

Πάντα ρει!



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On the Cover:

A photo taken by Monty Shaw of a bench in Christ Church Cemetery, Philadelphia, Pennsylvania USA. Monty's comment: "Amazing what can happen in 250 years." (His estimate, based on nearby tombstones.)

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Bingham Medalist 2011: Eric Shaqfeh



Profile by Ron Larson, Susan Muller, Bamim Khomami

Eric S. G. Shaqfeh received his B.S.E. degree in chemical engineering in 1981 from Princeton University (summa cum laude) and an M.S. (1982) and Ph.D. (1986) from Stanford University, where his dissertation research on buoyancy-driven convective flow was supervised by Andy Acrivos. Following a postdoctoral year at the University of Cambridge working with G. K. Batchelor and E. J. Hinch, Eric joined AT&T Bell Laboratories (Murray Hill, NJ USA) as a member of technical staff in 1987. Eric moved to academia in 1990 joining the faculty at Stanford University and rising to full professor in 1999. Among various awards Eric has received the NSF Presidential Young Investigator award (1990), the Camille and Henry Dreyfus Teacher-Scholar Award (1994), and the ASEE Curtix W. McGraw Research Award (1998), as well as numerous honorary lectureship positions. Eric is a fellow of the American Physical Society, associate editor of *Physics of Fluids*, and on the editorial board of three other journals.

When Eric began his research career at AT&T Bell Laboratories, his research was in theoretical fluid mechanics and suspension mechanics. Since that time, the scope of his research interests has steadily expanded, first to combined experimental and theoretical suspension rheology, then to viscoelastic fluid mechanics and stability theory, to the dynamics of dilute flexible polymers, and now to entangled polymer dynamics, polymer turbulent drag reduction, polymer biophysics, and even blood rheology.

Eric is particularly well known to the rheological community for his body of theories of transport in suspensions of rods, including non-local interactions. This work was responsible to a significant degree for his being awarded the Frenkiel Award of the American Physical Society for research in fluid mechanics by a young researcher. A particularly important contribution in this area is Eric's analysis, with Glenn Fredrickson, of hydrodynamic interactions in fiber suspensions using slender body theory. This work marked a milestone of rigor in this important area, extending the work of Batchelor, and allowing for calculation of effective rotational diffusivities in non-Brownian suspensions resulting from multi-body hydrodynamic interactions. He and his group also produced a beautiful theory, with supporting experi-

ments, on stochastic dynamics of flow through a fixed bed, including the effects on

polymer dynamics of such flows. Eric has continued his work on suspension dynamics up to the present, with his recent studies of sedimentation dynamics of colloids, and his rigorous treatment, with Jason Butler, of the hydrodynamics of beadrod chains.

While still at Bell Labs, Eric began writing a series of papers on dynamics and fluid mechanics of dilute polymer solutions. His work in these areas began with a collaborative study of purely elastic instabilities in polymeric fluids, including work co-authored with Susan Muller and Ron Larson on the Taylor-Couette instability, and continued in his own group with analyses of purely elastic instabilities in the Taylor-Dean flow, eccentric cylinder flow, and continuing with analysis of the effects of inertia. He also produced the most significant body of work world-wide on Brownian dynamics simulations of flexible polymers, eventually collaborating with Steve Chu to perform wonderfully elegant and important experiments on long DNA molecules in various flows, including extensional, shear, and mixed flows. In an experimental tour de force, Eric and coworkers were able to create a mixed flow in which real-time microscopic observation of a single stained DNA molecule could be achieved. This work showed the transitions between polymer stretching and tumbling present in such flows, and, when combined with Brownian dynamics simulations, provided an essentially complete experimental and theoretical understanding of the molecular dynamics of dilute flexible polymers in general velocity gradients. Even more spectacular was Eric's work with Steve Chu on extensional flows of super-long (1 mm long) DNA molecules. These studies confirmed the prediction made long ago by de Gennes that long polymers should show quasi-hysteresis in plots of chain stretch versus extension rate. That is, there should be two quasi steady-state values of polymer stretch at each value of extension rate, for a range of extension rates near the critical value for a "coil-stretch transition." This prediction has beautiful analogies to phase co-existence in thermodynamics,

where the coiled and stretched states are the two “co-existing phases,” and there are “nucleation” events required to transit from one state to the other. Not only did Eric and his colleagues finally perform the definitive experiment on this topic (published in *Science*), but Eric’s group followed this up with a comprehensive theoretical and computational analysis that included predictions of magnitude of the hysteresis, the time scales required for barrier hopping between coiled and stretched states, and the development of computationally cheap coarse-grained dumbbell models that capture the behavior of the much more sophisticated fine-grained models. This body of work, on its own, qualifies Eric as one of the pre-eminent molecular rheologists in the world.

Another very important rheological contribution by Eric Shaqfeh is the development of a greatly enhanced understanding of the mechanisms of polymer drag reduction. In this work, Eric’s group carried out direct numerical simulation (DNS) of turbulent flows of viscoelastic fluids and determined the structures of drag-reduced turbulence for both flexible and rigid polymers and particles. In some of the most comprehensive and insightful DNS studies of full turbulence yet, Eric developed insights into the differences between modest and maximal drag reduction and the importance of biaxial extensional velocity gradients in the drag-reduction mechanism.

Eric has recently developed a powerful experimental program in the area of dynamics of entangled flexible polymers, again using stained DNA molecules and elegant flow geometries to directly visualize the relevant polymer dynamics. In his earliest work, he discovered, among other things, a new relaxation time in the relaxation dynamics of entangled polymers under flow, which was apparently not anticipated in any existing theory in this field. Very recently, Eric and his group have used so-called “slip link” simulations to explain one of the major mysteries of extensional rheology of entangled polymers, namely the $-1/2$ power-law extension-thinning regime seen at extension rates above the inverse reptation time by Ole Hassager and coworkers. Eric’s work indicates that this regime results from flow-induced disentanglement of polymer chains, an idea much discussed, but never convincingly demonstrated theoretic-

cally or computationally. This break-through illustrates the speed with which Eric is able to move to the forefront of a deep, well-studied, and complex area.

Eric’s recent computational work is on margination of platelets in circulating blood flow. Eric’s group is using advanced computational methods to track red blood cells under flow through a capillary, including their shape deformations, their hydrodynamic interactions, their migration across the capillary, and their effect on other blood components, specifically platelets. These remarkable simulations have set a new standard in computational rheology, demonstrating that rigorous simulations are now possible even for fluids as complex as blood. Eric’s findings correlate well with experimental data and provide deep insights into platelet transport, with implications for wound healing.

