection moulding. Whilst most of the information presented refers to polyethylene and polypropylene, the principles are applicable to other thermoplastics and some other moulding techniques.

Five main properties have been selected—creep, impact strength, environmental stress cracking resistance, chemical resistance and outdoor ageing. The effects of service conditions, polymer parameters, moulding design and processing conditions on these properties are discussed.

Mr. Morris joined Shell's Carrington Plastics Laboratory in 1960 and has considerable experience in standard testing, polymer properties, performance testing and injection moulding. He has written many papers on polyolefins and in 1968 was awarded the Plastics Institute's silver medal for his paper "Impact strength of thermoplastics".

PROGRESS OF RUBBER TECHNOLOGY FOR 1975

Tyre design, urethanes, recycling and accelerators/retarders—these are the subjects chosen for "in-depth" treatment in the 1975 issue of Progress of Rubber Technology (Volume 38), just published by the Plastics and Rubber Institute, Major "state-of-the-art" reviews by leading authors—Dr. E. R. Gardner on tyre design, the P.R.I. Urethanes Group on urethanes, Dr. D. G. Lloyd on accelerators/retarders and Mr. G. Cheater on recycling—provide an informed assessment of developments in these fields and underline areas of interest for the future. The volume also contains a review of world rubber and rubber-goods production statistics for the past year, contributed by Mr. R. Haynes. Progress of Rubber Technology Volume 38 runs to 115 pages, and is available from the P.R.I. at 11 Hobart Place, London SW1W 0HL, price £5.25 including postage (£1.75 to P.R.I. members).

Progress of Rubber Technology, now in its thirty-eighth year of publication, adopted its "in-depth" style of reviews in 1973. Authors now have the scope to examine developments throughout their field over recent years and to explore aspects which previously could not be covered.

The review of tyre design covers developments in cast and injection moulded tyres, safety tyres, replaceable tyres, winter tyres, tyre materials and manufacturing techniques. That on accelerators and retarders summarises developments in sulphur systems and discusses new crosslinking systems, EV-systems for N.R. and S.R., and curing systems for speciality polymers and blends.

B.S.R. MEMBER WINS HANCOCK MEDAL

The Plastics and Rubber Institute has announced that one of two Hancock Medals for 1974 will be awarded to Mr. D. Bulgin.

Mr. Bulgin was educated at Kings Norton Secondary School and Central Technical College, Birmingham. He is a Fellow of the Plastics and Rubber Institute and an Associate of the Institute of Physics.

He joined Dunlop in 1926 and has established a worldwide reputation for his work on the electrical properties of rubber. He invented the "Statigun" for determining electrostatic hazards and as an expert in this field has been widely consulted on problems in industry, hospitals and mines.

His study of pendulum measurement of rebound resilience brought improvements which established the Dunlop pendulum internationally. He also designed the rotary power loss machine, used in wartime for tank tyre development and recognised as a standard test method today.

Mr. Bulgin has been a member of many B.S.I. and I.S.O. committees. He has been associated with about 50 patents and has published over 20 papers.

FUTURE MEETINGS

POLYMER RHEOLOGY AND PLASTICS PROCESSING

September 16th-19th, 1975

Date and Venue

An international conference sponsored by the British Society of Rheology and the Plastics and Rubber Institute will be held at the University of Loughborough from September 16th-19th, 1975.

Programme

The programme includes thirty papers equally divided between industrial and academic workers, including eleven papers from overseas.

The first four sessions on Day 1 are entitled Principles and Properties, and contributors will discuss rheology in the broadest sense; the implication of polymer rheological behaviour in relation to machinery design and control; mechanical models of polymer solutions for strong flows with large polymer deformations; rheology in polymer processing; examples of the application of rheological data for the manufacture and processing of polyolefins; new methods for measuring rheological properties of molten plastics; aspects of rheology and processability of polypropylene; crystallisation of flowing melts; influence of plasticisers on the rheology of P.V.C.; viscosity of suspensions of spheres in polymer melts; phase separation effects in glass-containing polymer melts and characterisation of thermosetting materials for moulding.

Sessions five to seven will examine Plasticisation and Processing, and will include papers on: melting in single screw extruders; transport phenomena in the melting zone of a plasticating extruder; wall slip and its effect on single screw extruder performance; flow and mixing in double screw extruders; aspects of the callendering of plastics compositions; the extrusion of P.T.F.E. pastes; the realities of large blow moulding; development and current status of the extrusion coating process; thick wall extrusion of low density polyethylene of high molecular weight for dielectric applications. Session eight will debate attitudes to research into polymer rheology and plastics processing in industry and universities.

