Combustion Simulation Research Laboratory

The primary focus of the *Combustion Simulation Research Laboratory* is to allow students and faculty, to combine their efforts in the development and use of computational tools, in the design and analysis of combustion systems. In order to analyze and design combustion systems, it is often necessary to understand the interactions between fluid flow, heat transfer, mass transfer, and combustion.

Computational Fluid Dynamics (CFD) has become an established tool for the design and understanding of practical combustion systems. Numerical simulations can help identify the controlling variables to provide guidelines for more rational and hence, less costly experimental development efforts. The simulations may predict a system's behavior, over a wide range of design and operating variables, to screen concepts prior to major hardware construction, to determine trends and trade offs, and to optimize design and control. Multidimensional models have proven their value in reducing the need for physical experimentation, the benefit of which has been a reduction in product development time and cost.

Using CFD we have been able to simulate IC engine processes: Intake, Compression, Fuel Injection, Combustion, and Exhaust. The results have helped us evaluate a new class of engines that are expected to produce efficiencies well beyond those currently available. It is the results of these simulations that will guide the engine designs of the future. We have been extremely successful at modeling unique engine geometries, and simulating the performance of these advanced engine processes.

This research is being done to develop new engine technologies to reduce emissions, and increase fuel efficiency in order to reduce the dependency of the U.S. on imported oil. This research is an important part of a national presidential initiative to dramatically reduce the air pollution and green house emissions from motor vehicles, and to improve the competition position of U.S. manufacturers.

CFD has also been used to study and design fuel cell reformers that produce Hydrogen from Methanol. We have also used CFD to analyze and design automotive catalytic converters to control exhaust emissions through the oxidation of NO_x and CO.

The development of the Combustion Simulation Research Laboratory will allow us to educate our students in the use of these new tools and technologies in the design of a new class of combustion systems. Undergraduate students will have the opportunity to gain first hand experience in using computational tools in solving complicated systems. Graduate students will also be able to develop new tools and to use them in the design of advanced combustion systems. Computer simulations will also allow explaining difficult concepts, and demonstrating the use of theories in solving complicated engineering problems.

In recent years, computer systems have become so advanced that it is possible to solve a complicated three-dimensional, transient, turbulent reacting flow in a few days. A few years ago, these simulations were only possible on a powerful supercomputer. Computer processors are faster; accuracy has improved, computer memory and disc space have also improved. This computer laboratory will help us produce a new breed of students prepared to use new technologies to design and analyze combustion systems for the future.