As should be evident from the above account, not only is Eric a deeply insightful researcher, but also an excellent and valued collaborator. Outside of research, Eric is also an excellent organizer and manager. He emerged as the leader of the Stanford team in the DARPA-sponsored drag reduction research program, managing 5-10 faculty and students in a complex project involving experiments and simulations of phenomena ranging in scale from molecular to ocean-going vessels.

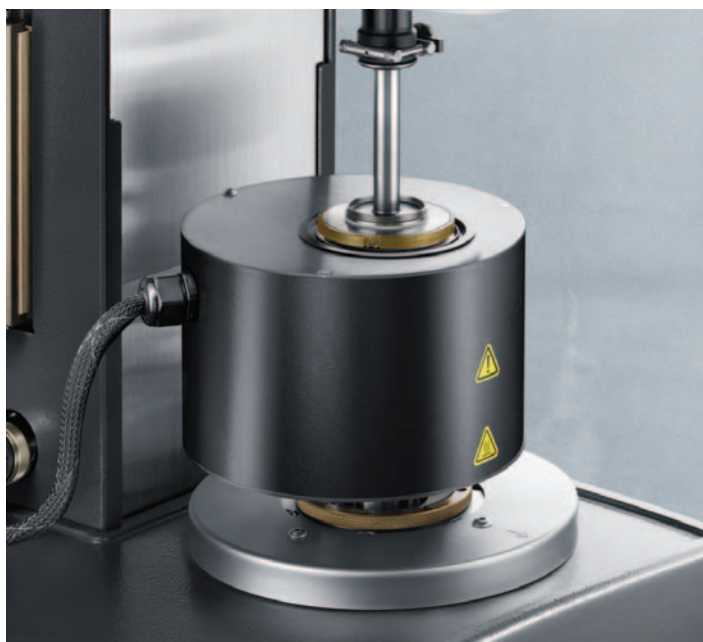
Eric is a devoted family man, sharing his life with his wife Terhilda Garrido and their children Stefan and
(continues, page23)



Shaqfeh and his 2011 research group, left to right: Vivek Narsimhan, Arash Abedijaberi, Andrew Spann, Sourav Padhy, Hong Zhao, Shenghan Yan, Shirin Ghaffari, David Richter, Amit Kushwaha, Eric Shaqfeh, Travis Walker, Shikha Somani, Byunghang Ha, Guihua Yu.

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Dr. Richard Graham has been chosen to receive the *2011 Arthur B. Metzner Early Career Award*, which is given to a member of the Society who is younger than 35 who has distinguished him/herself in rheological research, rheological practice, or service to rheology.

In choosing Graham for the Metzner award, the Committee cited his work in developing the most advanced non-linear theory of entangled polymer dynamics and rheology ever produced, as well as his work with experimental physicists and with chemists in developing his theoretical advances all the way into a unique “Neutron Flow Mapping” technique that resulted in a multi-author paper in *Science* in 2003, and in a series of publications in top journals since then.

Richard Graham is a lecturer in the School of Mathematical Sciences, University of Nottingham, UK. His first degree, awarded in 1999, was in Theoretical Physics from the University of Leeds. His PhD, also from the University of Leeds, was supervised by Tom McLeish and Oliver Harlen and was completed in 2002. McLeish describes Graham as “one of the most able, imaginative, and transformative students I have ever supervised.” In his thesis work Graham developed new non-linear flow models of entangled polymers and validated his models’ predictive capabilities against stress measurements and neutron scattering data. This comparison addressed several long-standing questions on entangled chain dynamics. Much of this experimental support was provided by the Micro Polymer processing project, and Graham took a key theoretical role in the project’s 2003 flagship paper in *Science*. Graham was awarded the Vernon Harris Doctorial prize by British Society of Rheology in 2004 and co-authored the article that received the *Journal of Rheology* Publication Award in 2005.

Following his studies at Leeds, Graham did post-doctoral work with Ron Larson at the University of Michigan (USA). At Michigan Graham uncovered

2011 Metzner Early Career Award: Richard Graham

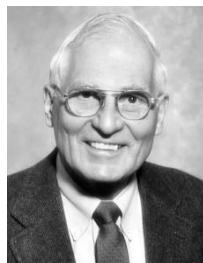
wide-ranging analogies between DNA electrophoresis and rheology. He recently proposed and validated the mechanism by which oscillating electric fields stretch entangled DNA.

In 2005, Richard returned to Leeds to work with Peter



Olmsted on flow-induced crystallisation in polymers. This extremely challenging field impacts strongly on both fundamental and industrial rheology. His recently derived molecular model was able to quantitatively capture nucleation measurements during flow, as described in articles in *Physical Review Letters* and the *Faraday Discussion Journal*. Graham continues to pursue global collaborations in this area and has attracted UK funding to build a group around his research program.

In 2007 Graham gained a permanent position at the University of Nottingham. In addition to his core rheological research, Graham is applying his skills in molecular simulation, learnt in rheological modelling, to solve a key problems in the viability of carbon capture and storage. His current position also involves undergraduate teaching, PhD supervision and student mentoring. He leads several schemes assisting undergraduates into PhDs, including the School’s undergraduate internship program. Richard Graham is the third recipient of the *SOR Metzner Early Career Award*.



The *SOR Early Career Award*, established in 2009, was named for Art Metzner, distinguished rheologist, university professor, editor of the *Journal of Rheology*, and Bingham medalist.

Come to Cleveland!

The Society of Rheology will host its 83rd Annual Meeting in Cleveland, Ohio, 9-13 October 2011. The technical program will take place in the modern InterContinental Cleveland, just minutes from Case Western Reserve University, the Cleveland Clinic, and downtown Cleveland. The meeting is being held in the University Circle area, a neighborhood that boasts more than 50 scholarly institutions ranging from the beautiful Cleveland Botanical Garden to the Cleveland Museum of Art. SOR attendees will find something for everyone should they want to escape momentarily from the technical sessions.

For the evenings, an exciting social program is planned and is designed to give attendees and their significant others a fun and intellectually stimulating experience.

Cleveland is easy to get to, with Cleveland Hopkins International Airport hosting most major airlines and serving as a hub for



83rd Annual Meeting of The Society of Rheology Cleveland, Ohio USA 9-13 October 2011

Continental Airlines. From the airport, you will be able to take a quick cab or cost-effective train to the Intercontinental Hotel and Conference Center. Octobers in Cleveland are beautiful with the onset of autumn and associated foliage color changes, temperatures hovering the “nippy” range of 50-55 °F (10 – 13 °C), so plan to bring sweaters and jackets. For more information, visit www.positivelycleveland.com.