The final day will consider Shaping flows, and will include contributions on where the money goes in injection moulding; the relaxation behaviour of molecular orientation during the injection moulding process; rheotechnics approach to the mould-cavity filling process; the analysis of polymer processing operations involving free surface flows; the elongational phenomena in extrusion; prediction of time dependent non-linear stresses in polymer melts using a single integral constitutive equation with a generalised strain measure; the design of extrusion designs and will conclude with a review of polymer rheology and plastics processing: the past and the future.

Further information and registration forms available from Miss Keeble, Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL (Telephone: 01-245 9555).

"POLYPROPYLENE FIBRES IN TEXTILES"

September 30th and October 1st, 1975

Polypropylene has now been available commercially for about 20 years and world-wide usage in 1973/1974 was around 2.5 million tonnes. By 1980, assuming a steady growth and an improvement in the world economic situation, it is estimated that total world-

wide consumption will be as high as 6 million tonnes. It is used in many sectors of the plastics industry but probably the most interesting applicational area for Polypropylene is in the fibres field.

Approximately 30% of Polypropylene sales are for fibres of various types. The versatility of the material in such applications is due to its particular suitability for film fibres and also its increasing usage for textile fibre applications. The film fibre industry has reached its present important position because of the suitability of Polypropylene for various film fibre processes, and a range of new melt spinning techniques have been specifically developed for textile fibres. Economic incentives, technical developments, raw material and additive improvements have combined to ensure that Polypropylene is not only a major alternative to natural fibres (such as sisal and jute) but will also become a major factor in the textile industry. The time is thus appropriate for a detailed appraisal of the current status of the Polypropylene Fibre industry and also to assess its future role especially for textile fibres.

The Plastics and Rubber Institute (in association with the Textile Institute and the Shirley Institute) is therefore to hold the world's first major international conference devoted to all aspects of Polypropylene fibre technology. This conference, entitled "Polypropylene fibres in textiles" will be held at York University on September 30th and October 1st, 1975, and the timing has been chosen to fit in with the I.T.M.A. exhibition in Milan (October 6th-13th) and the Kunststoffe 75 exhibition in Dusseldorf (October 7th-14th).

The City of York is a delightful and historic place and its University facilities are very well suited for a major conference of this type. Further information is available from Mr. D. H. Cohen, Assistant Secretary (Activities), The Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL (telephone: 01-245 9555).

"HOW PLASTICS PACKAGING CAN HELP THE EXPORTER— A TECHNICAL VIEW"

October 1975

The Plastics and Rubber Institute's Packaging Group Committee, in association with the British Plastics Federation, is organising a one-day conference to inform British exporters of the many advantages of using plastics packaging for export goods.

The programme will aim to highlight the problems experienced by exporters, and suggest answers by the use of the appropriate plastics materials.

There will be two sessions. The first will set the scene and give statistical data on the tonnage of plastics packaging used in export

applications. Other contributors will discuss problems arising in packing pharmaceuticals, food, electrical goods and chemicals. In the second session, the materials suppliers will suggest means by which films, sacks, unitising methods, hollow containers and shockproof packaging can help answer exporters' problems. A final review paper covering international aspects (legislation, etc.) will complete the programme.

The conference should be of particular interest to British exporters in general, and to the engineering, pharmaceutical, food and chemical industries and to the plastics packaging sector of the plastics industry.

The conference will be held in London in October 1975. For further information please contact: Miss S. M. Keeble, Executive Officer (Meetings), The Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL (Telephone: 01-245 9555).

CONFERENCE

RECENT ADVANCES IN INJECTION MOULDING

November 11th-12th, 1975

The Processing and Engineering Group of the Plastics and Rubber Institute is organising a two-day conference entitled "Recent advances in injection moulding" which will be held at the St. John's Hotel, Solihull, Warwickshire, from November 11th-12th, 1975. This follows on from the Kunststoffe (K75) Exhibition in Dusseldorf.

The first day will be devoted to a review of developments in machine control systems. A number of papers will attempt to explain why it has been necessary to develop the more elaborate control systems now available (and becoming in more common use), how different approaches to these problems have produced different solutions and how end-users, i.e. moulders, have reacted (both favourably and unfavourably) to this available hardware.

The morning session of the second day will cover improvements in melt-preparation with papers on the development of the design of the screw and the screw-end and nozzle, the evolution of vented barrels and their advantages, and an account of the development of a screw designed for use in a new way.

The final session of the conference will deal with two of the newer injection moulding techniques: the use of foam materials and the injection-blow method. The conference will close with a review of the future of injection moulding and how this is likely to be influenced by material costs, capital cost of plant and the demand for larger components.

