

Report

The 12th International Symposium on Flow Visualization

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Abstract : The 12th International Symposium on Flow Visualization (ISFV12) was held at Göttingen, Germany, September 10-14, 2006. The symposium attracted 360 participants from 31 countries. The symposium was organized in 75 sessions, including one poster session, and seven invited lectures. Five special sessions focused on areas of current interest in flow visualization. Two awards: the Asanuma Award and the Leonardo Da Vinci Award have been presented to two experts in recognition of their excellent contributions to the field of flow visualization. Three awards have been provided for young scientists to acknowledge their scientific work and oral presentation at the symposium. The symposium was accompanied by a public lecture and an exhibition of vendors of equipment for flow visualization.

Keywords : Aerodynamics, Art, Biological Flows, CFD, Cylinder Flows, Data Analysis and Presentation, Tomography, Density, DGV, Engines, Combustion and Turbines, Experimental Studies, Flames, Flow Control, Polymer Flows, Interferometry, Jet Flows, Technical Flows, LIF, Life Sciences, Liquid Crystals, Liquid Films, Liquid Metals, Micro Flows, Multiphase Flows, PIV (Methods, Turbulence, Applications, MAVs and Low Reynolds Number Flows), Propellers/Convective Flows, PSP/TSP, Quantitative Visualization Methods, Shock Waves, Smoke/Dye, Thermography, Tracking, Vehicle Flows, Vortical Flows.

1. Introduction

This Symposium originated in 1977 in Tokyo (Japan) and continued in Bochum (Germany) in 1980, Ann Arbor (USA) in 1983, Paris (France) in 1986, Prague (Czech Republic) in 1989, Yokohama (Japan) in 1992, Seattle (USA) in 1995, Sorrento (Italy) in 1998, Edinburgh (UK) in 2000, Kyoto (Japan) in 2002 and Notre Dame (USA) in 2004. Mueller (2005) reports on details of ISFV11.

The great number of 360 participants, one third of them coming from Japan and other Asian countries, demonstrates the continuing and even increasing interest in methods and applications of flow visualization techniques over the last three decades. The progress made with lasers, video techniques, optoelectronics and computer hard- and software during this period has stimulated the development of a great number of image based measurement techniques which are now utilized on a broad basis for fundamental research, in industrial applications and for comparison with the results of numerical calculations, allowing a much better understanding of complex unsteady flow phenomena by providing quantitative information about the complete flow field and not just for a single point as with conventional techniques.

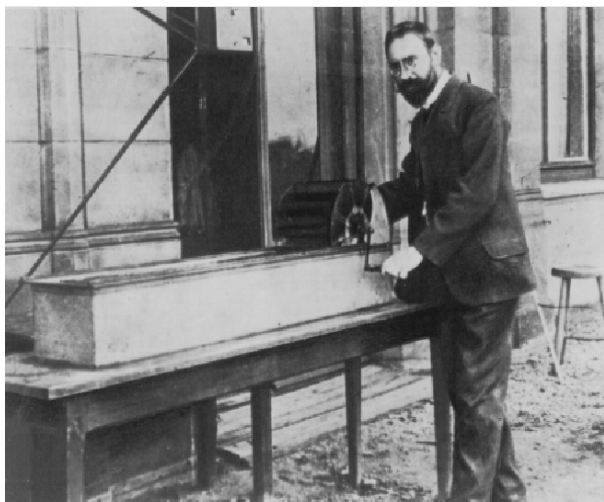


Fig. 1. Ludwig Prandtl, 1904, Water channel for flow visualization.

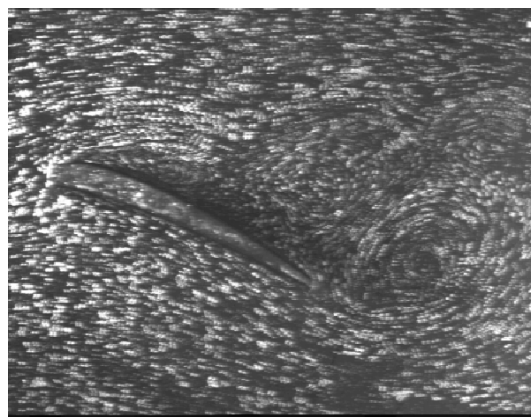


Fig. 2. Separated flow behind profile (1998/1904), visualized in a replica of Ludwig Prandtl's channel by means of tracer particles and a video camera. Today the instantaneous velocity vector field can easily be extracted employing PIV algorithms.