Conference registration (ranging from members, early \$140 to non-members, late \$280; see www.rheology.org/sor/annual_meeting/2011Oct/) includes access to all technical sessions and the vendor display, program and abstract booklets, and all receptions and coffee breaks. On-site registration will be held on Sunday, October 9th from 3pm to 7pm and throughout the meeting in the Lobby Foyer of the InterContinental Cleveland.

All attendees are encouraged to attend the annual business meeting of The Society of Rheology. This year the business meeting will be held during the lunch break on Monday, October 10th. This meeting will start at approximately 12:15 pm immediately following the morning technical session and will be held in Room 207. Boxed lunches will be provided.

The Bingham Award Reception and Banquet in honor of 2011 Medalist Eric Shaqfeh will be held on Tuesday, October 11th, in the Terrace Club of Progressive Field – home to the Cleveland Indians baseball team. The reception will begin at 7pm in the adjacent Terrace Club Pub. The reception will be followed immediately by the Bingham Award Banquet at 8pm in the Terrace Club. This exciting location will provide a unique visual experience while dining with friends, old and new. The reception is open to all meeting participants at no extra charge. Banquet tickets can be purchased with the meeting registration. More information about the meeting may be found at www.rheology.org/sor/annual_meeting/2011Oct/.

We look forward to welcoming you to Cleveland!

Pat Mather, Local Arrangements Chair



Photo courtesy of (c)www.positivelycleveland.com

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Course on Rheology of High-Interface Systems

The Cleveland meeting will be preceded by a two-day short course on the rheology of high-interface systems. This course is aimed at the rheology and structure of foams, emulsions, and blends as well as the rheology of interface-dominated systems from biology where the behavior of phospholipid monolayers and bilayers control the mechanical response of lung surfactants, cells, and vesicles. Registration for the short course may be completed online after June 15 (www.rheology.org/sor/short_course/2011Oct/default.htm#Registration).

The short course instructors are **Gerald G. Fuller** (Stanford University, USA), **Jan Vermant** (Katholieke University Leuven, Belgium), and **Andy Kraynik** (Sandia Laboratories, USA, retired). Gerry Fuller has conducted research in the areas of optical rheometry and interfacial rheometry for more than 30 years. Jan Vermant's research focuses on bulk and interfacial rheology and relations to flow-induced structures in complex fluids and interfaces, particularly for colloidal dispersions. Andy Kraynik has been involved in research on liquid and solid foams with emphasis on a microrheological point of view since 1976.

Course Outline: *Saturday Morning (all instructors)*

The syllabus begins with a presentation of capillarity and wetting. The concepts of surface tension, wetting, contact angles, and capillary forces are discussed. The Young-Laplace equations are developed and the stresses imposed by curved interfaces are predicted. Marangoni stresses arising from surface tension gradients are described. The molecular structure of surfactants, amphiphilic polymers, and proteins are described and their manner of attachment to fluid interfaces is explained. The attachment of colloidal particles to interfaces is also described. The phase behavior of complex fluid interfaces is explored along with the techniques to measure them. These include Langmuir troughs and Wilhelmy balances, Brewster angle and fluorescence microscopies, pendant drop, and du Nouy tensiometers.

Saturday Afternoon (Kraynik)

Foams are complex fluids in which gas bubbles are dispersed in a small amount of liquid. Applications include foods and beverages, froth flotation, petroleum production, fire fighting, and polymer foam processing. Foams exhibit a wide range of rheological properties (shear modulus, yield stress, non-Newtonian shear viscosity, slip at the wall, and expansion viscosity) that strongly depend on their microstructure (cell size and liquid fraction), which can evolve by various mechanisms

(foam expansion, diffusive coarsening, and foam drainage). Techniques for characterizing foam structure and measuring foam rheology will be reviewed. Models of foam structure ranging in complexity from the regular honeycomb in two dimensions to random polydisperse foams in three dimensions will be discussed. The connection between macroscopic foam properties and cell-level structure and flow mechanisms will be illustrated with many examples.



Sunday Morning (Fuller)

The rheology of emulsions and blends depends on the interfaces (composition, deformation and orientation) that divide the dispersed and continuous liquid phases. Morphological processes, such as deformation, different types of break-up and coalescence will cause the interfacial contributions to the rheological behavior to depend on the flow conditions and history. The base case of immiscible mixtures with Newtonian components will be reviewed first. The evolution of the rheological properties in combination with *in-situ* observations of the microstructure will be compared to the predictions of continuum models. The effects of a presence of interfacial agents and the role of their interfacial rheology will subsequently be addressed. Both systems compatibilized by surfactants and block-copolymers, as well as particle stabilized systems (Pickering systems) will be addressed. It will be discussed how the morphological processes which control the rheological properties are altered by the presence of interfacial agents.

(continues, page 23)



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*The Society of Rheology
Constitution and By-Laws*

Constitution

Article I

*The Name of this organization shall
be the Society of Rheology*

Article II

*The object of this society shall
be the advancement of Rheology
and its applications. Rheology
is here defined as the science
of the deformation and flow of
materials. The object shall be
promoted (a) by meetings
(b) by the publication of a journal
designed to increase & disseminate
knowledge of rheology (c) by other
appropriate means.*

The original constitution of The Society of Rheology is preserved in the collections of the Niels Bohr Library and Archives of the American Institute of Physics in College Park, Maryland, USA. Handwritten on the stationery of the Wardman Park Hotel, which is now a Marriott hotel, this document lists the objective of the society as the “advancement of Rheology and its applications.” The Wardman has been restored and remains one of the grand hotels of Washington, D.C.

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Joachim Meissner

1929 – 2011

Joachim Meissner was born in 1929 in Sehma/Annaberg, a small town in Germany. When he graduated from high school in 1947 there was no longer a single Germany, and he found himself in the then Soviet sector. After a short apprenticeship as an electrician, he moved to Stuttgart, then West Germany, in 1948, with his belongings consisting of three packs of cigarettes. He obtained his doctorate in physics at Stuttgart in 1958 with a thesis on the plasticity of Ni-Co single crystals.

He joined BASF AG, Ludwigshafen, in 1958. The curious melt flow behavior of polyethylene caught his imagination, and two years later he was asked to set up a rheology research laboratory. Joachim made his first international appearance at the 4th International Congress of Rheology, Providence, Rhode Island USA in 1963. His paper on the shear-stress dependence of the flow activation energy of branched polyethylene is still relevant today. He was a notable presence at these conferences for many years after that, in later years accompanied by his wife Lilo.

