



# ***What is CFD?***

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## Computational Fluid Dynamics

### ◆ An Engineering Tool

- Computer “experiments”
- Design
- Troubleshooting

### ◆ A Numerical Method

- Solves equations of motion for fluid
- A Graphical User Interface
  - set up problem
  - solve
  - view results



# ***CFD: A Numerical Method***

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- ◆ CFD Solves the Navier Stokes Equations

$$\Gamma \frac{\partial}{\partial t} \iiint \mathbf{Q} dV + \iint [\vec{\mathbf{F}} - \vec{\mathbf{G}}] \cdot d\vec{\mathbf{A}} = 0$$

$$\mathbf{Q} = [p, v_x, v_y, v_z, T]^T$$



# ***Getting at the Solution: Interface***

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- ◆ Problem set up or “Pre-Processing”
  - integration with design group
  - easy to use interface
  - parametric studies
- ◆ Solver computes the flow field
  - speed, accuracy, reliability, ease of use
  - features “models”
- ◆ Viewing Results “Post-Processing”
  - numbers, graphs, figures, animations



# ***The CFD Process***

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- ◆ Create or import your geometry using CAD-style tools
- ◆ Discretize the geometry: mesh generation
- ◆ Define flow conditions, fluid properties, physics
- ◆ Submit the calculation (solution of the conservation equations for mass, momentum, energy, chemical species)
- ◆ Review results (graphically, numerically)

# ***What Can be Modeled?***

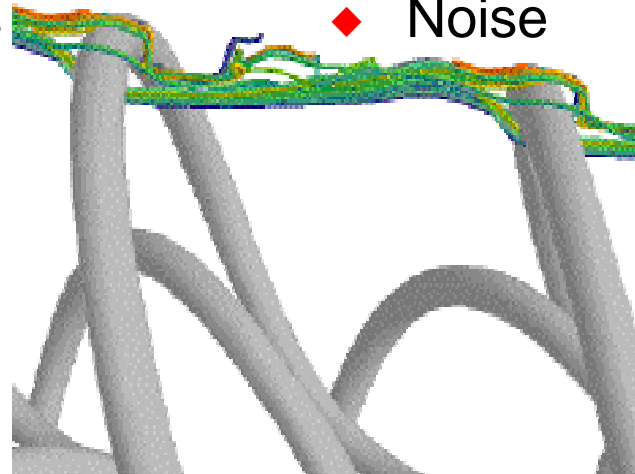
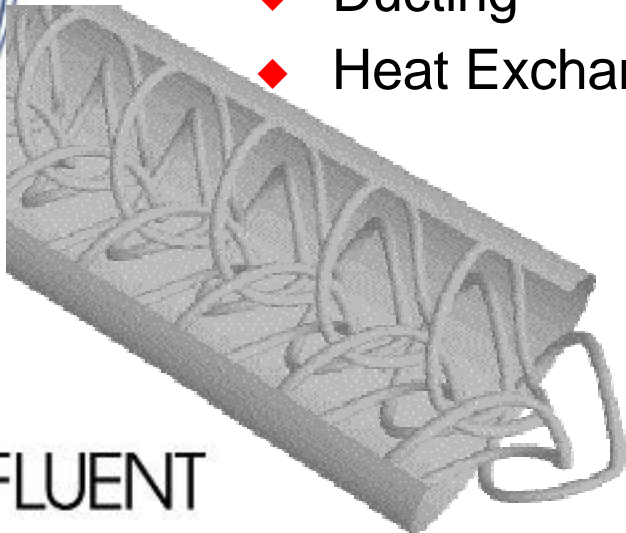
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## Devices

- ◆ Screw Compressors
- ◆ Centrifugal Compressors
- ◆ Expansion Turbines
- ◆ Dryers
- ◆ Separators
- ◆ Filters
- ◆ Ducting
- ◆ Heat Exchangers

## Results

- ◆ Performance
- ◆ Bearing loads
- ◆ Clearance effects
- ◆ Visualization
- ◆ Erosion
- ◆ Fouling/plugging
- ◆ Heat transfer
- ◆ Noise