To illustrate this statement, it shall be referred to Ludwig Prandtl, one of the pioneers of aerodynamics in Göttingen, who performed first qualitative visualization of unsteady flows behind profiles and other models in his simple water channel by observing the movement of tracer particles on the surface of the water more than 100 years ago. Nowadays modern image based measurement techniques such as Particle Image Velocimetry, following the same simple physical principles, easily allow to determine the displacement of the tracer particles within a given time interval thus providing quantitative information about the velocity in a plane or even in a volume of the flow.

Today, most physical quantities of interest to aerodynamics can be assessed quantitatively by image based experimental techniques, even in large industrial wind tunnels, as it is of prime interest for the main organizer of ISFV12, the Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center, DLR). DLR is Germany's national research centre for aeronautics and space. Its research portfolio ranges from fundamental research to innovative development of the applications and products of tomorrow. DLR operates large-scale research facilities for the center's own projects and as a service provider for clients and partners. DLR Göttingen, where in 1907 the Aerodynamische Versuchsanstalt (AVA) has been founded, employs approximately 350 experts in the fundamental and application-oriented field of aviation and transport research.

Quantitatively measurable values of interest for aerodynamics, as mentioned above, are pressure (Pressure Sensitive Paint, PSP), velocity (Particle Image Velocimetry, PIV), location of transition lines (Temperature Sensitive Paint, TSP), density (Background Oriented Schlieren, BOS), and sound pressure (Acoustic Microphone Array), in parallel with the determination of deformation (Image Pattern Correlation Technique, IPCT) and position of the model in the wind tunnel. Application of these techniques by the Department of Experimental Methods of DLR's Institute of Aerodynamics and Flow Technology is mainly performed in the scope of large industrial projects in European co-operation. For this purpose mobile measurement systems have been developed by the department, which can be flexibly adjusted to particular testing environments.

All data is acquired non-intrusively so that no interference of the flow field by the measurement is to occur. In consequence, the methods developed are particularly suited for the aero-dynamical and aero-acoustical analysis of complex, unsteady three-dimensional flow fields. The acquired data sets constitute a reliable basis for the validation of numerical codes. Increasingly, these image based measurement techniques are applied in parallel to obtain a more complete description of the flow field by determining several physical quantities simultaneously.

When comparing these objectives of the work with image based experimental methods for aerodynamics in the Department of Experimental Methods with the main tracks of methods and results as being presented during ISFV12 the similarities become quite obvious. Thus, it has been a special pleasure for the department to welcome friends and colleagues from all over the world at ISFV12.

2. Organization

The 12th International Symposium on Flow Visualization has been organized by the *Deutsches Zentrum für Luft- und Raumfahrt (DLR)*, supported by the *Georg-August Universität Göttingen (Drittes Physikalisches Institut)*, the *Max-Planck-Institut für Dynamik und Selbstorganisation* and the *Laser-Laboratorium Göttingen*. These research institutes represent the strong scientific and technical competence and long tradition on measurement techniques in the Göttingen area. Some of these research institutes and companies, which have once been founded in their neighborhood, have also been visited during the Technical Excursion of ISFV12.

Special Sessions

In close contact with leading scientists five Special Sessions have been prepared and held during the symposium focusing on topics of high current interest:

- *Measurement and visualization of shock waves*, organized by Gabi Ben-Dor, Israel, and Kazuyoshi Takayama, Japan,
- *Micro and nanoscale flow visualization*, organized by Steve Wereley, USA, and Ralph Lindken, The Netherlands,
- *Visualization of Art*, organized by Jean Hertzberg, USA, Yasuki Nakayama, Japan, and Nobuyuki Fujisawa, Japan,
- *Measurement and visualization of multi-phase flows*, organized by Yassin A. Hassan, USA,
- *Visualization in Life Sciences*, organized by Antonio Delgado, Germany, and Albert Baars, Germany.



Fig. 3. ISFV12 CD ROM Proceedings.

CD ROM Proceedings

All 265 papers for ISFV12 submitted before the deadline have been published in the *CD ROM Proceedings* of ISFV12 (ISBN 0-9533991-8-4); Grant (2006). Some papers, submitted after the deadline, may be found as on-line publication at <http://www.isfv.org>.