An early major contribution to rheometry was Joachim's elaborate modification of a Weissenberg Rheogoniometer for the measurement of transient rheological properties of molten polyethylene and viscosity at extremely low shear rates. To this day, no one has matched this remarkable achievement. His most ingenious idea was the rotary clamp for molten polymers, first described in 1969. This inspired the development of a series of ever more elaborate and accurate elongational rheometers, which was the basis for the 1981 Annual Award of the British Society of Rheology to Meissner and his coworkers, Laun, Münstedt, and Wagner. Joachim was always trying to bridge the gap between research and application. A fine example of this is his organization of the IUPAC working party project on "Basic parameters, melt rheology, processing and end-use properties of three similar low density polyethylene samples."

His fruitful cooperation with Prof. Arthur Lodge began during a 1971/1972 stay as Visiting Professor at the Rheology Research Center of the University of Wisconsin. The photo on page 15 shows him listening to Arthur at UW. (Other prominent UW rheologists can also be seen.) This extended visit resulted in the articulation of the Lodge-Meissner relationship relating normal and shear stresses in a step-shear experiment.

In 1974 Meissner was invited to the Swiss Federal Institute of Technology (ETH) in Zürich to take the Chair in Polymer Physics. Joachim created a course of study for material engineers and was instrumental in building up the Materials Science Department to seven professors graduating 40 to 50 material engineers each year by the time of his retirement in 1996. Joachim also found time to organize the Swiss Group of Rheology in 1990.

At the ETH Meissner and his students developed ingenious rheometers for the measurement of the response of melts to biaxial extension. He turned a commercial shear rheometer into a useful device for measuring both normal stress differences, and he showed how interfacial tension in polymer blends can be determined by shear or elongational rheometry. With the ultimate goal of understanding melt fracture in mind, Joachim and his students



Arthur Lodge lecturing to Meissner during Meissner's industrial sabbatical to the Rheology Research Center at the University of Wisconsin, Madison (RRC). Meissner is in the corner, beside John Schrag (glasses). Milard Johnson is in the foreground, nearest the camera. Robert Armstrong and Ole Hassager are together across the table, Hassager in the thin tie. Photo courtesy of the Rheology Research Center.

measured velocity profiles in contraction flows, first by Laser-Doppler velocimetry and, more recently, by tracing particles in a flowing polymer melt with video cameras. Whenever he finished an instrument or a chapter of his unfortunately never finished book, he realized that there was a better way to do it and started over again. His famous advice to rheologists was: "Ask the material how it deforms, because only the material knows." After more than 20 years at the ETH, the relationship between Joachim and Switzerland was still a bit like that between Switzerland and Europe: each one being in the center of the other, inseparably interwoven, but somehow unwilling to really fit in, notoriously standing out like a rock of the surge.

His last public appearance was in 2006 at a conference in Wales to honor the career of Arthur Lodge. He is shown in the photograph on page 14 giving a hilarious dinner speech entitled "My Life with Arthur." The text was published in the *Bulletin* of the BSR. Meissner continued to come to his office several times a week until October of 2010 to work on his book. Joachim

was a stern taskmaster with his students, but many of them attended his memorial service, and it was obvious that they appreciated his efforts to help prepare them for professional careers. After the memorial service for Joachim his wife Lilo was heard to say: "When you ask where he, a Saxon living in Switzerland, was at home, the answer will be: his real home was truly rheology."

Manfred Wagner
Hans Christian Öttinger
John Dealy

Daniel D. Joseph

1929-2011

Daniel D. Joseph, a world-renowned expert of fluid mechanics for more than four decades, passed away on 24 May 2011 at the University of Minnesota Hospital in Minneapolis. He was Professor Emeritus and Russell J. Penrose Professor Emeritus of Aerospace Engineering and Mechanics at the University of Minnesota.

Dan was born on 26 March 1929 in Chicago, Illinois. He earned an M.A. Degree in Sociology from the University of Chicago in 1950, and during the next several years he worked as a semi-skilled machinist in different factories. Regarding this early experience he once jokingly said: "In those days, I was a flaming radical motivated by some mix of idealism and stupidity. I suppose the gradual realization that there was more stupidity than idealism involved led me to conclude that sociology was not my strong suit. Besides, sociology, unlike engineering, is a subject about which ordinary people think they have expert opinions, leading to a certain lack of respect". Therefore, he went back to school at the Illinois Institute of Technology (IIT), earning his bachelor's degree in mechanical engineering, a master's degree in mechanics, and his Ph.D. degree in mechanical engineering in 1963.

He began his academic career during 1962 as an Assistant Professor of mechanical engineering at the Illinois Institute of Technology (IIT). In 1963, he joined the faculty of the University of Minnesota in the Aerospace Engineering and Mechanics Department as an Assistant Professor where he remained until his retirement in 2009. He became a Full Professor in 1968 and was the Russell J. Penrose Professor from 1991 through 2001, and Regents Professor during 1994-2005. In addition, he was a Distinguished Adjunct Professor of Aerospace and Mechanical Engineering at the University of California, Irvine, and an Honorary Professor at Xi'an Jiaotong University of China. During his illustrious career, he held 10 US patents, was author or coauthor of more than 400 journal articles and 7 books, edited 6 more books, and consulted with various companies including Pillsbury, Gillette, M&M Mars, and many petroleum companies around the world. He was a sought-after speaker at conferences.

At the beginning of his research career, Dan studied various fluid flows in geometries with permeable bounding surfaces. Together with Gordon Beavers, he proposed and experimentally verified a "slip" boundary condition at the interface of a porous medium and a clear fluid, analogous to that in a rarefied gas flow, which is referred to



as the Beavers-Joseph boundary condition.

During the late sixties and early seventies, Dan's work was more mathematically oriented. He did research on the stability of fluid motions which led to a pair of well-known monographs, and on the theory of bifurcation which was summarized in a popular textbook on this subject written

with G. Iosue. Dan is especially known for these ground-breaking works on the energy theory of stability.

