

THE BRITISH SOCIETY OF RHEOLOGY

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THE BRITISH SOCIETY OF RHEOLOGY  
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1992/93

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## EDITORIAL

It is fifteen years since the Society conducted a survey of members' opinions or, in some cases, guesses about the future of rheology in Britain. Neil Cogswell was one of the authors of a report of the survey which was published in the Bulletin in 1978 and kindly agreed to write an article discussing the extent to which our vision has been fulfilled. The resulting thought-provoking article appears in this issue and is a timely precursor to a discussion to be held in Council in December this year.

We would like you to give us your views on the role of the British Society of Rheology in time for that meeting. Are we viable as a separate body? Can we continue our activities through calling on members' spare time? Should we merge or otherwise allow ourselves to come under the umbrella of another body? Are our meetings and our publications still fulfilling a need? Are we reaching the right audience? How can we encourage younger members? Please send us your comments.

Members will have an opportunity to refine their opinions by discussion with colleagues at the Autumn Conference and AGM in Cambridge in September. The technical sessions are of a high quality and the other events in and Robinson College and elsewhere promise to make it a memorable meeting. Malcolm Mackley is waiting to hear from you, using the form inside this issue. I look forward to seeing you in Cambridge.

Copy date for the next issue is September 15th.



## DELPHI REVISITED

In 1978, Council sought the collective wisdom of the Society to try to establish likely developments in rheology over the next fifteen years. This was with the intention of developing the policy of the Society to meet changing needs. Such 'Delphi' studies give the opportunity to highlight any areas where the inertia of an organisation is pushing it along a course which may not be consistent with the changes taking place about it. The idea of inertia in an organisation as intrinsically flexible as the British Society of Rheology may seem overweight, but there is also the inertia of tradition, which in our case, draws heavily upon the camaraderie of the British Rheologists Club. It was concern that such traditions may not have been appropriate to a Society dedicated to the Science of Change which prompted this consultation in 1978. Of all organisations, ours should not be unaware that, when he said 'panta rhei' Heraclitus was speaking of flux in Society. The study was approached without fear of change, but, equally, without seeking change for its own sake.

The results of the study were published in the Bulletin under the title 'Rheology in Fifteen Years'<sup>1</sup>. The general view, expressed in some cases rather forcibly, was that members liked the Society as it was and only rather minor changes should be expected, or even countenanced, in the time scale of fifteen years.

Most 'Delphi' studies are soon forgotten, usually to the relief of those who were involved in conducting them. In this case, it was the diligence of the Editor of the Bulletin which prompted him to search the files and ask how accurate were those predictions.

About 15% of the membership, representing a fair cross-section, responded to the survey. The format of the questionnaire was divided into six sections considering: materials, techniques, the role of rheologists, the balance between theory and empiricism, education, and the role of the Society.

## MATERIALS OF INTEREST

In 1978, multiphase liquids and polymers were the main interests of members.

There was confidence (62%) that the importance of multiphase liquids would continue to grow. That confidence is reflected in current publications.

The future was less clear with respect to polymers: the confidence in growth was still strong (41%); but there was a significant minority

(6%) who anticipated a reduction of interest in this sphere. While polymers are still holding their own in the field of publications, the minority opinion deserves recognition. As noted by a correspondent in Brussels<sup>2</sup> there is more than just a whisper that 'there is too much work on polymers'.

John Benbow, who was President at the time of the survey and is now the Archivist of the Society (that is one development that was not predicted!) observes that, today, we are much more concerned with composite materials in the broadest sense, paying more attention to concepts like plasticity theory and particulate properties with rather less emphasis on visco-elasticity.

Of minority interests, biological systems was selected as the main growth area (61%). The subject of Biorheology has grown significantly in the last fifteen years; it is less clear that it has grown within the Society rather than outside it. I suspect that biorheologists know rather more about main stream rheology than main stream rheologists know about the key interests of biorheologists. This is a question that needs an expert answer — letters to the editor please!

#### MEASUREMENT TECHNIQUES

Three major areas of growth were foreseen: stretching flows, surface rheometry and oscillatory measurement.

In respect of stretching flows there has, undoubtedly, been a boom. Although interest in such techniques is probably higher today than in 1978, recent experience in organising meeting about such techniques<sup>3</sup> suggests that the tide may be on the ebb, especially amongst the industrial fraternity.

I cannot detect evidence of the expected increase in surface rheometry. Perhaps the response in 1978 reflected a perception of need which, for reasons of experimental difficulty, it has not yet been possible to answer.

No such difficulty has constrained the growth of oscillatory techniques. It might be unfair to say that most papers in this area before 1978 explained how to modify commercial rheometers to obtain meaningful data, but it is manifest that today there is not only a wide range of commercial instruments, but those instruments have good reputations for reliability and reproducibility. Today, thanks to the wonders of in-line micro-computers, the whole visco-elastic spectrum seems to be available at the push of a button.

This availability of data has raised some eyebrows. One initiative, undertaken by Council, has been a call for 'glasnost' on the part of instrument manufacturers, so that users can more readily

understand how the sophisticated data is achieved. Perhaps a little tension has arisen here between the instrument maker, who wishes to preserve his competitive edge which may often be in the software of his instrument, and the user, who is concerned in case he is tying his shoelaces in knots.

One particular growth area, which was not foreseen, has been the evolution of constant stress techniques to complement measurements at constant rate of deformation. This is actually a return to ancestral roots, for many of the earliest home-grown instruments tended to operate under predetermined stress. It was the electric motor and load transducer which brought about the dominance of fixed rate techniques, rather than any rheological reason.

John Benbow highlights the dramatic increase in the use of micro-computers for statistical analysis of results and data fitting over this time period. He hopes that this has not detracted from the need to observe material behaviour with a good pair of eyes and sensitive touch. This concern was even more forcefully expressed by David Cheng in 'The Art of Coarse Rheology'<sup>4</sup>, when he spoke of the danger of data diarrhoea combined with constipation of understanding.

A wide array of sophisticated commercial rheometers is now commercially available. This is a matter for great satisfaction. It is also a matter of financial significance to the Society, since competition between the instrument companies leads to advertising revenue at a level that the Treasurer probably would not have even dreamed of in 1978. To a generation of rheologists who built their own measuring techniques this growth of commercially available equipment may be viewed with both envy and concern. It is important that we continue to measure the response of the material that is important to us rather than collect impressive looking data because it can be easily collected.

#### THE ROLE OF THE RHEOLOGIST

The study was evenly divided in its view, expecting the interpretation of practical flow phenomena, the characterisation of materials, and the use of rheological data in design to be equally important activities. While the first two of these interests are well represented in the published literature, it is not clear that the use of rheological data in design represents a third of our activity. This is likely to be an area where proprietary interests are at stake, so that publication in the open literature may be constrained. One clear area of growth in the design field is the use of electro-rheological fluids. What are the other areas where the rheologist sees himself as designer?

## APPROACHES TO RHEOLOGY THEORY AND EXPERIMENT

Undoubtedly the most depressing prediction of the survey was the expectation that, in 1993 'We shall be discussing much the same phenomena and theories at a more sophisticated level with an increasing polarisation between empiricists and theoreticians'. 80% of respondents considered this to be more rather than less likely.

