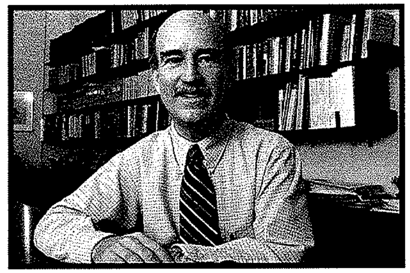
Harry G. Fair

Each year, a special lecture is given in memory of Harry G. Fair, an outstanding OU alumnus. Fair was born in Okmulgee, Okla., on June 3, 1916, and earned his bachelor of science degree in chemical engineering in 1939. He joined Phillips Petroleum Co. in 1939 and worked his way up to vice president for supply and transportation, with responsibility for worldwide exchange of crude oil and all transportation facilities. In 1966, Fair joined M.W. Kellogg Co. as executive vice president in charge of all engineering activities. He was named executive vice president of Coastal States Gas Corp. in 1971, a post he held until his death on July 27, 1974. A member of a number of professional societies and a licensed professional engineer, Fair was active in service to society and his alma mater.

This lecture is made possible by the Harry G. Fair Memorial Fund established by his widow, Jane Swift Fair. Arrangements for the lecture are made by the School of Chemical Engineering and Materials Science in OU's College of Engineering.



Robert C. Armstrong

Chevron Professor and Department Head
Department of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, Massachsetts

Rheology and Fluid Mechanics of Polymer Solutions Undergoing Rapid Elongational Deformations

Bead-spring kinetic theory models, which we illustrate in this talk by elastic dumbbells, have proven to be very useful in describing the rheological behavior of polymeric liquids and for understanding the response of these liquids in complex flows. In this talk we consider two experiments in which simple bead-spring models have failed to capture key physical observations, and we discuss improvements to the models motivated by these failures. The first experiment is filament stretching, which consists of the sudden startup of uniaxial elongational flow followed by stress relaxation. When stress is plotted against birefringence in this experiment, hysteresis is observed between the growth and relaxation parts of the experiment. Simple bead-spring models do not capture this hysteretic behavior. We analyze the Kramers chain, a fine-scale model for polymer dynamics, in order to assess the validity of the coarser-grained bead-spring models in these deformations. Whereas the spring force is a simple function of the dumbbell length for customary nonlinear elastic springs, we find that the relationship between the ensemble averaged end-to-end force and the extension for a Kramers chain depends on the kinematic history to which it has been subjected. We find that it is essential for a dumbbell model to have an end-to-end force that depends upon the deformation history in order to capture hysteresis in the filament stretching experiment.

We then turn to a discussion of a complex flow, namely flow around a linear, periodic array of cylinders. Viscoelastic liquids in this flow undergo a transition from steady, two-dimensional flow to a spatially periodic, three-dimensional flow at a critical flow rate. Simple bead-spring models do not correctly capture this flow transition, and we believe that this shortcoming is due to the failure of these models to describe well the rapid elongational flow in the wake behind the cylinders. In order to address this problem we construct a new bead-spring model that is simple enough to be used in finite element simulations, and yet captures correctly the dynamics of hysteresis observed in the first experiment. The new model describes a polymer molecule as a set of identical segments where each segment represents a fragment of the polymer that is short enough so that it can sample its entire configuration space on the time scale of the deformation and therefore stretches reversibly. As the molecule unravels, the number of segments decreases but the maximum length of each segment increases so that the model accounts for the constant maximum contour length of the parent molecule. The behavior of this new model in the flow around cylinders will be presented.

Robert C. Armstrong

Robert C. Armstrong is the Chevron Professor and department head of Chemical Engineering at the Massachusetts Institute of Technology. Born May 29, 1948 in Baton Rouge, La., he earned a bachelor of chemical engineering degree from the Georgia Institute of Technology, graduating in 1970 with highest honors. At Georgia Tech, he was a National Merit Scholar and was honored with the AIChE Outstanding Achievement Award and Georgia Architectural and Engineering Society Award. Under the supervision of R.B. Bird, Armstrong earned a doctoral degree in chemical engineering from the University of Wisconsin, Madison, in 1973. His thesis was titled "Obtaining Constitutive Equations from Molecular Theory." While at the University of Wisconsin, he was a National Science Foundation Fellow.

Armstrong's main research interests are polymer fluid mechanics, numerical simulation of viscoelastic flows, experimental characterization (LDV, video imaging, birefringence) of complex viscoelastic flows, rheological characterization of non-Newtonian fluids, rheology of foams, suspensions and other structurally complex fluids, polymer processing, kinetic theory and rheology of polymeric fluids, transport phenomena and applied mathematics. He has authored two books on the fluid mechanics and kinetic theory of polymeric liquids, authored or co-authored approximately 100 papers in refereed journals and edited volumes, delivered more than 100 invited lectures and co-authored more than 220 presentations at professional meetings.

Armstrong is a member of the American Institute of Chemical Engineers, Council for Chemical Research, American Chemical Society, Society of Rheology and Polymer Processing Society, and he serves as an assistant editor of the Journal of Rheology. He has served as president and on the executive committee of the Society of Rheology and is a member of the governing board and executive committee of the Council for Chemical Research. He currently serves as vice chair of CCR and will assume the chairmanship in 2005.

Professor Armstrong is happily married, with two children, a dog and a cat. An avid fan of the Boston Red Sox, he believes that the Sox will once again win the World Series during his lifetime.

You are
cordially invited
to attend

The 30th Annual

Harry G. Fair

Memorial Lecture in

Chemical Engineering

Thursday, April 8, 2004
Seminar – 3:30 P.M.
Sarkeys Energy Center
Room M-204
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Coffee and refreshments will be served prior to the lecture.

Accommodations on the basis of disabilities are available by calling (405) 325-5812.

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1980 A.B. Slaybaugh, Conoco Inc.
1979 Charles R. Perry, Perry Gas Cos.
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University of Oklahoma
School of Chemical Engineering
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100 E. Boyd Street, Room T-335
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