For further information, please contact Miss S. M. Keeble, Executive Officer (Meetings), The Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL (Telephone: 01-245 9555).

"POLYMERS AT WORK"

"Polymers at work" will be the title and theme of the Plastics and Rubber Institute's third annual National Conference, to be held at the Royal Lancaster Hotel, London, on November 12th-14th, 1975. Organised by the London Section (Rubber Division), the conference will be divided into sessions on applications, design and production developments, materials and future trends. Twelve papers will be presented. The Conference Chairman will be Mr. J. M. Buist, P.R.I. Chairman of Council.

On the afternoon of the first day the thirtieth Foundation Lecture will be presented by Professor Geoffrey Allen, Professor of Chemical Physics and Head of the Department of Chemistry at Manchester University. The subject will be "Two worlds of rubber technology: new products, new properties for industry".

A cocktail party, sponsored by materials suppliers, will be held on November 12th. The conference dinner will be held on November 13th, with the Confederation of British Industry's Director General Mr. Campbell Adamson as guest speaker. A ladies' outing to Windsor and Hampton Court has also been arranged.

Conference brochures giving full details are now available from Mr. R. H. Craven, Deputy Secretary-General, The Plastics and Rubber Institute, London SW1W 0HL (Telephone 01-245 9555).

For further information please contact Mr. M. J. Quinlan.

THE APPEARANCE, PROTECTION AND RESTORATION OF BUILDINGS—THE ROLE OF PLASTICS AND RESINS

The Building and Construction Group of the Plastics and Rubber Institute, in association with the organisers of the 36th International Building and Construction Exhibition (Interbuild), is to hold a 1½-day conference entitled "The appearance, protection and restoration of buildings—the role of plastics and resins" at Olympia on Wednesday 19th and Thursday, November 20th, 1975.

The aims of the conference are to:

- (a) help architects, engineers and builders to appreciate the role that plastics and resins can play in the production and maintenance of durable and aesthetically pleasing structures; and

- (b) help raw materials' suppliers and fabricators to appreciate the requirements of the building industry and how their products relate to other materials currently in use.

The two days of the programme will be separately registerable. Further information is available from Mr. D. H. Cohen, Assistant Secretary (Activities), The Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL (Telephone: 01-245 9555).

GROUPE FRANCAIS DE RHEOLOGIE

Annual Conference: December 1975

"The rheological behaviour of materials at elevated temperatures"

The discussions will cover metals, concrete and polymers, and all temperatures up to the flame point. Further information may be obtained from:

Secretariat du G.F.R.,
12 rue Brancion,
75737 Paris,
CEDEX 15, France.

VIIIth INTERNATIONAL CONGRESS ON RHEOLOGY

Chalmers University of Technology, Gothenburg, Sweden,

August 23rd–August 27th, 1976, under the auspices of the

International Committee on Rheology

The Congress will be held under the auspices of the International Committee on Rheology under the Honorary Presidency of Dr. R. S. Marvin. The Swedish Society of Rheology, a section of the Swedish National Committee for Mechanics, will act as the host organisation.

All aspects of rheology are within the scope of the Congress. Contributions that aim at a reduction of the diversity of the theoretical and empirical framework by introducing new unifying concepts will be especially welcome. Increasing evidence pointing towards far reaching similarities in the flow behaviour of substances with widely varying structure seems to support such an approach.

Scientific Programme

The scientific programme will consist of invited and contributed papers.

Contributed Papers

Participants intending to contribute papers are asked to give the title and a summary (maximum 300 words) with the preregistration

form, which should be returned before October 1st, 1975. The final selection of the contributed papers will be made by a scientific committee.

The time allowed for the presentation of papers will be specified in the Second Circular.

Publication

The contributed papers will be published as brief scripts containing the main results, illustrations and tables. These scripts will in no way preclude subsequent full publication. Together with the full text of the invited lectures, the scripts will constitute the Proceedings of the Congress. The brief scripts of contributed papers will be required by February 15th, 1976. They should have a length of maximum 1,500 words. If figures or tables are included, the text should be correspondingly reduced. Further details will be sent to the authors later.

Language

The use of English as the Congress language is recommended. No simultaneous translation will be provided.

Honorary President:

Dr. R. S. Marvin, National Bureau of Standards, Washington, D.C., U.S.A.

Organising Committee:

Professor J. Kubát, Chairman, Chalmers University of Technology, Gothenburg.

Professor E. Forslind, Royal Institute of Technology, Stockholm.

Professor L. E. Gelin, Sahlgrens Hospital, University of Gothenburg.

Professor F. K. G. Odqvist, Royal Institute of Technology, Stockholm.