The rheologist of 1978 would find little to be surprised at in the subject matter under discussion at our conferences today, and it is probably true to say that there has been no startling rapprochement between these two approaches but, is it really true about increasing polarisation between theoreticians and empiricists?

There have, undoubtedly, been significant advances and sophistication in theoretical understanding — at least judging by the weight of paper that those theories have been printed on. It is, however, not clear that empiricists have any greater appreciation of the finer points of those theories. This would suggest a real widening of the gap, but John Benbow detects that theoreticians have become more practically minded. John strongly believes that it is the theoreticians, with their bird's eye view of the field, who hold the key to integrating our understanding and showing how practical solutions achieved can be translated from one domain of industrial endeavour to another.

This is good news for the health of the theoretical wing of our subject, but it suggests concern that parallel advances from the empirical side are not being reported. That concern echoes some of the more eminent theoreticians speaking at Brussels, who are reported to have made remarks like 'there are no significant experimental results on melt fracture that were not reported twenty or more years ago'<sup>2</sup>. Surely, with the power that the theoretician now has to address such issues, there is need for more precise and comprehensive data to refute or confirm their predictions, otherwise the debate will become increasingly stale. As we noted in the discussion on measurement techniques above, the tools clearly exist: have we lost the will to use them for fundamental research? or, are the issues where many theoreticians spend their time no longer seen as being practically important?

Overall, it would appear that the balance within the Society has clearly shifted towards 'theory'. As will be discussed later this may not be the full story.

## RHEOLOGY AND STRUCTURE

On a more positive front, there was strong expectation (75%) that 'a major new area of morphological rheology will have evolved'.

It may be going too far to say that this prophecy has been fulfilled, but one correspondent<sup>2</sup> certainly maintains that 'morpho-rheology' is the new watchword for the study of materials with simultaneous changes of structure and shape. To some extent this has always been an important activity for our members, but, if it is to flourish, can it grow in a culture increasingly dominated by theoreticians for whom continuum mechanics is the starting point?

#### THE TEACHING OF RHEOLOGY

The survey reflected what could only be described as a 'bull market' for universities in both research and teaching.

In respect of the U. K., it is clear that those groups which were noted for their contributions to rheology in 1978 have continued to prosper, but it is not clear that they have actually grown. Similarly it is hard to identify a rheological centre of excellence that was not well established in 1978. I hope that the editor will be deluged with indignant refutations of these comments.

Two-thirds of respondents anticipated special courses in rheology at M. Sc. level at several universities. That certainly seems to have been over optimistic.

Nearly half the respondents expected that a British university would have a designated chair of Rheology. Whilst there are many professors amongst the most active of our membership, none occupy a chair with that title. With the granting of university status to many new establishments, it will be interesting to see if this position changes.

#### THE ROLE OF THE BRITISH SOCIETY OF RHEOLOGY MEMBERSHIP

The study was absolutely correct on one point. the overwhelming expectation was that membership would remain roughly constant. Over the last fifteen years, indeed over the last twenty-five years, membership has remained within 5% of 550. Despite the rapid growth in numbers of societies of rheology, overseas members continue to represent a third of the membership: this is a tribute to the continuing high value placed on the publications of the Society.

#### ACTIVITIES

The main activity of the Society is the organisation of meetings. The survey suggested that members would prefer more, shorter, meetings. Shorter meetings we now have, particularly in respect of the Spring meeting, but the emphasis still remains the three day Autumn meeting. More meetings we do not have; the issue here, I suspect, is lack of

volunteers to organise them. Taking inflation into account, it would seem that income from conferences is now less than in 1978. Does this mean better budgeting or lower attendance?

The Bulletin and Abstracts continue very much as before. The difficulties of recruiting abstractors also appears to remain. The Editor needs you for this vital activity.

A major new resource for the rheological community is the Archive funded by the Scott Blair bequest.

Perhaps the most disappointing feature of our activities initiated since 1978 has been the low number of applications which Council receives for scholarships and travel grants. In times such as these to find that you cannot give money away is just bewildering!

#### FINANCE

Aside from the Scott Blair bequest, the finances of the Society, when adjusted for inflation, have changed little over the period, see Appendix 1. Subscription income is now twice as important to us, while the net receipts from conferences are only half. A major new source of income is advertising revenue. The balance sheet of the Society today shows a much more modest excess of income over expenditure, which in 1978 was 30% of net assets.

#### AMALGAMATION, FRAGMENTATION OR FOSSILISATION

The Society was formed as a result of the recognition of common interests by members of the Institute of Physics. Organisations tend to evolve by amalgamation or fragmentation, but the overwhelming view was that this would not, and indeed should not, be the case with the British Society of Rheology. There was the overwhelming view that the Society was just right as it was organised in 1978. No changes in organisation have occurred in our time frame, although there have been significant developments going on outside.

European meetings, and collaboration with other European societies, are now firmly on the agenda, but there are no moves to amalgamate all the European societies into one.

Some of the learned bodies with whom we have collaborated in the past have recently amalgamated to form the Institute of Materials. That amalgamation included special interest groups, such as the British Composites Society as well as the main professional Metals, Ceramics and Plastics societies. Rheology is a Materials Science and it seems unlikely that such a powerful new body will not take on certain rheological interests. It is a matter for Council to decide what sort of interaction might be appropriate with the Institute of Materials, but they would like to hear the opinions of members on that subject.

The Society has not amalgamated, neither has it fragmented. When organisations do not evolve, there is the danger of fossilisation. Is there any evidence that the Society is moving down that path?

As discussed under 'Materials' above, there may be growing needs of the Biorheological community that are not being fully met from within the Society. It would be of interest to hear how that community is evolving.

There are worrying reports about a 'Non-Newtonian Club' organising separate meetings. Even more alarming is that the names associated with that club are of prominent industrial rheologists. The Society was formed by a group of 'industrialists' sharing their interests in rheology. The activities and interests of members of the British Society of Rheology has increasingly moved towards the 'academic'. Has that change been beneficial or has it led to a fossilisation of approach? Those engaged on 'The Case of the Missing Industrialists'<sup>2,5</sup> might well wonder if this has significance to their quest. Health in an organisation is often promoted by a group withdrawing from that Society, creating a new approach, and returning to give that new direction to the main body.<sup>6</sup> Is this happening here?

#### CONCLUSIONS

Little change was what members asked for fifteen years ago. Little change is what they have got. Superficially everything appears satisfactory, but is there a possibility that we may be becoming a fossil, while the real world is changing outside? 'The Case of the Missing Industrialists'<sup>2,5</sup> may be more serious than a first reading would suggest. Let us not be afraid to confront such questions. The editor will be glad to hear your opinion.

#### ACKNOWLEDGMENTS

I am indebted to John Benbow, Doug Hourston, Carole Moules, and Peter Anderson who shared their thoughts with me

#### REFERENCES

- <sup>1</sup> Bulletin 21 (3) 31-37 (1978).
- <sup>2</sup> Bulletin 35 (3) 80-84 (1992).
- <sup>3</sup> Bulletin 34 (1) 17-18 (1991).
- <sup>4</sup> David Cheng, 'The art of coarse rheology', Bulletin 32 (1) 1-21 (1989).
- <sup>5</sup> Bulletin 34 (2) 47-50 (1991).
- <sup>6</sup> Arnold Toynbee, *A Study of History* OUP (1935).

