Technology Roadmap

	Short Term, by 2009	Mid Term, by 2012	Long term, by 2015
Objectives / Needs	1) Model gas-liquid flow regimes effectively and accurately e.g. bubble column from “bubbly” to “churn turbulent” regime. Problems caused by inherent instabilities in flow. 2) Validate CFD codes against existing database of numerics, experiments and theory / DNS. J. Morris, A. Sangani, L.S. Fan, R. Fox. 3) Exp design 3D tomography, MRI, X-ray exps to provide data to validate models. L.S. Fan, M. Dudukovic, T. Heindel.	1) Need to model reacting multiphase flows with heat and mass transfer, e.g, methanol synthesis. 2) Design and perform simple heat and mass transfer experiments. 3) Define accurate boundary conditions 4) Design 3D tomography, MRI, X-ray experiments to provide data to validate models. L.S. Fan, M Dudukovic, T. Heindel.	1) The ability to use code for industrial scale-up. 2) Design 3D tomography, MRI, X-ray experiments to provide data to validate models. L.S. Fan, M. Dudukovic, T. Heindel.
Technical Challenges	1) Capture regimes correctly. 2) Understand constitutive relations 3) To model steady-state axi-symmetric, statistical steady state simulation.	1) Capture regimes correctly. 2) Understand constitutive relations. 3) Formulate Meso-scale models to bridge gap between micro and macro-scales.	1) Capture regimes correctly. 2) Understand constitutive relations
Approaches	1) Collaboration is key between academia and industry. 2) Experimentalists should work with code developers. Design code by 2015 that can tackle wide range of problems.	Industry would like to see a few typical problems validated for confidence in CFD results – benchmark problems.	
Notes			

Technology Roadmap

	Short Term, by 2009	Mid Term, by 2012	Long term, by 2015
Objectives / Needs			
Technical Challenges			
Approaches			
Notes	1) Scales need to be bridged between single bubble case (which can be accurately computed using free-surface flow) and swarms of bubbles. 2) Experiments are not always up to par to address some of these issues. 3) Measurement of in situ fluid properties at different scales is challenging. 4) This is an opportunity to leverage 20+ years of expertise to solve multiphase flow problems in the fossil fuel energy sector. 5) NSF can provide funding for internships/research through IGERT. Success rates for GOALI project higher.		

Technology Roadmap

	Short Term, by 2009	Mid Term, by 2012	Long term, by 2015
Objectives / Needs	**Industrial G-L examples:** Bubble Columns / Fischer-Tropsch / CO_2 sequestration, adsorption and desorption.		
Technical Challenges	1) Can solve bubbly regime but challenging to solve churn-turbulent flows. 2) Model bubble size distribution accurately. 3) Assumptions do not model the actual problem realistically. 4) Need to span across regimes.	1) Need to develop measurement techniques for high pressure and temperature bubble columns. 2) Need for reliable turbulence models without losing key flow features. 3) Need to span across regimes.	Need to study concentration effects on flow. Sub-grid inhomogeneities.
Approaches	Tomography, MRI, X-ray techniques provide data to validate models.		
Notes	There is a wealth of literature on bubble column available. We should try to avoid repeated work.		

Technology Roadmap

	Short Term, by 2009	Mid Term, by 2012	Long term, by 2015
Objectives / Needs	**Industrial L-S flow examples:** Hydrocyclones; Crystallization; Pipeline transport.		
Technical Challenges	1) Lubrication; Particle-particle interaction; 2) Particle size distribution and density variation; 3) Highly swirling, turbulent flow separation. 4) Experimental challenge: measurement of phasic velocities and stresses. 5) Boundary Conditions are not well understood.		
Approaches	1) Melany Hunt: Single particle experiments provide insight into modeling multi-particle systems. 2) Focus on coal required to solicit funding from NETL?		
Notes			

Technology Roadmap

	Short Term, by 2009	Mid Term, by 2012	Long term, by 2015
Objectives / Needs			
Technical Challenges			
Approaches			
Notes			