Scandinavian Co-ordination Committee:

Professor A. Björkman, Technical University of Denmark, Lyngby.

Professor J. J. Lindberg, University of Helsinki, Finland.

Dr. N. Bergem, Central Institute for Industrial Research, Oslo, Norway.

7th INTERNATIONAL CONGRESS ON RHEOLOGY

Gothenburg, August 23rd-27th, 1976

A special group travel scheme on regular scheduled flights is being arranged for delegates, their families, and accompanying persons attending the above Congress by Express Boyd Limited, 4/5 Bonhill Street, London EC2A 4BX (Tel. No. 01-628 6060), in conjunction with the British Society of Rheology. By travelling on the tours detailed below, substantial savings on regular costs can be made. It is essential that early bookings are made as space is limited; however, in the event of cancellation in writing made before April 5th, 1976, all deposits paid will be refunded in full.

Tour No. 1

Depart London (Heathrow) Airport on Saturday, August 21st, by S.A.S. flight S.K. 522 at 11.55 hours, arriving in Gothenburg at 13.40 hours. Transfer to hotel for 7 nights' accommodation. On Saturday, August 28th, transfer from hotel to airport for return by S.A.S. Flight S.K. 521 departing at 08.55 hours, arriving back at London (Heathrow) Airport at 10.55 hours.

Tour No. 2

Depart London (Heathrow) Airport on Sunday, August 22nd, by British Airways Flight B.E. 786 at 16.20 hours, arriving in Gothenburg at 18.05 hours. Transfer to hotel for 7 nights' accommodation. From Sunday, August 29th, to Sunday, September 5th, you will be free to make your own arrangements (e.g. to visit other parts of Sweden, etc.). The return on Sunday, September 5th, will be by British Airways Flight B.E. 787, departing at 19.00 hours, and arriving back at London (Heathrow) at 20.45 hours.

Costs per Person (applicable to both Tour No. 1 and Tour No. 2) *with accommodation at the:*

	<i>in twin-bedded room</i>	<i>in single room</i>
Hotel Volrat Tham	£70.00	£86.50
Hotel Opalen	£100.00	£118.00
Hotel Europa	£108.00	£131.00

All costs include economy class air travel by regular scheduled services as described, 7 nights' accommodation in twin-bedded rooms with hot and cold running water (at the Volrat Tham Hotel), and with private bath and W.C. at the Hotels Opalen and Europa, Continental breakfast daily, hotel service charges and local taxes, transfers airport/hotel and vice versa.

Please complete both sides, detach and return to Express Boyd Limited, 4/5 Bonhill Street, London EC2A 4BX, *as soon as possible but no later than January 12th, 1976*

Re: 7th International Congress on Rheology
Gothenburg—August 23rd/27th, 1976

Please book place(s) on Tour No. 1/2* to Gothenburg as described, with accommodation in twin-bedded/single rooms* at the Hotel Volrat Tham/Opalen/Europa.*

Insurance details are/are not* required.

* Please delete as applicable.

General

The Hotel Volrat Tham is a modern multi-storey summer hotel in a residential section of Gothenburg, about three miles from the town centre, and approximately 4 minutes' walk from the Congress venue at the Chalmers University of Technology. Outside the summer period (June 1st–August 31st), it is used as student residential quarters. The Hotel Opalen is a modern superior first-class hotel about 5 minutes' drive from the railway station and city centre, on a main thoroughfare, and approximately ten minutes' walk from the Congress venue. All rooms are with private bath, telephone and radios, and the Hotel has its own restaurant and bar. The Hotel Europa is a superior first-class commercial hotel in the heart of the city, and is of a higher standard than the Hotel Opalen. It is not within walking distance of the Congress venue, but there are trams which operate from near the Chalmers University of Technology to the City Centre. All rooms at the Hotel Europa are with private bath, radio and TV., and the Hotel has its own restaurants, cocktail bar and lounges.

Prices quoted are at this stage approximate, and are based on a minimum of 20 participants for each tour at currently prevailing rates for commodities and exchange. It is possible that these will alter as rates for 1976 are not yet known, and in that event appropriate adjustments will be made when invoices are issued, approximately six to eight weeks before departure.

It is strongly recommended that you arrange comprehensive insurance against loss of baggage and money, personal accident, medical expenses and cancellation, before travelling. Please tick the appropriate space on the booking form if details are required. A valid passport is required for travel to Sweden; no visas or other health certificates presently being required by holders of British passports issued in the U.K. and resident there.

EXPRESS BOYD LIMITED

JUNE 1975.

I enclose a deposit of £10.00 per person to secure reservations, and understand this will be refunded in the event of written cancellation being received before the April 5th, 1976.

