Conference Report III

Bringing Eureka into Rheology at ARC08

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Teaching rheology has always been a challenge as its multi-disciplinary nature places it among the most difficult areas of materials science and engineering. Because of its complexity, rheology is rarely applied to its full potential and few people grasp the field to a sufficient level. Difficulties inherent in rheology are furthermore compounded by the fact that necessary expertise is distributed into specialized groups across the globe. Considering these challenges, it has become clear that the classical model of learning, in which new knowledge is introduced gradually, must be improved upon. Specifically, students must be able to more quickly access the full scope of rheological information.

Many scientists are eureka junkies. In other words, they live for those flashes of insight in which complex problems suddenly unravel into digestible answers – or, better yet, lead towards solutions for previously unconquered questions. A recent New Yorker article (Lehrer, 2008) investigates studies seeking to understand "eureka" moments. The general consensus is that such moments occur only after a significant volume of information has been accrued, even if some of the information is not entirely understood. It is thought that soaking up as much knowledge as possible allows the brain to keep working at a powerful subconscious level and ultimately leads to understanding. These new findings regarding "eureka" moments can be capitalized upon through new modes of teaching.

The Amherst Rheology Course (ARC) aims to encourage discovery-inspired learning that excites and motivates students to explore ideas in greater depth. It does this by combining the classical model of learning with a fresh approach: The key advantage of ARC is that it provides students with efficient access to otherwise illusive quantitative information through "Rheo-Hub" (Winter and Mours, 2006), a central computer platform from which users examine rheological expert codes ("engines") and data by comparing, merging, and funneling them into further interrogations and explorations. In this virtual environment, results then appear on the computer screen as easily manipulated graphs and charts, which allow students to engage their visual intelligence. Using this platform, rheological explorations may be repeated in different ways (using different expert codes for answering the same research question, for example) and observed from different graphical viewpoints. Thus, Rheo-Hub creates the multi-scale and multi-expertise workspace that is necessary to achieve quantitative rheological acumen. By offering a means to smoothly navigate a wide range of data that is otherwise arduously compiled, students speedily gain a broad overview of relevant material - the basis for discovery.

Last June, a diverse group of 27 participants from industry and academia met on the campus of the University of Massachusetts, Amherst, MA, USA, for at the fifth Amherst Rheology Course (ARC). The theme of the course was "Synergy Between Experiments and Theory in Rheology" and lectures were given by Ron Larson/Ann Arbor, Jonathan Rothstein/Amherst, and Henning Winter/Amherst. The main purpose of ARC08 was to broaden the access to rheology as an essential knowledge base for solving complex problems at the frontier of materials science and engineering.

Short lectures on rheology fundamentals were followed by hands-on tutorials, for which participants brought their laptop computers. Using Rheo-Hub, participants overlaid experimental data with theory predictions to produce visual representations of rheological material functions for polymer melts and solutions, block copolymers, polymer blends and complex materials, such as gels and colloidal suspensions.

Rheo-Hub is the outcome of a global rheology project (Winter and Mours, 2006) in which many of the world's leading groups share cutting-edge rheology codes for data analysis and modeling of polymer dynamics and colloidal suspensions dynamics. This collection of diverse software codes is merged into a single program (IRIS Rheo-Hub) for calculations and visualization on the laptop (The laptop is advantageous for this purpose because of its widespread acceptance and use). As rheology has a uniform ontology (Dealy, 1995) that is generally accepted by both experimentalists and theoreticians, visual plots serve as a universal language shared by students, researchers, and rheology practitioners. Without Rheo-Hub, grasping rheology depends on performing tedious tasks such as data retrieval, formatting of data, and writing programs to plot results. All this groundwork is eliminated through our program. Leaving users free to begin their search for creative solutions without delay. ARC teaches how a comprehensive

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data analysis can be completed in a short time and performed on a regular basis. Without Rheo-Hub, theories that support quantitative answers are equally hard to access. This problem is easily overcome by installing the expert rheology software onto the PC laptops of course participants (and other rheology users worldwide). As a result, the diverse group who came to Amherst for ARC08 fluently navigated through experiments and theory after an initial very intensive day of training. Many eureka moments have already resulted from use of Rheo-Hub. Recent discoveries include a more effective way of exploiting the Cox-Merz rule when it is valid and exploring reasons for lack of validity when it is not (Winter, 2009), a rheological constitutive law for soft glassy dynamics (Winter et al., 2008), and evolving rheology of the ripening structure of a nanocomposite (Wang et al., 2008).

The Amherst Rheology Course (ARC09) will convene again in May 2009, this time in Berlin, Germany. New topics will be added concerning the rheology of emulsions. Information will be updated periodically at http://rheology.tripod.com/ARC.htm.

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H. Henning Winter
Department of Chemical Engineering and Department of Polymer Science and Engineering
University of Massachusetts
Amherst, MA 01003
USA
winter@ecs.umass.edu

Figure 1 (left): Henning Winter teaching.

Figure 2: Participants of the Amherst Rheology Course (ARC08).

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