## APPENDIX 1: SUMMARY OF FINANCIAL POSITION

|                              | 1978   | 1992   | ratio(1992/1978)* |
|------------------------------|--------|--------|-------------------|
|                              | £      | £      |                   |
| Membership subscription      | 2      | 10     | 1.9               |
| Subscription income          | 1,166  | 6,230  | 2.0               |
| Advertising income           | —      | 3,060  | large             |
| Rheology Abstracts income    | 1,989  | 4,882  | 0.9               |
| Conference income            | 1,352  | 1,428  | 0.4               |
| Investment income            | 605    | 2,591  | 1.6               |
| Excess of income/expenditure | 3,158  | 561    | 0.1               |
| Assets                       | 10,227 | 34,044 | 1.2               |

\* This ratio is adjusted for inflation based on the price of a first class stamp since postage represents one of the main expenses of the society. In 1978 this was 9p today it is 24p.

Neil Cogswell

## COMMENTARY ON 273rd MEETING OF COUNCIL

The Council meeting, at a very comfortable hotel in Newbury, starts promptly. We have to work to a strict schedule today. It is a special occasion, for the Weissenberg lecture is to follow the meeting, and so we must be on time. In the rush we are fifteen minutes into the meeting before a 'volunteer' is found to write the commentary. Strange — I don't usually volunteer for such things — must have been the after effects of the over hot hotel sauna from which the President and I had so recently emerged.

By this time we are into the President's report. (I'm told to record 'nothing of note' for the first part of the meeting. Ralph describes the very successful 'S1' meeting at Fontevrand in the Loire Valley. There is gasped admiration for reports from other members of a long speech in French by our President. Ralph moves on to detail some correspondence he has had relating to the 'Toms' effect and confirms that indeed it was Toms who was first to publish this. Finally details are given of the possibility of a joint meeting with the French Society. Ralph is negotiating this (in French presumably!)

There follows the Treasurer's report on the financial state of the Society which we are told is better than anticipated. Abstracts fees from Pergamon are at a record level. This promotes assorted

unprintable comments about Robert Maxwell and pension funds. Other good news is that we are no longer registered for VAT. Bureaucracy has been defeated. Hooray!

It's Carole's turn and she's been very busy. Numerous letters are read out, mainly asking for money. There begins an endless discussion on the merits or otherwise of supporting various causes. There is only one way to resolve this. Yes, use the usual trick, set up a sub-committee. Everybody steps back one pace. Too slow — I'm elected.

On to the Membership Secretary. Doug reports on the membership level and how many are paid up. We consider possible names for honorary membership. Tony points out some constitutional difficulty which is ignored and we move on.

Phil has relatively little to report on the Bulletin and so we move quickly to Geoff and 'Abstracts'. This is going well with an ever increasing volume of abstracts. There is a brief discussion of difficulties in handing over to a new editor and a unanimous vote of thanks is recorded in the minutes for Geoff's efforts over the past four years.

Conferences are the next topic. The Manchester meeting was small but successful. (See elsewhere in this Bulletin). Plans for the forthcoming Cambridge meeting were described including a very full technical programme, a wine tasting and a musical evening.

Time is getting short now. We postpone the discussion on 'The future role of the society' to a special meeting. There is no news from the working parties and so we are on to the Scott Blair Collection. Tony gives a detailed report. Our books now share a room with some 'computer people'. He reassures us that these are apparently quite civilised folk. However the visitor's book is missing. The suggestion that we should fill in gaps in the holding of some other societies' newsletters receives the overwhelming support of at least one person, and we move on.

The President summarises the Society Archivist's report. His first task has been to weed out unwanted material. We are told that two inches of paper have been reduced to half an inch. We wish him luck with the remaining twenty five feet.

A few items are dealt with quickly and we end on a very sad note for it is realised that Tony is to leave Council after twenty four years service. Everybody congratulates him for the fine work he has done for the Society.

The meeting is over and members adjourn to the bar to meet our guests for the Weissenberg lecture.

## RHEOLOGY OF PARTICULATE SYSTEMS

'The press are here, so we'll begin'. With these words Professor Howard Barnes declared this meeting of the Non-Newtonian Club open. It was March 30th, 1993 and this, jointly organised with the B. S. R., was the first 'public' meeting of the N. N. C., now 21 years old having been formed as an informal club to discuss common industrial interests in suspensions and to link industrial interests and academia. Forty seven delegates assembled in the smart modern surroundings of the Manchester Conference Centre to hear eight talks, but the first of three challenges was to find the correct venue. At least one delegate had to be redirected from the UMIST Staff House Conference Centre, 400 metres down the road. The second challenge was to find and retain a seat, as there were precisely 47 seats in the conference room, leading to a game of musical chairs as people moved around to facilitate their departure for trains at the end of the day.

Dr D. Smith (Silsoe Research Institute) gave the first talk on the design of a large (1.5 metre diameter) viscometer for tests on foods such as processed peas, baked beans and vegetables, to generate an understanding of how they flow out of hopper and into tins. A believer in visual aids, he treated us to a demonstration of dilatancy (wet sand in a squeezezy bottle fitted with a capillary tube) and showed us a balsa wood model of his viscometer.

Dr M. Mackley (Cambridge University) described a recently patented method of either mixing or preventing sedimentation in suspensions by oscillating a baffled tube back and forth along its axis, supported by the first public showing of a video showing the particle motion.

Next Professor Howard Barnes (Unilever, Port Sunlight) treated us to a rapid and comprehensive review of suspension rheology, concentrating on the way the Krieger-Dougherty equation can be used to understand experimental effects.

In the final talk before lunch Dr A. Jomha (Courtaulds Coatings) described work on normal stresses in solvent free coatings systems.

After lunch and time to admire the Foucault pendulum in the foyer, we heard about latex suspensions and clay paper coatings from J. Husband (ECC International) and the extrusion of ceramic pastes from Dr S. Blackburn (Birmingham University). The former described how the aggregation in latex suspensions is affected by pH and shear but not that in latex/china clay paper coating suspensions. The latter drew attention to the very narrow range of liquid phase volume concentration over which extrusion is possible in pastes: at one extreme the material is an unextrudable wet powder, while with only 2% more water it is a slurry which cannot support its own weight after extrusion.

Next Dr P. Banfill (Liverpool University) described the structure that exists in cement-based materials and its consequences on the practical rheology of cement pastes, mortars and concretes in processes such as pumping, trowelling and vibration compaction.

The last talk was by Dr T. Annable (ICI) who described the rheology of solutions of associative thickeners. These are polymer solutions conforming to the Maxwell model whose relaxation time is a function of molecular weight, such that it is possible to build up a tailored fluid with a spectrum of relaxation times, dictated by the molecular weight of the several components.

Overall, it was a friendly and informal meeting with plenty of discussion and some well presented work — a credit to Steve Beckett, the organiser. The third challenge was for those people staying overnight for the B. S. R. meeting next day to find their rooms.

