What is CFD?

- CFD is the simulation of fluids engineering systems using modeling (mathematical physical problem formulation) and numerical methods (discretization methods, solvers, numerical parameters, and grid generations, etc.)

- Historically only Analytical Fluid Dynamics (AFD) and Experimental Fluid Dynamics (EFD).

- CFD made possible by the advent of digital computer and advancing with improvements of computer resources

Why use CFD?

- Analysis and Design
    - Simulation-based design instead of "build & test"
        - More cost effective and more rapid than EFD
        - CFD provides high-fidelity database for diagnosing flow field
    - Simulation of physical fluid phenomena that are difficult to experiments
        - Full scale simulations (e.g., ships and airplanes)
        - Environmental effects (wind, weather, etc.)
        - Hazards (e.g., explosions, radiation, pollution)
        - Physics (e g planetary boundary layer) ‰
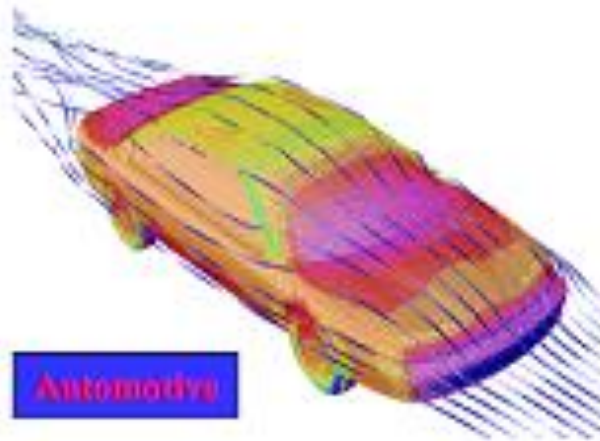- Knowledge and exploration of flow physics

Where is CFD used?

Where is CFD used?

- Aerospacee
- Automotive
- Biomedical
- *Chemical Processing*
- *HVAC*
- *Hydraulics*
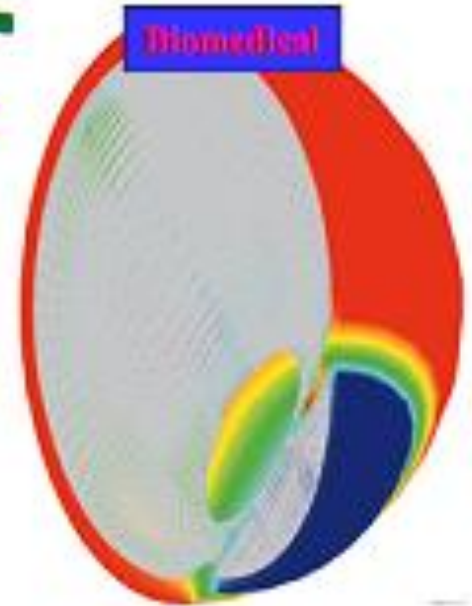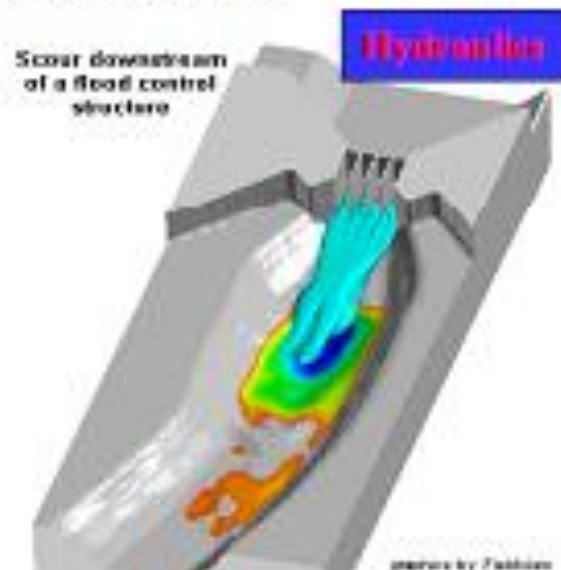- Marine
- Oil & Gas
- Power Generation
- Sports

