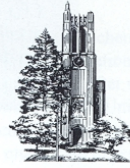
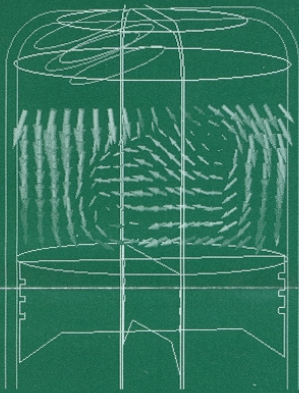


Michigan State University
College of Engineering



presents
a short course on



Computational Fluid Dynamics
Modeling and Simulation

16-18 June 1999

University Faculty Club
East Lansing, Michigan

A course for CFD practitioners and
managers who are serious about
using CFD to obtain useful answers
to realistic engineering problems

Sponsored by:

The Multiphysics Computational
Research Laboratory of Michigan State
University's Automotive Research
Experiment Station (ARES)

The Computational Fluid Dynamics
(CFD) Laboratory of MSU's
Department of Mechanical Engineering

MICHIGAN STATE
UNIVERSITY

This course focuses on issues that affect accuracy and interpretation of CFD predictions; utility of CFD to impact design through analysis and optimization; and turn-around time, especially in grid generation and optimization. Topics addressed include those related to modeling of turbulence and combustion as well as those related to simulations such as grid generation and solution algorithms.

Course Synopsis

Day 1
8:00 a.m. - 5:00 p.m.

An Introduction to CFD with Focus on Issues (T. Shih)

- Conservation equations and modeling issues
- Grid generation (*structured and unstructured grids; grid quality measures; guidelines*)
- Solution algorithms (*space-time de-coupled methods*)
- Methods for the Navier-Stokes equations (*density-based and pressure-based*)
- Stability and error analysis

Space-Time Coupled Methods (H. Huynh)

- Interpolation, reconstruction, and staggered-mesh schemes
- Upwinding and limiters

Day 2
8:00 a.m. - 4:00 p.m.

An Introduction to Optimization (A. Diaz)

- Overview of methods
- What to optimize—dimensions, shape, or layout?
- Multiple objectives and the characterization of optimal solutions
- Imposing constraints on time-dependent performance
- Sensitivity analysis (*numerical, semi-analytical, or analytical computation of gradients; adjoint variable; response surface approximations*)
- Method for optimization without gradients (*genetic algorithms*)
- Latest trends (*representation of shape as a material property; homogenization methods and their role in optimization*)

CFD Shape Optimization (A. Jameson)

- Issues of optimal design
- Theory of optimal control for partial differential equations
- Application to aerodynamic shape optimization

Day 3
8:00 a.m. - 4:00 p.m.

Low-order Turbulence Models for Flows with Streamline Curvature (C. Petty)

- Times scales of turbulent transport from vorticity dynamics
- Realizability and anisotropic distribution of turbulent kinetic energy in low-order turbulence models
- Benchmarking k- ϵ type turbulence models in confined vortical flows

Tools for Turbulence-Model Evaluation (G. Brereton)

- Flow-specific vs. universal calibration of turbulence models
- Instantaneous vs. gradual redistribution of Reynolds stresses
- Turbulence modeling for highly unsteady flows

Combustion Modeling (F. Williams)

- Conservation equations of combustion
- Premixed and non-premixed systems
- Chemical kinetics of combustion and pollutant production
- Model equations for spray and turbulent combustion
- Regimes of turbulent combustion and modeling approaches
- Complications in CFD from finite-rate chemistry
- New formulations of modified conservation equations
- Roles of direct numerical simulation, large-eddy simulation, moment closures, Reynolds and Favre averaging, and probability-density functions
- Future prospects of CFD for combustion processes

Registration Information

Course fees

The course fee is \$800. This fee includes tuition, course notes, continental breakfast (each day), lunch (each day), and refreshments. This fee does not include hotel accommodations.

Location, lodging, and travel information

You will receive course location, hotel, and travel information with your registration confirmation letter.

Registration

A check or money order must accompany your registration form. We will mail you a confirmation letter with course details within ten business days of receiving your registration.

For additional information about the course, contact:

Professor Tom I-P. Shih, course organizer
Phone: 517/432-3658; E-mail: tomshih@egr.msu.edu

For additional information on registration, contact:

Professor André Benard
Phone: 517/432-1522; E-mail: benard@egr.msu.edu

Mail registration form together with payment to:

Professor Mei Zhuang
Dept. of Mechanical Engineering
Michigan State University, East Lansing, MI 48824-1226
Phone: 517/353-9450; E-mail: zhuangm@egr.msu.edu

Instructors

Giles Brereton

Giles Brereton (Ph.D., Stanford University) joined Michigan State University in 1997 as associate professor of mechanical engineering. Previously, he was at The University of Michigan. Dr. Brereton has conducted extensive research for industry and government laboratories in the areas of turbulence and turbulence modeling.