Phil Banfill

## EXPERIMENTAL RHEOLOGICAL MEASUREMENTS

This meeting had originally been planned as a two day event to follow the N. N. C. meeting, but lack of response forced Carole Moules, the organiser, to reduce it to one day, at the cost of a lot of last minute telephoning and faxing. Despite the not unreasonable gloom which results from a disappointing response like this, the meeting turned out to be very good with plenty of informal discussion among the score of participants and some well presented, thought provoking talks on the theme of rheometrical measurements. It had all you could wish for in a one day meeting: descriptions of new techniques, new observations on well known substances and systems, discussions on precision and curve fitting, comparisons from a round robin experiment and another consideration of yield stresses ('revisited').

Carole Moules opened the meeting by explaining that it had been called in support of the Society's initiative in promoting greater openness on the part of rheometer manufacturers about their measurement and data handling methods. She introduced Howard Barnes who gave a report on the current state of that initiative. Starting from the premise that the manufacturers' attitude is that the display on the video screen is all the user needs to know, he put the opposite point of view that because all the steps in the data treatment are hidden the display cannot necessarily be trusted. The manufacturers' response to the questions posed by the working group in

1992 had been minimal so a round robin had been organised using the Strathclyde University test fluid. This has been well characterised by numerous academic groups around the world and Howard presented the results on it received from five manufacturers using seven commercial instruments in their own labs. The agreement was very good for the viscosity versus shear rate or shear stress, but the variations were slightly more than had been achieved in the universities. Elastic modulus versus frequency data showed more variations with results least consistent at highest frequencies and much less consistent than the university results. He concluded that the results say more about manufacturers use of their instruments than about the instruments themselves which, in the hands of university researchers, yield more consistent data.

Trevor Gregory (Coates Lorilleux, Orpington) described some data collected on paste inks with Bohlin CS and VOR rheometers in the linear viscoelastic region using frequency sweeps and relaxation spectra. He had noted that the normal expectation that the peaks in relaxation spectra should superimpose on the time axis at different strain rates had been observed using serrated parallel plates but not when using smooth plates. In controlled stress modes the viscosity versus shear rate data showed a sharp transition around the yield stress with serrated plates but a more complex change at lower stresses in smooth plates. The existence of slippage at the plate surface was confirmed photographically by showing the movement of a line of different coloured ink drawn on the free outer surface of the cylinders. He concluded that smooth geometries generate slip which gives misleading results.

John Davison (Davison Chemographics) described an experimental arrangement to follow the progress of a photochemical reaction using rheology. The reaction in question is used in mass production of a sensor for determining glucose content in a drop of blood. A letterpress system is used to print the circuit containing the various electro-bio-chemicals dispersed in a continuous phase which is then cured. The chemical sensitivity of the various components severely restricts the range of possible processes and non solvent based inks which can be used and the chosen system involves exposure to a burst of ultraviolet light to initiate the polymerisation of the ink resin. He described his photochemorheometer in which a light guide had been fed through a quartz bottom plate of a parallel plate rheometer so that after a camera shutter had allowed a known amount of UV light to pass, the progress of the chemical reaction could be followed by the rheological response of the sample.

After coffee Eirion Jones (University of Plymouth) described a small scale apparatus which has been built to model the response of cohesive sediments. He briefly described previous work done on a circular flume, 3.5 metres diameter, to study the effect of secondary and turbulent flows on the bed of sediment, work which is of interest to hydraulics engineers with jurisdiction over estuaries. Stress in the sediment bed surface is measured by a constant temperature hot bed stress meter in which current is fed to the sensor to maintain it at constant temperature against the cooling influence of the fluid flow. Because stress is proportional to current raised to the sixth power, calibration using a defined geometry is crucially important. He then went on to describe a complicated upside-down double annulus geometry which had been built to fit a rheogoniometer and which enabled measurements of bed shear stress on the elasto viscous sediments to be measured free from the problems caused by free open surfaces. He finished with a conundrum, which raised interest among the audience: what is the shape of the meniscus formed in a double concentric cylinder geometry by an elastic liquid?

Jim Ferguson (Strathclyde University) described efforts underway to get acceptable agreement for elongational flow measurements on polymer solutions. While round robin shear measurements now give good agreement similar measurements of elongational flow produced elongational viscosity-strain rate data falling into three broad zones depending on whether spin-line, falling-drop or opposing-jet methods had been used. The reason for the inconsistency is that the experiments are transient and fall within different time scales. When a third dimension, time, is added to the viscosity-strain rate plot, the results for a Newtonian liquid fall on a horizontal plane since elongational viscosity is a constant at three times the shear viscosity. However the surface for a non-Newtonian liquid is convoluted and the elongational viscosity-strain rate results depend on where the experiment lies on the surface. At very long times the surface corresponds to the results obtained from equilibrium experiments.

In the final talk before lunch Ralph Oliver (Birmingham University) described load enhancement effects in polymer thickened oils, measured by the journal bearing simulator. This consists of a cylindrical rotor, slightly eccentric on its own shaft, which rotates within a stator which can be moved in such a way that their relative eccentricity is gradually increased. Load cells in the stator measure hydrodynamic loads produced by the lubricant. Results on polymer thickened oils show that the maximum force on the stator (and consequent enhancement of the loadbearing ability of the bearing) is

produced when the rate of decrease of oil film thickness is greatest and not when the oil film itself is at its lowest, suggesting a major squeeze film contribution to load and confirming that elasticity in the oil is beneficial for load bearing.

After lunch Phil Banfill (Liverpool University) described measurements of the Bingham parameters of mortar using a small mixer type apparatus which had been calibrated, following the Metzner-Otto principle of a mean effective shear rate, to enable the yield stress and plastic viscosity to be expressed in fundamental units. Measurements carried out in parallel with a 200mm diameter coaxial cylinders viscometer produced values which showed good numerical agreement.

Karl-Heinz Moos (Göttfert GmbH, Buchen, Germany) described an on-line capillary rheometer for real time process control of polymer processing. He pointed out that elasticity of polymer melts can dominate rheology at high shear rates, but no one takes account of it even though much processing takes place at high shear rates.

In his second contribution of the day, Eirion Jones showed some spectacular results achieved by applying stress varying in a non-sinusoidal waveform to a viscoelastic polymer solution. In conventional oscillatory shear rheometry the computer controlled rheometer carries out a frequency sweep to generate the modulus-frequency curves over a range of frequencies. This takes time and is not satisfactory for on-line control or in other situations where information is needed quickly, for instance in a system which is curing during the time of the measurements. Accordingly he had experimented with various applied stress waveforms, requiring Fourier analysis of the output waveform, and showing increasingly good fits to the conventionally obtained rheological data, culminating in the 'cos 9' waveform, which consists (I think) of all the odd harmonics at equal amplitude up to 40 Hz. The agreement was spectacular and demonstrated what a powerful combination modern electronics and computer controlled rheometers can be. All present agreed that this 'one shot' oscillatory measurement taking 30 seconds could revolutionise rheometry.