Chemical Processing

Polymerization reactor vessel - prediction of flow separation and residence time effects.
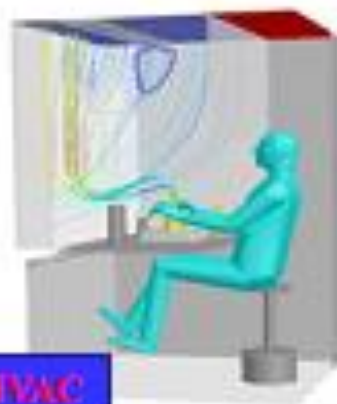
HVAC

Streamlines for workstation ventilation

Hydraulics
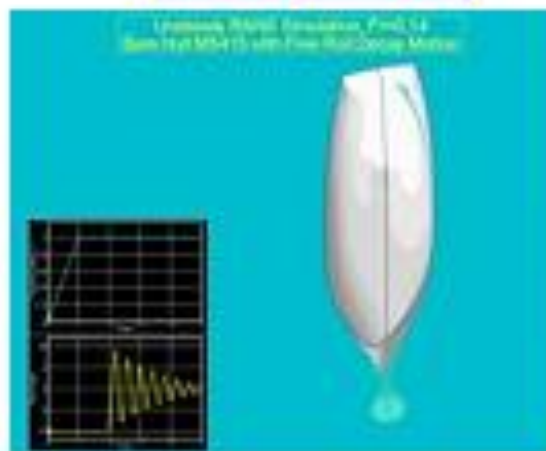
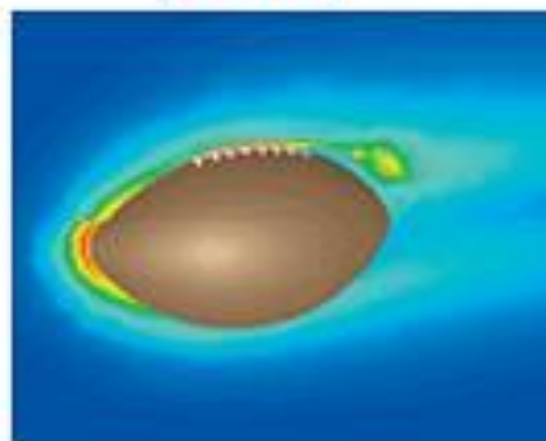Scour downstream of a flood control structure

graphics by Fluidexx

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Marine (movie)

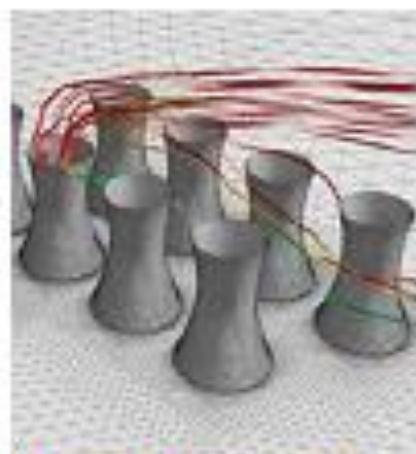

Sports

Oil & Gas

Flow of lubricating mud over drill bit

Power Generation

Flow around cooling towers

Commercial software

The market is currently dominated by four codes:

1) PHOENICS

2) FLUENT

3) FLOW3D

4) STAR-CD

5) CFX

Non-Commercial CFD Software

- There are also non-commercial CFD software. One of the best non-commercial software is OpenFOAM.

- The OpenFOAM® (Open Field Operation and Manipulation) CFD Toolbox is a free, open source CFD software package.

- OpenFOAM has an extensive range of features to solve anything from complex fluid flows involving chemical reactions, turbulence and heat transfer, to two-phase flows, solid dynamics and electromagnetics.

Advantages of CFD over EFD

- Substantial reduction of lead times and costs of new designs.
- Ability to study systems where controlled experiments are difficult or impossible to perform (e.g. very large systems).
- Ability to study systems under hazardous conditions at and beyond their normal performance limits (e.g. safety studies and accident scenarios).
- Practically unlimited level of detail of results.

How does a CFD code work?