Alex Diaz

Alex Diaz (Ph.D., University of Michigan) joined Michigan State University in 1986, and is currently associate professor of mechanical engineering. Previously, he was a research scientist in Venezuela and a visiting professor in the Mathematical Institute of the Technical University of Denmark. Dr. Diaz has contributed significantly to the area of optimization and its application to mechanical systems and structures. Currently, he is an associate technical editor of ASME's *Journal of Mechanical Design*.

Antony Jameson

Antony Jameson (Ph.D., Cambridge University) holds the Thomas V. Jones Professorship at Stanford University. Previously, he was professor at the Courant Institute and the James S. McDonnell Distinguished University Professor at Princeton. For his outstanding contributions to CFD, he received the NASA medal for exceptional scientific achievement, the gold medal of the British Royal Aeronautical Society, AIAA's Fluid Dynamics Award, ASME's Spirit of St. Louis Medal, and NASA Langley's Theodorsen Lectureship Award. Dr. Jameson is a Fellow of AIAA and a foreign member of the National Academy of Engineering.

Hung Huynh

Hung Huynh (Ph.D., University of Washington) is a research scientist at NASA's John H. Glenn Research Center at the Lewis Field. He has been performing research in computational methods for fluid dynamics over 15 years, with focus on upwind schemes and staggered-mesh (centered) schemes. In 1997, he was awarded the NASA medal for exceptional achievement and outstanding contribution in the area of algorithm development in computational fluid dynamics.

Charles A. Petty

Charles Petty (Ph.D., University of Florida) is professor of chemical engineering and director of the Multiphase Flow and Separations Laboratory at Michigan State University. He joined MSU after teaching chemical engineering at the University of Delaware and the University of California (Santa Barbara). Dr. Petty is presently directing a new initiative at MSU to establish a state-of-the-art multiphase experimental and computational flow facility. Petty consults with industrial users and manufacturers of hydrocyclone technology, and has published extensively on applied and fundamental topics related to transport phenomena.

Tom I-P. Shih

Tom Shih (Ph.D., University of Michigan) joined Michigan State University as professor of mechanical engineering in 1998. Previously, he was research engineer at NASA's Lewis Research Center, associate professor at the University of Florida, and professor at Carnegie Mellon University. Dr. Shih has conducted extensive research for industry and government laboratories in developing and applying CFD to study a wide range of problems including piston and rotary engines, control of shock-wave/boundary-layer interactions with bleed, internal and film cooling of turbines, and DNS of particle-particle/particle-fluid interactions. Dr. Shih is a Fellow of ASME and an Associate Fellow of AIAA.

Forman A. Williams

Forman Williams (Ph.D., California Institute of Technology) is the chair of the Department of Applied Mechanics and Engineering Sciences at the University of California (San Diego), and director of the Center for Energy and Combustion Research. He holds a presidential chair of the same name. Previously, Dr. Williams was an assistant professor at Harvard University and Robert H. Goddard Professor at Princeton University. He has received the silver medal and the Bernard Lewis Medal from the Combustion Institute. Also, he is a Fellow of AIAA and a member of the National Academy of Engineering.

Industrial Panels

To enhance the usefulness of this short course, there will be two industrial panel discussions. A June 16 panel will be made up of representatives from commercial code companies, such as AVL-FIRE, AVL-SWIFT, FLUENT, STAR-CD, and CFX-TASCflow. These representatives will describe their views on CFD and its future prospects.

The second panel discussion will be from 10:30 a.m. to noon on June 17. This panel will be made up of invited experts and leaders from industry and government laboratories to present industry's point of view on needs, concerns, and challenges. Invited participants include:

Dr. Derlon Chu, Ford
Dr. Louis Povinelli, NASA—Glenn Research Center
Dr. Fred Shen, General Motors
Dr. Bijay Sultanian, General Electric
Dr. Richard Sun, DaimlerChrysler
Dr. Nizar Trigui, Ford

Institutional Sponsor

This three-day short course is partially supported by MSU's Automotive Research Experiment Station (ARES). ARES is focused on serving the research and development needs of the automotive industry. ARES involves 33 professors and over 100 graduate students and research staff who perform research in the following laboratories:

Powertrain Research Laboratory—*Harold J. Schock, Head*
Automotive Materials and Structures Research Laboratory—*Lawrence T. Drzal, Head*
Sensor Technology and Electric Motion Control Laboratory—*Elias Strangas, Head*
Multiphysics Computational Research Laboratory—*Tom I-P. Shih, Head*
Ride Safety and Comfort Laboratory—*Robert Hubbard, Head*

For more information on the mission and research activities in ARES, contact:

Dr. Harold J. Schock
Professor of Mechanical Engineering and Director of ARES
Phone: 517/353-9328
FAX: 517/432-3341
E-Mail: schock@egr.msu.edu