Howard Barnes revisited the theme of yield stress by pointing out that the Krieger-Dougherty equation for non-interacting spheres permits a critical stress to exist at which viscosity becomes infinite and that this is more sharply defined at high solids concentration. However the majority of systems for which a yield stress is claimed are flocculated, so he described the way in which fractals can be applied to floc geometry, which is beginning to give some principles for the behaviour of flocs. A fractal dimension of one is equivalent to an open floc structure consisting of unbranched, rod-like arms, whereas fractals

of dimension three look like raspberries. Low dimension fractals are produced by a hit and stick mechanism as primary particles come together and they usually show a large attractive energy component. High fractal dimensions result from a hit and roll mechanism and usually show weak attraction between particles. Most particle systems have dimensions around two and the effect of a small change in fractal dimension on rheological parameters is dramatic. I think everyone present hoped that Howard would soon be writing an informative article on the implications of fractals for yield stresses in flocculated systems — perhaps 'Flocs of fractals for fools'.

In the last session, after the tea interval, Stefan de Smedt (University of Ghent, Belgium) described rheological and diffusion experiments on hyaluronic acid solutions which are used in controlled release drug systems. This is a high molecular weight polysaccharide which forms a tangled network in solution. Diffusion of the active drug out of the network into the patient's metabolic system takes place at a slow rate, controlled by the degree of entanglement, which can be determined by rheological and diffusion measurements.

Finally, David Cheng described a numerical method of estimating the confidence limits of curve fitting parameters. This involves 'calibrating' the numerical algorithm employed in the data reduction software using data generated with known parameters and known 'experimental errors', and the discrepancies in the recovered parameters are related to the 'experimental error' to give a calibration curve. In a measurement, comparison between the data and the best-fit curve allow the actual experimental error to be estimated. This is then used with the calibration curve to estimate the errors in the best-fit parameters. The method can be applied generally, such as in the model fitting of flow curves, the relaxation time spectral fitting of creep-recovery and complex moduli properties, and the determination of viscosity and normal stress.

In conclusion, it was a good informal meeting with plenty of lively discussion and no hesitation on the part of the audience to interrupt, asking questions for clarification during talks. It was disappointing both that so few younger rheologists were there and that there were so few contributions from manufacturers, but I hope that this extended description will show members what they missed.

Phil Banfill

## WEISSENBERG CENTENARY LECTURE

27 people gathered at the Hilton National Hotel, Newbury on June 10th, 1993 to celebrate Karl Weissenberg's centenary. Professor Ken Walters introduced the speaker, Professor Arthur Lodge, as the former holder of Britain's first Chair of Rheology, who joined the brain drain to set up the Rheology Research Centre at the University of Wisconsin, Madison, which has become renowned as a centre of excellence.

Arthur described his lecture (his first and last centenary lecture, he hoped) as a pre-prandial after dinner speech and recognising the mixed audience he kept it (almost) free from mathematics. He described how he had met Weissenberg in 1948 while working at the British Rayon Association in Manchester and had grasped what Weissenberg was trying to do when considering the problem of a flowing liquid. Weissenberg differed from Rivlin in thinking that the stress ellipsoid in a flowing fluid would be tilted with respect to the shear flow and that this would effectively strangle the liquid and result in a force normal to the flow direction, thereby forcing it up a rod. Arthur demonstrated this effect with a pack of cards on the side of which a circle had been drawn: as the cards sheared, simulating the liquid flow, so the circle changed to an ellipse and the contraction strain was clearly seen.

In about 1953 Weissenberg advised Arthur to try to measure these normal stress differences and, in the latter's words, 'I've not had time to think since then'. Certainly all of Arthur's work has been based on this so called Weissenberg effect, including his now famous hole pressure effect measurements.

Arthur said he was prepared for some heckling from the audience but had not bargained for the interruption from the public address speaker announcing a telephone call for someone. We eventually found the speaker control to silence that, but the announcement was matched for stridency only by the smoke detector which was triggered by the sparklers garnishing the dinner main course.

After a short vote of thanks from Ralph Oliver and some personal reminiscences of life with Weissenberg from Jack Roberts we adjourned for a pleasant dinner in the adjacent suite. The whole event was jointly sponsored by TA Instruments (formerly Carri-Med) and the Society and it was a pleasure to renew old acquaintances.

Phil Banfill

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## NOTICE OF THE 53RD ANNUAL GENERAL MEETING

The 53rd Annual General Meeting of the British Society of Rheology will be held on Thursday, September 23rd 1993 at Robinson College, Cambridge starting at 6.30 p.m..

Members are reminded that, under rule 7(b), the business of the meeting includes:

- a) The election of Officers and Council Members for 1993-94.
- b) The receipt of a report and audited accounts from Council.
- c) Dealing with matters raised by Council or by any Member, and receiving suggestions from Members for consideration by Council.

Nominations to date are as follows:

|                       |                     |
|-----------------------|---------------------|
| (President:           | Dr D. R. Oliver)    |
| Honorary Secretary:   | Mrs C. A. Moules    |
| Honorary Treasurer:   | Mr R. E. Carter     |
| Membership Secretary: | Dr D. J. Hourston   |
| Bulletin Editor:      | Dr P. F. G. Banfill |
| Abstracts Editor:     | Dr G. H. Meeten     |

Ordinary Members of Council:

Mr P. C. Anderson  
 Dr N. E. Hudson  
 Dr M. R. Mackley  
 Professor P. Townsend  
 Dr N. D. Waters

There is one vacancy resulting from the retirement of Dr A. Evans. He is not eligible for re-election. Council has nominated Dr N. D. Waters.

Nominations for Council or for any of the Offices are invited. Nominations should be sent to the Secretary or may be made at the meeting (see rule 5[b]).

The Secretary would be pleased to receive notice of any matter that any Member wishes to raise.

C. A. Moules  
 Honorary Secretary

MINUTES OF THE 52ND A. G. M.  
HELD IN THE DEPT. OF CHEMICAL ENGINEERING, UNIVERSITY  
OF CAMBRIDGE ON SEPTEMBER 15TH 1992

The meeting started at 17. 30 with Dr Cheng, President, in the Chair and 25 members present.

1. APOLOGIES FOR ABSENCE

Received from Dr G. H. Tattersall

2. MINUTES OF THE 51ST A. G. M.

These had been published in Bulletin 35 (2), June 1992. There were no queries and the minutes were duly signed by the President.

3. MATTERS ARISING

There were no matters arising

4. OFFICERS' REPORTS

4. 1 PRESIDENT

The President read his report which is published in Bulletin, 35 (3) September 1992.

Dr Cheng reported on the meeting of the ICR which is described in Bulletin 35 (4) December 1992.

4. 2 TREASURER

Mr Anderson presented the draft accounts, stating that the final accounts would be published in Bulletin 35 (4) December 1992. The year showed that once again income exceeded expenditure. Council expenses were higher as some costs had not appeared in the 1990/91 accounts, the President's expenses to meetings were included as were the Working Parties expenses thus giving an unbalanced view of the figures. Revenue from advertising was up due to chasing of debtors. Dr Brownsey pointed out that subscription costs of the Abstracts had been doubled to £200 and it was from this income that the B. S. R. was given royalty. Dr Oliver asked if monies were suitably invested with respect to interest. Mr Anderson said that Council could make alternative suggestions. Dr Evans felt that it was tedious to keep playing the market but that it was sensible to keep the situation under constant review. Dr Goodwin proposed that the draft accounts be accepted, Mr Carter seconded and the motion was carried. Dr Evans proposed and Dr Hudson seconded that Alfred Simmons be retained as auditors. All agreed.

