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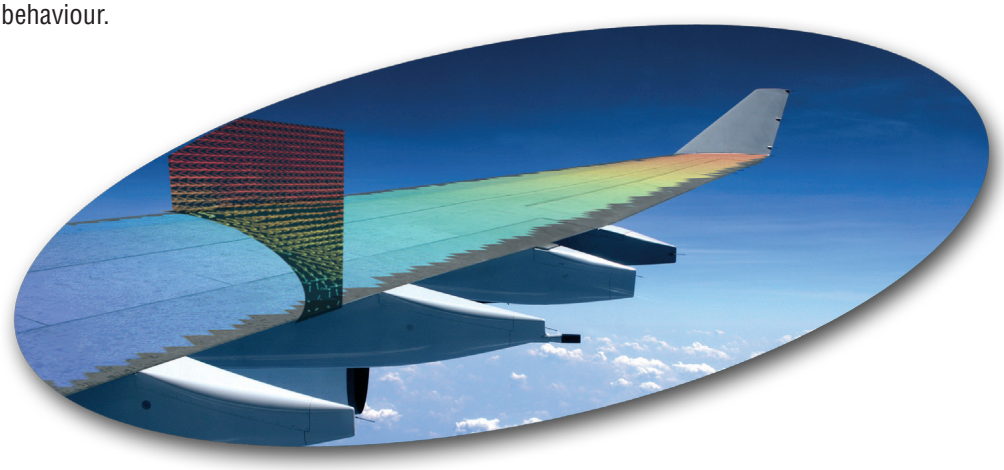
Fluid-Structure Interaction

Full field experimental measurement systems

Fluid-Structure Interaction (FSI) is the study of fluid flow causing deformation of a surface or structure. Because of the interaction and the change of the surface profile, this results in a change in the fluid flow path: the behaviour of the fluid depends upon the surface shape, and the surface shape depends upon the fluid forces imparted on the surface. This interaction between fluid and structure may result in periodic or cycling instabilities which can establish Fluid Induced Vibrations (FIV). LaVision offer systems which can simultaneously measure and quantify the fluid and surface behaviour.



Methods

- Particle Image Velocimetry (PIV) utilizes short pulses of laser light separated by known time intervals to illuminate a plane (or volume) of the seeded airflow. By imaging this it is possible to accurately ascertain a map of velocities
- Digital Image Correlation (DIC) images a surface and is able to track the shape and deformation of that surface

By coupling our PIV and DIC technology we are able to measure the **Fluid-Structure Interaction** behaviour allowing users to validate and optimise their simulations.

Fluid-Structure Interaction phenomena can be complex and non-linear, especially with today's novel materials and flexible lightweight components, and therefore experimental validation is increasingly important. **Fluid-Structure Interaction** effects are present in many different applications.

Applications

- ships and yachts
- heart valves and biomechanics
- wave energy generation systems
- flutter effects in aircraft
- internal mechanics of pumps
- wind turbines
- car suspension systems
- micro air vehicles
- building design

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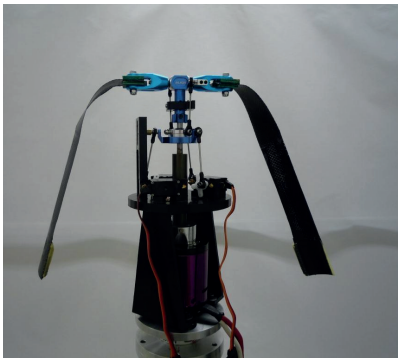
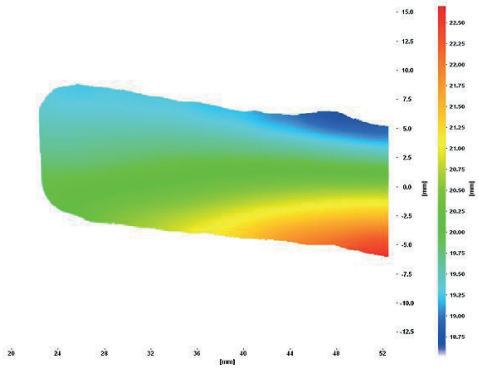
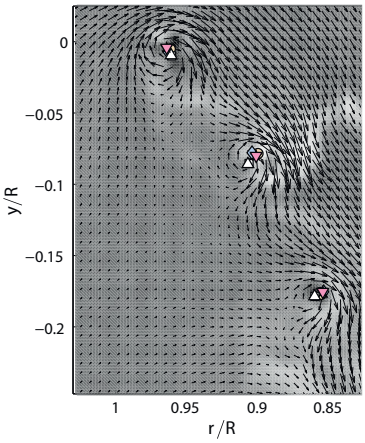
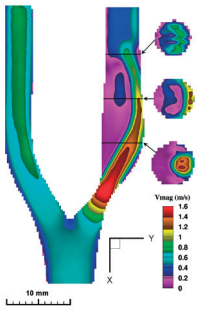


Courtesy of Charles E. Tinney (PIV data), and Dr Jayant Sirohi (DIC data), Aerospace Engineering and Engineering Mechanics, The University of Texas at Austin

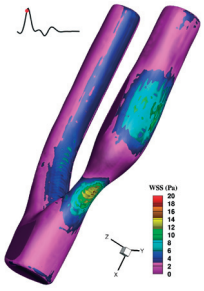




The example above shows the results of studies on a flexible rotor and illustrates the power of the two system types. DIC systems are able to accurately map the shape of the surface (and identify strain localization due to aerodynamic overloads - not shown), and PIV quantifies fluid dynamic features such as tip vortex shedding. Less obvious topics for **Fluid Structure Interaction** include biomechanical testing: the example on the left was acquired from a time-resolved PIV system making measurements on a carotid artery bifurcation model.
It provided insight into the complex interaction between flow conditions and changes in blood biology and vessel geometry. Results obtained provide clues to unlocking the puzzle of how damaged blood cells progress into thrombogenic conditions, rupture of plaque, and vessel damage.



central-plane map of velocity magnitude



3-D wall shear stress from the systolic phase of the cardiac cycle

Courtesy of T. Poepping and S. Kafayati, University of Western Ontario, Canada

Fluid-Structure Interaction systems from LaVision can work in a variety of modes depending upon the needs of the customer

- low cost systems capable of time averaged measurements measuring fluid and structure behaviour on separate test runs
- intermediate setups able to make simultaneous measurements to gather instantaneous snapshots, time averaged, or phase locked data
- fully time resolved systems simultaneously measuring fluid and structure phenomena and identifying transient coupling features

LaVision have a wide range of experience in applying DIC and PIV system to a variety of challenging applications and welcome enquiries related to **Fluid-Structure Interaction** studies. We are able to supply turn-key systems or highly customized configurations with extensive triggering options. To learn more about our full field measurement systems please contact us for information.

Data provided by LaVision is believed to be true. However, no responsibility is assumed for possible inaccuracies or omissions. All data are subject to change without notice.

Mar-14

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