In the late seventies Dan developed an interest in rheology. He advocated an approach for analyzing slow and slowly varying flows in which the flow and constitutive equations for the viscoelastic fluids are perturbed together, independent of viscoelastic models. Together with his co-workers and using his method of domain perturbations for free-surface problems, Dan developed a theory for the Weissenberg effect governing the rise of the free surface in the neighborhood of a rod rotating in a viscoelastic fluid. He also showed how to develop a rheometer based on this phenomenon. During this period of time, Dan, working with his colleagues, classified the equations of viscoelastic fluids and found that the unsteady vorticity equation is hyperbolic, giving rise to waves of vorticity. His research group subsequently solved many problems in which the governing equations involve a "change of type" from region of elliptic to that of hyperbolic, as in transonic flow. He also invented a device to measure the speed of a shear wave in the fluids, and showed that the measured speed correlated with the delayed die swell data, as well as with the tilt angle of sedimenting long particles.

In the eighties, Dan did ground-breaking experimental and theoretical work developing an understanding of the underlying physics of flow-induced particle microstructures in particulate flows. He devised simple experiments to understand the particle-scale mechanisms for these flows and came up with very-simple explanations. For example, he and co-workers noticed that in fluidized suspensions the inertial effects associated with wakes are very important. They noted that particles continuously rearrange, and that in this process "Two local mechanisms are involved: drafting and kissing and tumbling into stable cross-stream arrays. Drafting, kissing and tumbling are rearrangement mechanisms in which one sphere is captured

in the wake of the other. The kissing spheres are aligned with the stream. The streamwise alignment is massively unstable and the kissing spheres tumble into more stable cross-stream pairs of doublets which can aggregate into larger relatively-stable horizontal arrays.”

Because of Dan, drafting-kissing-tumbling phenomenon has now become one of the standard test cases in the validation of direct numerical simulation techniques for particulate flows. Dan also identified that the particles falling in viscoelastic fluids draft and kiss, but instead of tumbling, they form chains along the streamwise direction.

Another project that Dan liked greatly was the water-lubricated transport of heavy viscous crude oil, in which the oil travels within a sheath of water along the pipeline, thus reducing the power required for pumping. He explained this technology in anthropomorphic terms “High viscosity liquids are lazy. Low viscosity liquids are the victims of the laziness of high viscosity liquids because they are easy to push around.

Dan realized that experimental tools alone were not sufficient to understand the complex physics underlying particulate flows. He devoted the 1990s to the development of new computational approaches that could provide the details of the particle-level physics of suspension flows. In this effort he led a multi-institution team to develop efficient direct numerical simulation methods that could simulate the time-dependent motion of large number of solid particles for sufficiently long-time durations from which the complex physics of these systems could be analyzed. He used these techniques to develop novel models for the lift force on a particle in dense suspensions, which was a hitherto difficult problem.

In the past decade, Dan worked on what he sometimes called one of his “legacy work”. While the viscous effects in an irrotational flow have been assumed to be small, Dan realized that this may not be actually so. Consequently he set out to show that this is not the case for a range of problems, and computed the error that occurs because of this approximation. Many of these results are published in a



These photos, supplied by Chris Macosko, were taken at the University of Minnesota rheology short course banquet in June 1993, the year Dan won the Bingham award. Bill Russel, Matt Tirrell and Chris presented Dan with a medal to wear around his neck; a ketchup bottle was attached to the medal in honor of his Bingham award.

book which he and his co-authors have recently published. In recent years Dan was intrigued by the problem of dispersion of small particles which disperse violently when they first come in contact with a liquid surface, and was working on the modeling of the coal gasification processes.

The hallmark of Dan’s body of work has been to pursue fundamental enquiry (he would say “pick low lying fruit”) and to extract practically relevant models that can be useful in engineering practice. This led to broad impact of his work in multiple fields. He was a rare blend of a gifted mathematician and a brilliant engineer. The spectrum of prestigious awards that Dan received is a testimony to this fact. Dan received many awards including membership in three national academies: the National Academy of Engineering, the National Academy of Sciences and the American Academy of Arts and Sciences. He was a Guggenheim Fellow, and was awarded the G.I. Taylor Medal of the Society of Engineering Science, the Timoshenko Medal of the American Society of Mechanical Engineers, the Schlumberger Foundation Award, the Bingham Medal of the Society of Rheology, the Fluid Dynamics Prize of the American Physical Society, Professional Achievement Awards from Illinois Institute of Technology and University of Illinois, and the Distinguished Service Award from the U.S. Army.

Dan was lover of classical music, opera, and the Rolling Stones. In mid life he became a marathon runner. Beside his family, he took pride in the 48 students whom he directed toward a PhD and who are now working throughout the world. The principles of his laboratory were “have some fun, tell the truth, and do good research.” After retirement as a Professor, he continued to do research with

(continues, page 23)



NEWS

Society Elections: Report of the Nominating Committee

This year is an election year in The Society of Rheology, and our Constitution/Rules spell out the procedure. The Nominating Committee reported on their nominations, and the membership was informed on 22 April 2011 of their selections, as outlined below.

President: A. Jeffrey Giacomin

Vice-President: Michael Graham
Gregory B. McKenna

Secretary: Albert Co

Treasurer: Montgomery T. Shaw

Editor: John F. Brady

Members-at-Large:

Shelley Anna
Ole Hassager
Chongyoun Kim
Gareth McKinley
Jai Pathak
Norman J. Wagner

Balloting will take place electronically; members in good standing will receive instructions on how to cast their ballots by email. The Constitution specifies that balloting will begin at least 80 days before the annual meeting, and thus for 2011, balloting will begin 21 July 2011 and will end 10 September 2011.

Travel Grants Available for Cleveland 2011

The Society of Rheology is offering student-member travel grants to support the cost of attending its 83rd Annual Meeting in Cleveland, Ohio. These grants are available to any graduate student who is a member in

good standing of the Society as of 24 July 2011 and whose faculty advisor is also a member as of that date. In addition, the student must coauthor a paper or present a poster at the meeting, and stay in the official meeting hotel, InterContinental Cleveland. We anticipate that each grant will cover up to a maximum of four nights lodging at the conference rate (sorry, no funds are available for registration or travel costs to and from the meeting). Only students who have not received a travel grant for an SOR meeting in the past are eligible (students who have only received a travel grant for the International Congress of Rheology in the past may apply).

To apply, the student must write a letter requesting the grant; and the student's advisor should add a letter of support, certifying that both the advisor and the student are members of the Society and indicate the title and session of the submitted presentation abstract (or poster) and that the student will be the presenter. Only one application per faculty advisor will be accepted for this meeting. Letters from the student and advisor should be uploaded as ONE PDF file onto:

www.che.udel.edu/SOR-STG-2011

starting 1 June 2011 and by 24 July 2011. Inquiries can be sent to the following e-mail address: SOR-STG@udel.edu.