4. 3 MEMBERSHIP SECRETARY

Dr Hourston updated the meeting on progress with the membership. There were 531 *bona fide* members including 46 Honorary members. 24

formal resignations had been received. 71% of the membership came from the U. K. with 29% from abroad. Dr Hourston showed a draft copy of the membership list which included past Presidents, Award winners and the Constitution. Once the new Council had been elected the list would be finalised and sent to print. The new booklet should be with members before the end of the year. Dr Hourston also displayed the new application form which he had designed during the year. Dr Meeten asked how many people had been eradicated from the membership. Dr Hourston said that he still had on record 280 names who had received three reminders. He said that there did not appear to be any pattern to explain why those people had fallen behind in their payments. Dr Banks asked how often the list would be updated. Dr Hourston said that a mechanism was in place for easy updates and reprinting. The full report is given in Bulletin 35 (3) September 1992.

#### 4. 4 BULLETIN EDITOR

Dr Banfill said that the Bulletin was growing in size with about 140 pages in Vol. 34 including 26 pages of adverts. Vol. 35 would be a similar size. He said it was his policy to include a technical article in each volume. The diary had proved very popular but the competition was not a success either through lack of skill or interest. He emphasised that the Bulletin was a means of communicating for the members. Dr Oliver said that the Bulletin was much appreciated by the overseas membership.

#### 4. 5 ABSTRACTS EDITOR

Dr Brownsey reported that over the last 3 years 199 journals had been covered. Abstracts were now totalling ~1000/year and of that number he himself took 60% of the journals which provided 20% of the abstracts. He said that there was a continuing requirement for more abstractors and that he would be happy to match volunteers to journals as he knew which ones required coverage. The questionnaire had provided a few responses but more offers to help would be most helpful. Quarterly deadlines for printing were February, May, August and December. Dr Meeten was surprised at the low response for volunteers to abstract and he suggested that members should send abstracts of their own papers directly to Dr Brownsey. Dr Cheng agreed that this was a good idea.

#### 4. 6 HON. SECRETARY

Mrs Moules read her report which is published in Bulletin 35 (3), September 1992.

#### 5. ELECTION OF OFFICERS

**President:** Dr D. R. Oliver, as Council Nominee, was unanimously appointed.

**Officers of the Council:** The 1991/92 Officers being unopposed, they were unanimously reappointed

Hon. Treasurer: Mr P. C. Anderson  
 Hon. Secretary: Mrs C. A. Moules  
 Membership Sec.: Dr D. J. Hourston  
 Bulletin Editor: Dr P. F. G. Banfill  
 Abstracts Editor: Dr G. J. Brownsey

**Members of Council:** Dr R. Buscall retired at the end of 4 years and Dr G. Meeten and Dr N. Walters were nominated together with the remainder of the 1991/92 Members.

Following a paper vote, with Dr Banfill and Dr Hourston acting as tellers, the Members elected for 1992/93 were:

Mr R. E. Carter  
 Dr A. Evans  
 Dr N. E. Hudson  
 Dr M. R. Mackley  
 Dr G. H. Meeten  
 Prof. P. Townsend

#### ADDRESS BY THE NEW PRESIDENT

Dr Oliver reflected on the British Rheology Club of 1940 which, although turned into an official body for collecting fees, has maintained its friendliness.

He stated that he was not going to be evangelical in outlook but wished to retain the original concept as a meeting of friends for the exchange of knowledge. He would encourage and promote meetings with other Societies and continue support to students.

He acknowledged the Bulletin and Abstracts as the lynchpins of our Society.

Dr Oliver continued by offering his/our thanks to Dr Cheng for the hard work during his term in office.

#### 6. ANY OTHER BUSINESS

Dr G. H. Tattersall who had been unable to attend the A. G. M., sent a written report about the North Midlands Group, which appears in Bulletin 35 (3), September 1992.

Mr Carter offered his thanks to Dr Jones and Mrs Ghosal for organising the Scott Blair Collection at the University of Wales, Aberystwyth. The Collection was now held in a publicly accessible area and contained a large amount of archival material, a full set of Rheology Abstracts and many books and papers. There was an ongoing aim to collect as many books as possible within the field of rheology and donations are gratefully received.

There being no further business the meeting closed at 18.40 hours

Carole Moules  
 Hon. Secretary

## MEMBERSHIP NEWS

The following applications for membership were approved at the Council Meeting, June 10th, 1993.

Dr H. Al-Khalid,  
Civil Engineering Department,  
The University, P. O. Box 147,  
Liverpool,  
L69 3BX.  
(etaDFGK)

Professor C. Balan,  
Hydraulics Department,  
Technical University of Bucharest,  
Splaiul Independentei 313  
Romania.  
(fetsaDGGJ)

Dr S. Barnard,  
Coates Coatings International,  
Station Lane,  
Whitney,  
Oxon.  
(feadGHJ)

Mr F. Butler,  
Dept. of Agricultural & ,  
Food Engineering,  
University College Dublin,  
Earlsfort Terrace,  
Dublin 2, Ireland  
(feta L)

Mr A. Girling,  
Lloyd Instruments Ltd.,  
Whittle Avenue,  
Segensworth West,  
Fareham, Hants.,  
PO15 5SH  
(etsa D)

Mr R. Greenwood,  
Chemical Engineering &  
Chemical Technology Dept.,  
Imperial College,  
Prince Consort Road,  
London SW7 2BY.  
(fets F)

Mr P. N. Heyworth,  
Paar Scientific Ltd.,  
594 Kingston Road  
Raynes Park,  
London,  
SW20 8DN.  
(fetsa O)

Dr M. I. James,  
Proctor & Gamble (HABC) Ltd.,  
Rusham Park,  
Whitehall Lane,  
Egham, Surrey,  
TW20 9NW.  
(pea CDFGJ)

Miss M. A. Odrjzola,  
Department of Pure &  
Applied Chemistry,  
University of Strathclyde  
295 Cathedral Street,  
Glasgow, G1 1XL.  
(fetsa D)

Ms G. N. Ozcan-Taskin,  
School of Chemical Engineering,  
University of Birmingham,  
Egbaston,  
Birmingham B15 2TT.  
(pe FGHJLM)

Mr I. D. Roberts,  
Dept. of Chemical Engineering,  
University College of Swansea,  
Singleton Park,  
Swansea SA2 8PP.  
(fet GL)

Dr P. F. Rogers,  
Teroson U. K.,  
Cromwell Road,  
St. Neots,  
Cambs. PE19 2JW.  
(ea GO)

Mr I. P. Whelan,  
Cortecs Ltd., Newtech Square,  
Techbase 1, Deeside Industrial Park  
Deeside, Clwyd, CH5 2 NT.  
(eta FGHO)

Mr M. Whiskens,  
31 Oliver Road  
Ladywood  
Birmingham, B16 9ER.  
(feta BCD GI)

Honorary Membership has been granted to the following: Dr N. Casson, Dr P. Howard, Professor D. W. Saunders, Mr G. R. Sothern, Dr A. J. M. Spencer, Dr D. Tabor.

Professor R. Meredith, formerly Professor of Fibre Science at Strathclyde University, has died.