Name

Address

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Telephone No.

Names of Accompanying Persons

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NOTICE OF ANNUAL GENERAL MEETING 1975

The Annual General Meeting of the British Society of Rheology will be held on Wednesday, September 17th, at 17.30 hours at the University of Loughborough.

Council's nominations for 1975-76 are as follows:—

<i>President</i>	Professor K. Walters.
<i>Secretary</i>	Mr. F. N. Cogswell.
<i>Treasurer</i>	Dr. D. R. Oliver.
<i>Memb. Sec.</i>	Dr. T. E. R. Jones.*
<i>Editor Abstracts</i>	Dr. D. E. Marshall.
<i>Editor Bulletin</i>	Mr. M. Camina.*
<i>Ordinary Members</i>	Dr. K. M. Beazley.
	Dr. D. C-H. Cheng.
	Mr. T. T. Davenport.*
	Mr. A. Evans.
	Dr. J. Ferguson.*
	Dr. J. M. Hobbs.*

* Signifies for election.

DIARY

1975

16-19 September. B.S.R./P.R.I. Conference "Polymer Rheology and Plastics Processing", Loughborough University.

17 September. A.G.M., B.S.R., Loughborough University.

30 Sept.-10 Oct. "Polypropylene Fibres in Textiles", York.

October. "How Plastics Packaging can help the Exporter", London.

11-12 November. "Recent Advances in Injection Moulding", Solihull, Warwickshire.

12-14 November. "Polymers at Work", London.

19-20 November. "The Appearance, Protection and Restoration of Buildings", London.

1976

8-9 April. "Colloid Rheology", Bristol.

LETTER TO THE EDITOR

Dear Sir,

A research programme is currently being undertaken at the Management Centre of the University of Bradford into the employment problems of professional people who become physically disabled during the course of their professional career. This immediate concern of the programme is with the rehabilitation needs of such people and the relevance of the present government rehabilitation services to them.

Within the United Kingdom rehabilitation services are more directly concerned with the semi-skilled, skilled and clerical worker. Even the occupational therapy within hospitals appears to be of more benefit to these workers, relative to their future employment, than to professionals. It is suggested that rehabilitation for the professional, regardless of profession, should reflect the need of the professional to practice professional thinking during the time he or she is unable to work. In other words, as well as the usual rehabilitation services there should also be provision for what may be termed "educational rehabilitation."

In order that the research may be more than an academic exercise it is vital that the Management Centre learn the views, comments, and experiences of disabled professionals. To that end, therefore, it is hoped that this letter will be printed in your publication (and in the publications of many other professional associations, societies and institutions) in order to appeal to those of your readers, disabled or not, with any knowledge of rehabilitation (or, indeed, the lack of it) to write to the Management Centre. Their replies will, of course, be treated in strict confidence and will be of invaluable help.

Thank you for your co-operation.

Your faithfully,

MELVYN KETTLE, M.Sc., C.Eng.,
M.I.Prod.E., A.M.B.I.M.,

Production Management Research Unit,
Management Centre,
Emm Lane,
Bradford,
Yorkshire BD9 4JL.

NEW MEMBERS

Mr. J. Barbenel, B.D.S., M.Sc.	Bioengineering Unit, University of Strathclyde, Wolfson Building, Glasgow.
Mr. S. P. Bentley, M.Sc.	Civil Engineering Dept., Leeds University, Leeds.
Mr. G. O. Jones, M.A.	Chemical Engineering Dept., University College of Swansea, Singleton Park, Swansea SA2 8PP.
Dr. M. J. Folkes, Ph.D.	Dept. of Materials, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL.
Mrs. Li-Yar Lee Kao, M.S.	Rheology Research Centre, E.R.B., 1500 Johnson Drive, Madison, Wisconsin, U.S.A.
Mr. J. Laven, drs	Delft University of Technology, Lab. of Physical Chemistry, Julianalaan 136, Delft, The Netherlands.
Mr. J. S. Lumley, B.Sc.	A.P.C.M. Research Dept., 305 London Road, Greenhithe, Kent DA9 9JQ.
Mr. A. O. Peterson, B.S.	6050, West 51st Street, Chicago, Illinois, 60638, U.S.A.
Dr. W. A. C. Swift, Ph.D.	Dept. of Mechanical Engineering, The University, Sheffield, S1 3JD.
Dr. A. Wilkinson, Ph.D.	I.C.I. Organics Division, Stevenson Works, Stevenson, Ayrshire.

RESIGNATION

Dr. T. Richards	45 Maxstoke Rd., Sutton Coldfield.
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