2011 Roy W. Tess Award in Coatings Announced

Dean C. Webster of North Dakota State University, Department of Coatings and Polymeric Materials will receive the Roy W. Tess Award in Coatings for 2011. The announcement was made by the Officers and the Award Committee of the Division of Polymeric Materials: Science and Engineering (PMSE) of the American Chemical Society.

Dr. Webster began his career in the coatings industry in 1984 working initially in corporate R&D and later for the Consumer Division of Sherwin-Williams in Chicago, IL, where he was involved in resin development for industrial coatings as well as long-range research in new resins and crosslinking chemistry. In 1993 he moved to

Eastman Chemical Company where he led project teams in the areas of application development for new monomers, new chemistry for coatings systems, and polymer development for coatings. In 2001 he joined the Coatings and Polymeric Materials Department of North Dakota State University as Professor.

Dr. Webster received his Ph.D. in Materials Engineering Science at Virginia Polytechnic Institute and State University in 1984. Prior to that, he received his B.S. degree in Chemistry at Virginia Polytechnic Institute and State University.

A New Edition of the Rheology Handbook

The third edition of *The Rheology Handbook* has appeared. The new edition is completely revised and describes the principles of rheology in practical terms. This reference book has been expanded to include the topic of the rheology of additives in waterborne dispersions and surfactant systems. The new publication covers the areas of quality control, production and application, chemical and mechanical engineering, materials science, industrial research and development.

The Rheology Handbook
3rd Revised Edition by Thomas G. Mezger
ISBN 978-3-86630-864-0, Vincentz Network

Minutes of the ExCom Meeting

Sunday, 10 April 2011

Rosemont, Illinois USA



Attending: Faith Morrison, Jeffrey Giacomini, Albert Co, Monty Shaw, Bob Prud'homme, Hiroshi Watanabe, Ole Hassager, Norm Wagner, Andy Kraynik, Bo Hammer (AIP), Doreen Hall (AIP), Pat Mather, Marie-Claude

Heuzey, Michael Mackay, Victor Breedveld, Mike Solomon (via Skype), Shelley Anna, Anne M. Grillet, Amy Shen.

President Faith Morrison called the meeting to order at 8:00 a.m. in Hartsfield Room, Hyatt Regency O'Hare,

Rosemont, Illinois.

The minutes of October 24, 2010 were read by Secretary Albert Co. A motion to approve the minutes was passed.

Monty Shaw reported on the financial status of the Society and JOR. He's working to separate costs into appropriate categories. The Santa Fe Meeting has a net of \$2500. Shaw discussed liability coverage for Society officers and volunteers, as related to the Volunteer Protection Act of 1997. The cost is \$1,300 for \$1,000,000 in coverage. A motion to authorize the Treasurer to proceed with the volunteer insurance policy was passed.

Shaw summarized the costs of the JOR editorial office. The office expenses are running \$16,000/year. With PEERX doing much of the editorial office work, Shaw commented that perhaps JOR office expenses could be less than this.

Faith Morrison gave the JOR Editor Report for John Brady, who was unable to attend the meeting. The usual statistics were presented.

Albert Co gave the secretary's report. He reported that the abstract submission site for the Cleveland meeting has been live and the site for program and session chairs will be on line in a week or two. Co is working on a website for local arrangement chairs to access previous meeting registration databases. He also reported that he is working on a website to upload files for poster competition. The site will be similar to the one used for uploading PDF files for ICR2008. In late July the election site will go live. Co also reported the Society currently has three domain names: rheology.org, societyofrheology.org and the newly acquired rheology.com.

Faith Morrison reported that through the efforts of Jeffrey Giacomini, Dow Chemical has donated the domain name rheology.com to the SOR. Morrison will thank individuals from Dow, specifically Dr. Kurt Koppi and Dr. Gretchen Baer in Midland, Michigan, who are responsible for this donation. Co reported that the transfer of ownership is in progress and should be completed in another week.

Morrison circulated a thank-you letter for Janis Bennett; this and a small engraved item will be sent by Morrison. Morrison reported that per the budget, \$1,500 was being donated to the AIP in support of the Physics Team.

Policy on compensations for plenary lecturers was discussed. The consensus was to offer complementary meeting registration and four nights of hotel accommodations. Additional funds, if needed, can be obtained from the presidential discretionary fund.

Mike Mackay reported for the Nominating Committee. A slate of candidates is being assembled.

Anne Grillet reported for the Education Committee. After reviewing instructors' honoraria, the committee recommends that the honoraria remain as \$2,100 for a two-day course and \$1,400 for a one-day course. Instructor travel is also reimbursed. The committee would like to always offer the beginning rheology course. The committee is looking into whether to pursue obtaining ECTS points, which are measures of the workload of courses, for SOR short courses.

Shelley Anna reported the statistics on membership. She discussed efforts to retain student membership and the use of social media. Bo Hammer (AIP) commented that one must constantly remind members to renew. Hammer asked would the SOR want its Society of Physics student numbers to grow. The membership committee will consider this.

Kalman Migler reported for the Bingham Committee. There were several good candidates. The committee functioned well and recommended a candidate. The ExCom thanked Migler and the committee.

Doreen Hall (AIP) reported on AIP matters. A small AIP dues increase is in the works, as announced some time ago. The SOR iPhone app iRheology will be ready in a month. Hall and AIP invited SOR to send representatives (president, treasurer, and others) to AIP for a "Strategy Day" at their Melville location. The purpose of this meeting would be to engage in discussions of what AIP can do and does do for SOR. The AIP structure is changing from "fee for service" to "partnerships" The goal would be to do this over the summer. Faith Morrison said that SOR would consider this.

Bo Hammer (AIP) reported for himself and Will Hart, who are organizing the Industrial Outreach session at the Cleveland meeting. They are planning a Sunday afternoon event with three 45-minute presentations and discussions. Mather will reserve a room.

Andy Kraynik gave a presentation on Meeting Planning 101. There were several future meeting planners present who benefitted. Kraynik will produce a written version for archiving.

Mike Solomon (via Skype) reported for the Metzner Committee. There were five very good applications. The committee met by conference call. An awardee was reported to the ExCom. The ExCom thanked Solomon and the committee.

Pat Mather reported that the planning of the Cleveland Meeting was proceeding appropriately. The meeting room layout was reviewed. The banquet is scheduled to be held in Progressive Field. However, hotel space has been reserved for the banquet as a back-up in case the Cleveland Indians need their stadium in October. The

registration fees for the meeting were discussed.