Dr J. A. Wilkie has resigned

J. G. Cabrera has been appointed Professor of Civil Engineering Materials, University of Leeds. His rheology interests include cement pastes, surfactants and bitumen based composites.

## RECENTLY PUBLISHED BOOKS

This information is largely taken from publishers' handouts and is given for the benefit of members, but the Society cannot assist members in obtaining copies of books mentioned. Order them through your normal bookseller or agent.

*Polymer Process Engineering*, Eric A. Grulke, Prentice Hall 1993, pp. 384, ISBN 0-13-015397-4, £59. 90. A comprehensive overview of both the engineering and science required for polymer systems design. A thorough treatment of the composition, morphology, properties and physical states of polymers as well as quantitative analytical methods and surveys of processes.

*Flow Distribution and Efficiency*, V. Stanek, The Ellis Horwood Series in Chemical Engineering, 1993, pp. 256, ISBN 0-13-322033-8, £45. A study of fixed bed systems from an engineering viewpoint, this book looks at systems where gases or liquids (or both) pass through a layer of solid particles — systems in widespread use in a number of industrial areas. Equations and relationships are well explained and presented and are accessible to non-mathematicians.

*Low Temperature Lubricant Rheology Measurement and Relevance to Engine Operation*, Editor: Robert B. Rhodes, ASTM: STP 1143, 1993, pp. 192, ISBN 0-8031-1438-9, £43.00. Nine peer reviewed papers offer a chronology of developments regarding the low temperature rheological techniques and specifications that apply to the low- temperature cranking and pumping characteristics of engine oils. Focus on the technological changes that have occurred since the completion of the last round of low-temperature engine and bench test studies. Bringing to light new information that will help determine whether the cranking, starting and pumping needs of present-day engines are adequately served. These papers not only bring the reader up-to-date on the measurement of low-temperature rheology tests for engine lubricants, they also call attention to concerns about the use of present test methods to portend lubricant engine performance.

*Flow and Microstructure of Dense Suspensions*, L. J. Struble, C. F. Zukoski, G. C. Maitland, editors, Materials Research Society Symposium Proceedings Volume 289, 1993, pp. 260, ISBN 1-55899-184-0 \$80.00. This book is the proceedings of a symposium held in 1992 and contains 38 papers grouped into sections on fundamental aspects of suspensions, theoretical aspects of flow and microstructure, ceramic materials, cement-based materials, other industrial important materials (clays, metal slurries, coatings etc.) and characterisation of flow behaviour.

## CONFERENCE ANNOUNCEMENTS

THEORETICAL AND GENERAL RHEOLOGY  
AT ROBINSON COLLEGE, THE UNIVERSITY OF CAMBRIDGE  
Wednesday 22nd to Friday 24th September, 1993

A JOINT MEETING ORGANISED BY  
THE BRITISH AND DUTCH SOCIETIES OF RHEOLOGY

This meeting will cover recent advances in the rheology of fluids, pastes and particles, and both theoretical and experimental papers will be presented.

Robinson College is the most recent addition to the Cambridge Colleges, and enjoys excellent conference facilities. The College offers accommodation of the highest standard and is set in beautiful grounds. There will be a programme for accompanying partners and a full range of social, musical and wine-tasting events should help to ensure that this will be a memorable meeting.

The scientific sessions start at 10. 00am on Wednesday September 22nd and finish at 3. 30pm on Friday September 24th.

## PROVISIONAL LIST OF PAPERS

Isolating component contributions to the overall rheology in 1, 4-polyisoprene/1, 2 polybutadiene miscible blends, Professor G. G. Fuller (Stanford University, California).

Extensional viscosity and recoverable strain, Dr C. J. S. Petrie (University of Newcastle upon Tyne).

Stochastic simulations of polymeric liquids, B. H. A. A. van den Brule & P. J. Hoogerbrugge (Shell Research).

Nonlinear rheology of micelles and polymers, Dr M. E. Cates (University of Cambridge).

Determination of molecular weight distributions from linear viscoelasticity, D. W. Mead.

The use of complex flows to determine constitutive equations, H. E. H. Meijer, F. P. T. Baaijens & G. W. M. Peters (Eindhoven University of Technology).

Brownian dynamics simulations of Kramers chains, Dr H. J. M. Slot (DSM Research).

Relationships between the equilibrium shear modulus and network parameters, K. te Nijenhuis (Delft University of Technology).

Growth process of polymers near the gelation threshold, Professor D. Durand (Université du Maine).

Steric forces in rigid particle suspensions, P. Strating (University of Twente).

Multi-phase models for rheologically complex fluids, Professor J. R. A. Pearson (Schlumberger Cambridge Research).

A finite element analysis of the squeeze-film flow of plastic fluids, Dr M. J. Adams (Unilever).

Brownian dynamics simulations of dense suspensions: viscoelastic behaviour, Dr D. M. Heyes (University of Surrey).

Velocity distributions in granular materials discharging from hoppers, Dr R. M. Nedderman (University of Cambridge).

An axiomatic approach to constitutive models for the stress tensor based on non-affine motion, G. W. M. Peters (Eindhoven University of Technology).

Some comments on inelastic fluids, Dr D. M. Binding (The University College of Wales).

Steady states in the theoretical rheology of suspensions, Dr L. Woodcock (University of Bradford).

Corner flows on viscoelastic liquids, Professor A. R. Davies (The University College of Wales).

Biot poroelasticity of a chemically active shale, Dr J. D. Sherwood (Schlumberger Cambridge Research).

Control of the displacement of one fluid by a second, in an annulus, by altering the rheologies, Dr S. H. Bittleston (Schlumberger Cambridge Research).

Monte Carlo simulation of associative polymer networks, R. D. de Groot & W. G. M. Agterhof (Unilever Research Laboratorium Vlaardingen).

Effects of thermotropic liquid crystalline polymers on the rheology of high density polyethylene, Dr C. K. Chai et al.

Influence of absolute pressure on shear stress at the wall in the flow of ceramic pastes, Dr D. R. Oliver (Birmingham University).

Zero shear viscosity of MDPE and its influence in production of large pipes, Dr J. Pittman (University College Swansea).

Numerical simulation of time-dependent viscoelastic fluid flows, M. A. Hulzen (Delft University of Technology).

Deformation behaviour of polymer melts and rubbers, Prof. Dr-Ing M. H. Wagner (Universitat Stuttgart).

Rheology of Hetero-Star polymer melts, Dr T. C. B. McLeish (University of Sheffield).

Computation of converging flows, Dr E. J. Hinch & Dr R. A. Keiller.  
An experimental and numerical investigation of a viscoelastic flow around a cylinder, F. P. T. Baaijens & H. P. W. Baaijens (Philips National Laboratory & Eindhoven University of Technology).

Thermodynamic constraints for viscoelastic constitutive equations, Dr A. I. Leonov.

Phase transitions in sheared suspensions, J. Laven & J. Kaldash (Eindhoven University of Technology).

Rheology of associating polymers, Dr R. Buscall (ICI).

Computer simulation of colloid aggregates under flow, Dr J. R. Melrose (University of Cambridge).

A generic matrix representation of rheological models, R. J. J. Jongschaap (University of Twente).

Multiphase chaotic flow, Dr M. R. Mackley, N. D. Wise & K. Smith (University of Cambridge).

