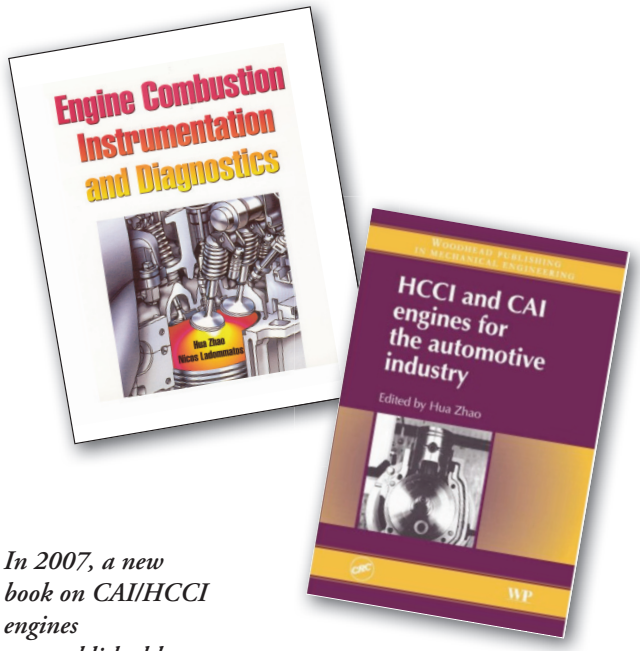
Centre for Advanced Powertrain and Fuels (CAPF)

Research on internal combustion engines and their fuels are of vital importance to both industry and our everyday life.

The combustion engines and fuels research at Brunel is one of the largest and most active research groups in UK academia and a core member of the European Union's Network of Excellence in Combustion Engines (ECO-Engines).

The research carried out in the centre has received support by the European Union, EPSRC, DTI, Dft, TSB, and a number of automotive and motorsport companies in UK, Europe and China, with research income over 5 million pounds. The Group comprises Professors H. Zhao, T. Ma, and Drs T. Megaritis, L. Ganippa, A. Cairns, J. Xia, and collaborates with several other staff in engine control, environmental studies, and special imaging techniques.



In 2007, a new book on CAI/HCCI engines was published by Professor Zhao

Current Activities

The Centre's activity covers both gasoline and diesel engines and involves substantial experimental work and modelling studies. In addition, the centre are researching and developing innovative cost-effective regenerative engine braking and air hybrid powertriain technologies.

Advanced Combustion Engines and Their Control

Over the last several years, the group have conducted pioneering research on the fundamentals and development of advanced internal combustion engines, such as the Controlled Auto-Ignition (CAI) or Homogeneous Charge Compression Ignition (HCCI) combustion in both gasoline and diesel engines, stratified fuel fraction gasoline engines, Direct Injection gasoline engine and HSDI diesel engines, switchable two-stroke/four-stroke poppet valve engines, highly downsized gasoline engines, air hybrid powertrain, and camless engines.

Zhao H., Homogeneous Charge Compression Ignition (HCCI) and Controlled Autoignition (CAI) Combustion Engines for Automotive Industry, ISBN 1 84569 128 8, 2007.

Zhao H., Advanced direct injection combustion engine technologies and development: Gasoline and gas engines (Volume 1), ISBN 978-1-84569-389-3, 2010.

Zhao, H., (Ed) Advanced direct injection combustion engine technologies and development: Diesel engines (Volume 2), ISBN 978-1-84569-744-0 , 2010.

Advanced Experimental and Laser Diagnostic Techniques for IC Engines

The group has been engaged in the development and application of advanced laser and optical diagnostics to internal combustion engines for over a decade, and published a comprehensive book on the engine instrumentation and laser diagnostics. The techniques include Particle Imaging Velocimetry (PIV), Planar Laser Induced Fluorescence (PLIF) for fuel and combustion species measurements, Laser Induced Exciplex Fluorescence (LIEF) for simultaneous liquid and vapour fuel measurements, Laser Induced Incandescence (LII) for soot diagnostics, two-colour techniques for in-cylinder soot and combustion temperature measurements, Spontaneous Raman Scattering (SRS) for simultaneous multiple species, residual gas and air/fuel ratio measurements, as well as high-speed high repetition spray and combustion imaging.

Engine Simulation and Advanced CFD Techniques

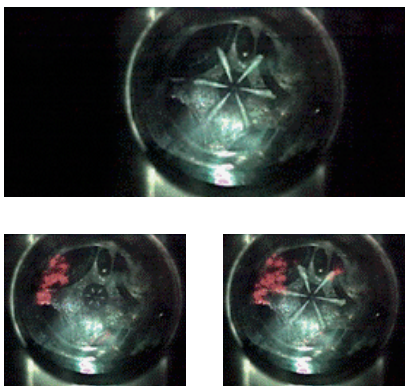
Both 1D and 3D engine simulations have been developed and applied to in-cylinder flow, mixing and combustion studies in both gasoline and diesel engines. In addition to the conventional RANS approach, LES (large eddy simulation) and DNS (direct numerical simulation) are used to study the spray, mixing and combustion process in IC engines. The images shown are the auto-ignition process of CAI combustion.

Alternative and Renewable Fuels

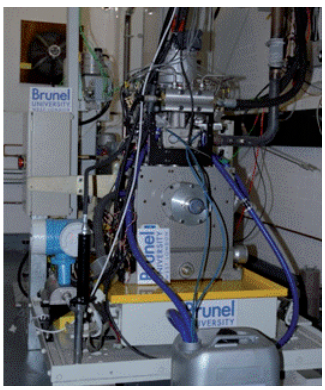
With the limited supply of fossil fuels, there is an increasing demand for alternative and renewable fuels. In addition, fuel reforming is necessary for engines and fuel cell applications. Various bio-diesel fuels and fuel blends are investigated for their use in IC engines.

Facilities

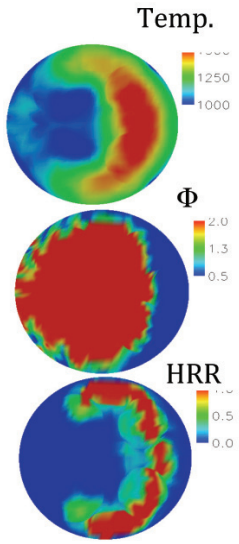
There are 12 engine testing facilities, including 2 Ricardo Hydra single cylinder optical engines with direct injection gasoline and CR diesel fuel injection systems, a 2/4 stroke camless single cylinder engines, a 250kW fully automated transient dynamometer, prototype multi-cylinder DI gasoline and HSDI diesel engines, Horiba 7000DEG emission analysers, fast response FID, fast acting in-cylinder sampling valves, particulate size and smoke measurement systems, FTIR multi-species analysers, GC-MS analysers. The optical equipment include 2 Nd:YAG lasers, XeCl and KrF Excimer lasers and dye lasers, copper vapour laser, 3 ICCD cameras, a high-speed video camera with dedicated image intensifier, and an imaging spectrometer. In addition to the university's computing facilities, the Group has a dedicated cluster computer of 16 CPUs for engine simulation and computational fluid dynamics research.



CR diesel fuel injection



Camless 2/4 stroke engine



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