Victor Breedveld reported on the session chairs for the Cleveland meeting and the consideration of five versus six parallel sessions. Breedveld also presented a formal proposal that the Metzner awardee presents a mini-plenary on Thursday morning. After considerable discussion, the motion passed with six for, two opposed, and one abstention. The Metzner presentation will be 40 minutes long and will be unopposed. It will be shorter than a plenary talk but longer than a regular talk and will not be billed as a plenary talk.

Andy Kraynik reported that the planning for ICR2012 was proceeding appropriately. Faith Morrison presented John Brady's report that the planning of the spring 2013 Pasadena meeting is going well. Kraynik further reported that the Welcoming Reception is planned at the Convention Center and the banquet, at Caltech.

Marie-Claude Heuzey reported on the planning of the fall 2013 Montreal meeting. The room block and rates, as well as the meeting space and room layout, were reviewed. Also discussed were the social program, budget, and conference services.

Michael Mackay reported on the planning of the 2014 Philadelphia meeting. The meeting venue and the meeting room layout were presented. Kalman Migler reported on the planning of the 2015 Baltimore meeting. Meeting venue, room blocks, and meeting room layout were presented.

Hiroshi Watanabe reported that the location of the ICR in 2016 would be decided at the Korean SOR meeting in summer. Faith Morrison reported that proposals for meetings in Chicago (Venerus, Burghard, Schieber) and Seattle (Shen) were expected in October. In addition, proposals for meetings in North Carolina (Khan) and Denver (Liberatore) were being encouraged. Shen and Liberatore are invited to the October ExCom meeting.

The meeting entered into Executive Session at 3:55 p.m. The meeting was adjourned at 4:10 p.m.

Submitted by Albert Co, Secretary.

Treasurer's Report

To the Membership:

The tables below provide information concerning the 2010 financial transactions, the financial position at the end of 2010, and the proposed budget for 2012. Those with sharp



Treasure's Report

eyes will note a slight change in reporting this July: the 2010 projection has been eliminated in favor of the 2009 receipts and disbursements. While the projection is useful for discussion at the annual meeting, it has very little archival value.

As can be seen from the net in the table labeled "Receipts and Disbursements," 2010 was a good year, but not a great year. Aside from plunging interest rates, we agreed to a one-time charge of \$15,000 to upgrade the

The Society of Rheology, Inc. Balance Sheet

(all amounts, USD)	2010 Year End	2009 Year End	2008 Year End	2007 Year End	2006 Year End
Assets					
Cash in checking account(s)	13,257	18,330	10,859	24,466	9,777
Securities	0	0	0	0	0
Balance in AIP account	1,435,019	1,425,005	1,342,819	1,292,672	1,185,978
Total Assets	1,448,276	1,443,335	1,353,678	1,317,138	1,195,755
Liabilities and Net Assets					
Liabilities					
Deferred revenue	89,283	125,501	87,675	111,995	129,339
Total Liabilities	89,283	125,501	87,675	111,995	129,339
Net Assets					
Publication reserve	450,000	450,000	450,000	450,000	450,000
Student travel grant reserve	30,000	30,000	10,000	10,000	10,000
Annual Meeting reserve	300,000	300,000	300,000	300,000	200,000
Operating reserve	150,000	150,000	100,000	100,000	100,000
Unrestricted	428,994	387,834	406,003	345,143	306,416
Total Net Assets	1,358,994	1,317,834	1,266,003	1,205,143	1,066,416
Total liabilities and net assets	1,448,276	1,443,335	1,353,678	1,317,138	1,195,755

Journal of Rheology Receipts and Disbursements (all amounts, USD)

	2012 <u>Budget</u>	2011 <u>Budget</u>	2010 <u>Year End</u>	2010 <u>Budget</u>	2009 <u>Year End</u>
RECEIPTS					
Subscriptions	150,000	165,000	159,285	172,000	174,199
Royalties & Reprint Sales	5,500	4,000	5,337	11,000	4,951
Ad Sales	45,000	43,000	49,814	39,000	39,198
JORO revenue	65,000	61,000	70,946	54,000	59,588
Miscellaneous	2,100	2,000	2,105	2,500	2,000
TOTAL RECEIPTS	267,600	275,000	287,488	278,500	279,936
DISBURSEMENTS					
Ads	12,000	10,000	13,180	11,000	9,990
Reprints, Single Copy	1,800	2,200	1,382	1,300	1,999
Paper, Printing	29,000	27,000	28,605	40,000	31,189
SOR Editorial	45,000	36,000	46,217	39,000	35,769
Production	35,000	39,000	36,322	41,000	39,208
Fulfillment	5,925	5,725	5,882	5,825	5,538
Distribution	22,650	22,700	20,855	28,800	24,899
Electronic publishing	41,000	41,000	55,765	38,000	35,595
Miscellaneous	7,000	8,500	6,431	7,600	6,863
TOTAL DISBURSEMENTS	199,375	192,125	214,638	212,525	191,048
Net	68,225	82,875	72,850	65,975	88,888

Journal of Rheology Online. Please also examine the budget for 2012; the budgeted net is the lowest in recent history. Worse, the budget is being saved from a deficit because 2012 is an ICR year, which means there are no awards and no student-travel expenses. To remain in the

black, increases in dues, journal or meeting revenues will need to be budgeted for 2013.

Respectfully submitted,
Montgomery T. Shaw, Treasurer

Treasurer's Report

The Society of Rheology Receipts and Disbursements (all amounts, USD)

