From art to science: The revolution of Quantitative Visualization

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The progress in science has greatly depended on the experimentalists' capabilities to question nature by means of observation and experimentation, and by way of measuring magnitudes that could be analyzed and interrelated through mathematical formulation. It is a historical fact that every time experimental techniques have taken a leap forward, the "experimentalist" has made totally unexpected and unimagined discoveries. In the field of fluid mechanics, for more than a century, the progress in understanding some of the grand challenges of the field such as turbulence, unsteady separated flows and many others depended on techniques that could only reveal a partial view of the real physics of these important problems. In recent decades, advances in computer science and Computational fluid dynamics (CFD) have opened the attractive prospect of accurately simulating the experimentally hard to realize fluid mechanical problems. However, many fluid mechanical problems of scientific and engineering importance exhibit complex, unsteady and multi-dimensional dynamics that makes it difficult if not impossible to resolve them through current state-of-the-art in CFD. The Invention of Particle Image Velocimetry (PIV) and its amazing development into a method of choice in the field of fluid mechanics have helped us to acquire new capabilities in the whole-field flow mapping techniques. In fact these capabilities have enabled us to efficiently interface with CFD. This new horizon is promising in its capabilities to guide, validate and actively interact in conducting reliable simulation of complex flows. In this lecture we present some of the key challenges and technological advantages that the revolution of PIV has accomplished in making quantitative visualization an important research tool in the field of fluid dynamics.