# ***Setting Expectations***

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## **What To Expect**

- ◆ Values for
  - Performance
  - Heat Transfer
  - Forces
  - Erosion
- ◆ Trends
- ◆ Parametric studies
- ◆ Visualization
- ◆ Investment that pays off

## **What Not To Expect**

- ◆ Replacement for good engineering judgement
- ◆ Complete replacement for testing
- ◆ Something for nothing
  - Accurate results require
    - Detailed models
    - Knowledge of your problem
    - Knowledge of limitations



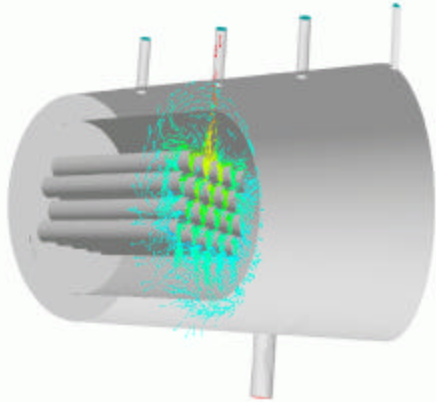
# ***CFD: The Advantages***

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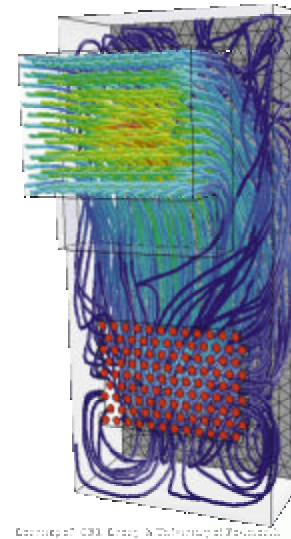
- ◆ Complements physical modelling.
- ◆ Provides comprehensive data not easily obtainable from experimental tests.
- ◆ Is more cost-effective than physical modelling.
- ◆ Reduces the product-to-market time scale.
- ◆ Answers the “what if...?” question.
- ◆ Highlights the cause not just the effect.

# Benefits of CFD

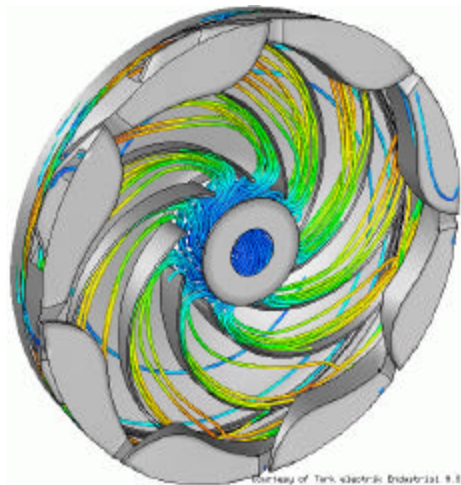
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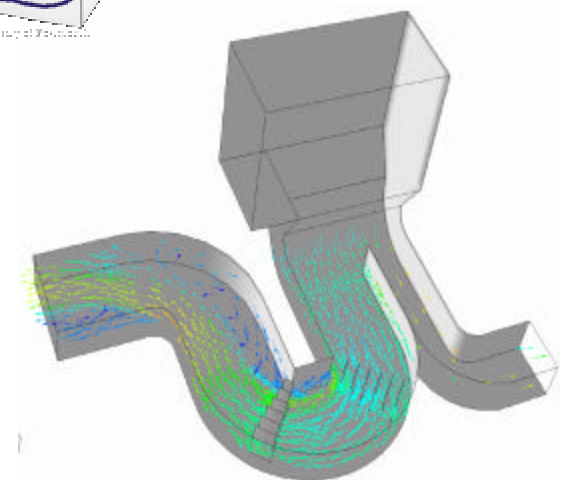
**Minimize System Cost**



**Understand Problems**



**Improve Performance**



**Reduce Design Time & Expense**