

# Object-Oriented CFD Solver Design

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## Abstract

Continuing improvements in numerics, reliable and accurate physical modelling and decreasing price/performance of computer hardware is extending the applicability of numerical methods in an industrial setting. The traditional “physics-based” view of the problem is being replaced by the “application-based” view, which typically includes a set of various materials, physical models and coupling between them.

Modern numerical simulation forks into two sets of requirements. On one hand, ease of use and integration into the design process is paramount, while on the other easy implementation, modification and experimentation with new models and handling complex equation coupling issues is sought. The latter, together with issues of code customisation (user coding) falls under the heading of complex physics.

The first part of the presentation describes **FOAM (Field Operation And Manipulation)**, a numerical simulation package for continuum mechanics designed to answer the complex physics demands. The package is designed to allow easy, quick and reliable implementation of physical models by mimicking the form of partial differential equations in the code. FOAM implements several modelling paradigms (Finite Volume, Finite Element, Lagrangian particle tracking) in library form using an object-oriented design, handles complex geometries through polyhedral mesh support and allows for close coupling between various models. Model-to-model interaction is handled by grouping related models under a common interface. The novel software design allows extensive code re-use, unit testing, layered development, and user-defined extensions, resulting in purpose-built, high quality customisable solvers.

In the second part, capabilities of FOAM will be illustrated over a range of Computational Continuum Mechanics applications, including fluid flow, combustion, free surface modelling, non-linear stress analysis and solid-fluid interaction.