Microscopical modelling of weakly aggregating dispersions, R. de Rooij, A. A. Potanin, D. van den Ende & J. Mellema (University of Twente).

Lubrication flows of a rigid rod suspension, Dr J. M. Rallison (University of Cambridge).

THEORETICAL AND GENERAL RHEOLOGY  
A JOINT MEETING OF THE BRITISH AND DUTCH SOCIETIES OF RHEOLOGY  
at Robinson College, Cambridge, 22nd-24th September 1993  
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## CONFERENCE DIARY

| DATE        | PLACE                            | DETAILS                                                                                                                                                                                                                                                                                         |
|-------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 22-26/8/93  | Moscow, Russia                   | 'Advances in Structured and Heterogeneous Continua', contact: Prof. Y. G. Yanovsky, Institute of Applied Mechanics, Russian Academy of Sciences, 117334 Moscow, Russia or Prof. D. A. Siginer, Dept. of Mechanical Engineering, Auburn University, Auburn, AL. 36849 U. S. A..                  |
| 23-27/8/93  | Rhodos, Greece                   | 'The Mechanics of Swelling' Euromech 290, contact: Prof. T. K. Karalis, Democritus University of Thrace, 67100 Xanthi, GREECE.                                                                                                                                                                  |
| 30/8-3/9/93 | Minneapolis, Minnesota, U. S. A. | 'Rheological Measurements: Applications to polymers, suspensions and processing', contact: Prof. Chris Macosko, Dept. of Chemical Engineering and Materials Science, University of Minnesota, 421 Washington Ave. S. E., Minneapolis, MN 55455, U. S. A. Tel.: 612-625-6606, Fax: 612-626-1686. |
| 6-8/9/93    | York, U. K.                      | 'Adhesion 93' contact: Conference Dept., Institute of Materials, 1 Carlton House Terrace, London SW1Y 5YY.                                                                                                                                                                                      |
| 15-17/9/93  | Reading U. K.                    | 'Physical aspects of polymer science', contact: Prof. D. C. Bassett, J. J. Thomson Physical Laboratory, University of Reading, P. O. Box 220, Reading RG6 2AF.                                                                                                                                  |
| 21/9/93     | London, U. K.                    | 'Control of Extruders' contact: Society for Chemical Industry, 14/15 Belgrave Square, London SW1X 8PS.                                                                                                                                                                                          |
| 22-24/9/93  | Cambridge, U. K.                 | 'Theoretical and General Rheology' contact: Dr M. R. Mackley, Dept. of Chemical Engineering, University of Cambridge, Pembroke St., Cambridge CB2 3RA.                                                                                                                                          |
| 7/10/93     | London, U. K.                    | 'Modified Bitumen' contact: Society for Chemical Industry, 14/15 Belgrave Square, London SW1X 8PS.                                                                                                                                                                                              |
| 11-13/10/93 | Le Mans, France                  | 'Rheology for Polymer Processing' contact: J. F. Tassin, Groupe Français de Rhéologie, Université de Maine, Faculté des Sciences, Ave Olivier Messaien, 72017 Le Mans Cédex, France.                                                                                                            |
| 13-14/10/93 | Stevenage, U. K.                 | '10th Slurry Handling Seminar' contact: Susan Gartside, Warren Spring Laboratory, Gunnels Wood Road, Stevenage, Herts SG1 2BX.                                                                                                                                                                  |
| 17-21/10/93 | Boston, Mass., U. S. A.          | '65th Annual Meeting', Society of Rheology, contact: Dr A. M. Kraynik, Division 1511, Sandia National Laboratories, Albuquerque, New Mexico 87185, U. S. A..                                                                                                                                    |

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| 1-4/11/93     | Stevenage, U. K.        | 'Applied Rheology Course' contact: Susan Gartside, Warren Spring Laboratory, Gunnels Wood Road, Stevenage, Herts SG1 2BX.                                                                                 |
| 29/11-3/12/93 | Boston U. S. A.         | 'Symposium O: Complex Fluids', Materials Research Society Fall Meeting, contact: Eric Kaler, Dept. of Chemical Engineering, University of Delaware, Newark, DE 19716 U. S. A..                            |
| 21/12/93      | London, U. K.           | 'Rheological Problems in Suspension Concentrates' contact: Society for Chemical Industry, 14/15 Belgrave Square, London SW1X 8PS.                                                                         |
| 4-7/1/94      | Tobago<br>West Indies   | 'International Symposium on Viscoelastic Fluids', contact: Dr H. Ramkissoon, University of the West Indies, Dept. of Mathematics, St. Augustine, Republic of Trinidad and Tobago.                         |
| 23-25/3/94    | Dijon, France           | 'Food Macromolecules and Colloids', contact: Prof. E. Dickinson, Proctor Dept. of Food Science, University of Leeds, Leeds LS2 9JT.                                                                       |
| 3-7/4/94      | Akron, Ohio<br>U. S. A. | '10th Annual Meeting' Polymer Processing Society, contact: PPS Secretariat, 13400 A. David, St. Janvier de Mirabel, Québec, CANADA JON 1L0.<br>Fax: +1-514-433-9041.                                      |
| 11-14/4/94    | Cambridge, U. K.        | 'Deformation, Yield and Fracture of Polymers' contact: Conference Dept. Institute of Materials, 1 Carlton House Terrace, London SW1Y 5YY.                                                                 |
| 1-3/6/94      | Copenhagen, Denmark     | '3rd Annual Meeting' Nordic Rheology Society contact: J. Becker, Dept. of Polymeric Materials, Chalmers University of Technology, S-41296, Gothenburg, Sweden.                                            |
| 4-9/9/94      | Seville<br>Spain.       | '4th European Conference on Rheology', contact: Prof. C. Gallegos, Departamento de Ingenieria Quimica, Universidad de Sevilla, (Edificio de Quimica), 41071 Sevilla, Spain.                               |
| 21-23/9/94    | Cambridge, U. K.        | '8th European Conference on Mixing' contact: Conference Section (MIX8) I Chem E, 165-171 Railway Terrace, Rugby, Warwickshire CV21 3HQ.                                                                   |
| 26-29/9/94    | Kyoto, Japan            | 'First Asia-Oceanian Rheology Conference' Society of Rheology, Japan, contact: Professor Kunihiro Osaki, Institute for Chemical Research, Kyoto University, Uji, Kyoto 611, JAPAN<br>Fax: +81-774-331247. |

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| 6-10/11/94 | Yokohama, Japan      | 'International Adhesion Symposium' Contact: H. Mizumachi, University of Tokyo, Chemistry of Materials, Yayoi 1-1-1, Bunkyo-ko, Tokyo 113, Japan.                                                                     |
| 1995       | Caracas, Venezuela.  | '3rd Caribbean Conference on Fluid Dynamics', contact: Dr H. Ramkissoon, University of the West Indies, Dept. of Mathematics, St. Augustine, Republic of Trinidad and Tobago.                                        |
| 18-23/8/96 | Québec City, Canada. | 'XIth International Congress on Rheology' Canadian Rheology Group/Groupe Canadien de Rhéologie contact: Prof. D. DeKee, Dept. of Chemical Engineering, University of Sherbrooke, Sherbrooke, Québec J1K 2R1. Canada. |

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