	2012 Budget	2011 Budget	2010 Year End	2010 Budget	2009 Year End
RECEIPTS					
Dues	46,000	49,000	47,969	48,000	51,355
Interest	3,000	5,000	2,744	6,000	5,716
Journal of Rheology	267,600	275,000	287,488	278,500	279,936
Mailing List Sales	100	300	80	100	465
Donations	0	0	0	0	0
Bulletin Advertising	10,000	10,000	10,800	9,000	10,400
Annual Meeting (net)	0	0	13,106	0	4,599
Short Course (net)	0	0	16,247	0	5,578
TOTAL RECEIPTS	326,700	339,300	378,433	341,600	358,049
DISBURSEMENTS					
AIP Dues Bill & Collect.	11,500	11,000	11,386	11,000	11,076
AIP Adm. Services	8,000	8,000	7,568	9,000	6,912
AIP Mem. Soc. Dues	7,500	7,500	7,500	8,000	7,879
Contributions and Prizes	12,000	11,000	11,825	22,000	9,690
Journal of Rheology	199,375	192,125	214,638	175,000	191,048
Bulletin	22,000	19,000	22,127	19,000	18,735
Bingham Award	13,000	500	12,972	12,000	10,000
Executive Cmt. Meetings	13,000	13,000	16,695	8,500	11,583
Pres. Discretionary Fund	1,500	1,500	814	1,500	0
Treas. Discr. Fund	1,500	1,500	0	1,500	0
Bulletin Editor Discr. Fund	1,500	1,500	0	1,500	0
Progr. Chm. Discr. Fund	3,000	3,000	0	2,000	3,176
Webmaster Discr. Fund	3,000	3,000	1,030	3,000	1,202
International Activities Fund	5,000	5,000	2,000	5,000	886
Office Expenses	4,000	4,000	2,224	3,000	4,288
Banking Services	100	100	60	100	90
Liability Insurance	5,200	3,900	3,830	3,900	3,830
Membership Broch. & Appl.	2,000	1,500	2,193	500	0
Accountant	2,200	2,000	2,200	2,000	1,920
Student member travel	0	21,000	14,541	26,000	21,542
Annual meetings, future	6,000	8,000	2,299	9,000	5,926
Website	3,000	3,000	215	500	2,846
Miscellaneous	100	500	0	500	19
TOTAL DISBURSEMENTS	324,475	321,625	336,117	324,500	312,649
Net	2,225	17,675	42,316	17,100	45,400

the end

(continued from Short Course, page 11)

Second Afternoon (Vermont)

In many applications, the interfaces themselves respond nonlinearly to deformation and flow. The non-Newtonian rheology of these two-dimensional systems is a consequence of strong interactions and cooperative behavior of molecular amphiphiles and particles residing at the interface. In analogy to their bulk counterparts, two-dimensional polymer melts, gels, liquid crystals, and suspensions can assemble at fluid interfaces and strongly affect the stability and bulk rheology of emulsions, foams, and blends. Interfacial rheology plays an important role in controlling coalescence and Oswald ripening. The rheology of important classes of complex fluid interfaces is discussed and measurement techniques are discussed. These include interfacial shear and dilatational rheometry and the use of flow-microscopies to image nonlinear interfacial flow responses.

(continued from Bingham Medal, page 4)

Elena. The family enjoys traveling together, having recently taken family trips to Peru, Mexico, Death Valley California, and Greece. Eric has a broad range of non-scientific interests and talents including chess, skiing, golf, and racquetball. Finally, Eric enjoys cooking and good wine, as well as a good joke even when he is the butt of it, often skewering himself with relish. A gathering with Eric is a sure opportunity for fun. A sincere and hearty congratulations to Eric on receiving the Bingham medal this year.

(continued from Dan Joseph, page 17)

his students and colleagues. The funeral and burial were held in Philadelphia, PA on 26 May 2011. Dan was preceded in death by his son, Michael Joseph. He is survived by wife Kathleen Jaglo Joseph, his sons Charles Joseph and Samuel Guillopé Weissler, his daughter Shifra Chana Hendrie, and 13 grandchildren. A memorial is planned for later this fall in Minneapolis. Memorials are preferred to the scholarship fund at the Institute of Technology at the University of Minnesota.

*Howard Hu, University of Pennsylvania,
Neelesh Patankar, Northwestern University
Pushpendra Singh, New Jersey Institute of Technology*

(Calendar, continued from page 24)

ro2012/)

5-10 August 2012

XVIth International Congress on Rheology, Lisbon, Portugal, João M. Lopes Maia (every four years)

19-24 August 2012

XXIIIrd International Congress of Theoretical and Applied Mechanics ICTAM 2012; Beijing, China (every four years)

2013

9-10 February 2013

SOR Short Course on Rheology (topic TBA), Pasadena, CA USA

10-14 February 2013

84th Annual Meeting of The Society of Rheology, Pasadena, California, USA, John Brady

12-13 October 2013

SOR Short Course on Rheology (topic TBA), Montreal, Quebec, Canada.

13-17 October 2013

85th Annual Meeting of The Society of Rheology, Montreal Quebec Canada, Marie-Claude Heuzey, Paula Wood-Adams.

2014

4-5 October 2014

SOR Short Course on Rheology (topic TBA), Philadelphia, Pennsylvania USA

For other meeting notices, see also

www.rheology.org/sor/info/Other_Meetings.htm

<http://www.rheology-esr.org/Meetings.php>

[www.appliedrheology.org/\(click on conferences\)](http://www.appliedrheology.org/(click on conferences))



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CALENDAR OF RHEOLOGY CONFERENCES AND COURSES

2011

13-15 July 2011

Short course on the *Rheology of Polymers, Dispersions and Gels*, Golden Gate Polymer Forum, Mountain View, CA USA - Christopher Macosko (www.ggpf.org)

18-20 July 2011

Short course on *Introduction to Coatings Composition and Specifications*, Missouri S&T Coatings Institute (coatings.mst.edu/index.html)

5-9 September 2011

13th European School on Rheology, Leuven, Belgium - Christian Clasen (cit.kuleuven.be/ltrk/rheoschool/)

7-9 September 2011

Ibereo2011: Rheology Trends: From Nano to Macro Systems, Caparica, Portugal. Maria Teresa Cidade (www4.fct.unl.pt/ibereo2011/)

19-23 September 2011

Short course on *Basic Composition of Coatings*, Missouri S&T Coatings Institute (coatings.mst.edu/index.html)

25-27 September 2011

6th Korean-Australian Rheology Conference (KARC2011); Daejeon, Korea - Do Hyun Kim (www.rheology.org.au/)

8-9 October 2011

SOR Short Course on *Rheology of High-Interface Systems*, Gerry Fuller, Jan Vermant and Andy Kraynik, Cleveland, Ohio USA

9-13 October 2011

83rd Annual Meeting of The Society of Rheology, Cleveland, Ohio USA, Pat Mather

10-14 October 2011

Short course on *Introduction to Paint Formulation*, Missouri S&T Coatings Institute (coatings.mst.edu/index.html)

2012

5-10 February 2012

Gordon Research Conference on Colloidal, Macromolecular & Polyelectrolyte Solutions, Ventura, California USA, Norman J. Wagner and Andrey Dobrynin (www.grc.org)

10-13 April 2012

6th International Symposium on Food Rheology and Structure (ISFRS 2012); Zurich, Switzerland, Peter Fischer (www.isfrs.ethz.ch)

24-29 June 2012

MACRO 2012: World Polymer Congress, Blacksburg, Virginia USA - Timothy Long (www.cpe.vt.edu/mac-
(Continues, page 23)