Publication in Journals

The Organizing Committee of ISFV12 cooperated with the editors of leading scientific journals such as:

- *Experiments in Fluids*,
- *Journal of Visualization*,
- *Measurement, Science and Technology*,
- *Shock Waves - An International Journal*,

to provide authors presenting papers at ISFV12 with the possibility to submit their paper to an issue of the respective journal focusing on the 12th International Symposium on Flow Visualization. After the ISFV12 conference the editors of the different journals have invited prospective authors to submit their manuscript, subject to the normal review process.

Attendance

Finally, 360 participants from 31 countries attended ISFV12. The majority came from Japan (108 attendants) and Germany (98 attendants). Between 10 and 30 delegates have been sent from France, Korea, Russia, Taiwan, the United Kingdom and the USA. Australia, Belarus, China, India, Israel, Italy, the Netherlands and Turkey have been represented by 3 to 9 delegates each. The rest of the participants (with less than 3 participants each) originated from Algeria, Austria, Belgium, Brazil, Canada, Czech Republic, Finland, Greece, Luxembourg, Malaysia, Poland, Portugal, Singapore, South Africa, and

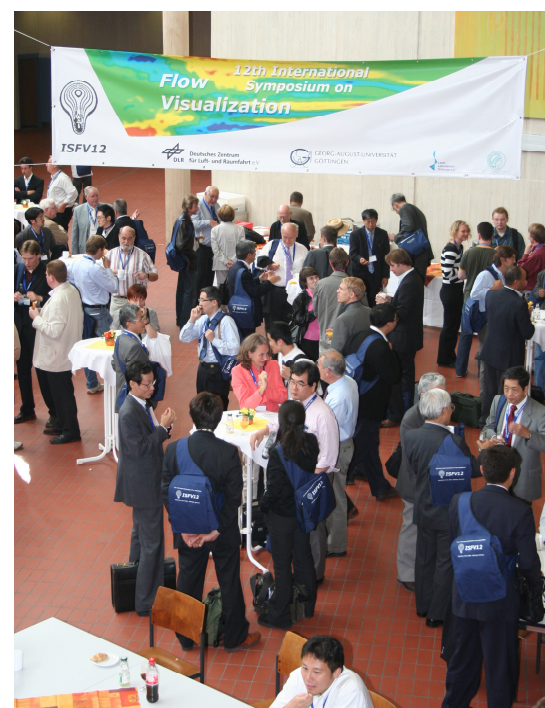


Fig. 4. Participants of ISFV12.

Switzerland. The Final Program of ISFV12, as printed one week before the symposium, comprises 277 oral presentations and 17 posters. Unfortunately, about 20 authors withdrew in last minute or did not show up without informing the organizer.

3. Symposium

According to the great number of abstracts received and accepted after review, the symposium has been organized in seven parallel sessions with a total of 75 paper sessions and one poster session within four days. Seven invited lectures have been given, two awards: the Leonardo Da Vinci Award and the Asanuma Award have been presented to experts in the field of flow visualization and three Young Scientists Awards have been provided as well. One half day has been devoted to a social excursion and the Symposium Banquet and one half day to Technical Excursions to research institutes and companies located in Göttingen. In addition, a lecture for the general public and an experimental exercise for the participants have been organized. Each half-day started with an Invited Lecture. The symposium took place in the central Lecture Hall of the Georg-August-Universität Göttingen.

Invited Lectures

Seven international experts from different areas of flow visualization have been invited to present the state-of-the art of flow visualization in their special field of interest:

- Quantitative Flow Visualization in Supersonic and Hypersonic Flows, by Fulvio Scarano, The Netherlands,
- Visualization of the Controlled Flow Patterns for Slender Bodies at High Angle of Attack, by Xiao Ming, China,
- Micro and Nanoscale Flow Visualization, by Steve Wereley, USA,
- Experimental Investigation of a Flapping Bird Model: Some Challenges from Instationary Aerodynamics, by Cameron Tropea and Tatiana Hubel, Germany,
- Experimental and Computational Visualization of Blood Flows in Macro and Micro Scales, by Marie Oshima, Japan / Ryo Torii, UK,
- Flow Visualization, a Useful Tool for Applying Shock Waves to Medicine (Leonardo Da Vinci Memorial Lecture), by Kazuyoshi Takayama, Japan,
- High Resolution Flow and Particle Distribution Measurements in the Laboratory and in the Ocean Using Digital Holography, by Joseph Katz, USA.

Where applicable the Invited Lectures served as some kind of introduction of the topic of a Special Session arranged immediately after the invited lecture.



Fig. 5. Presentation of Leonardo Da Vinci Award to Prof. K. Takayama.

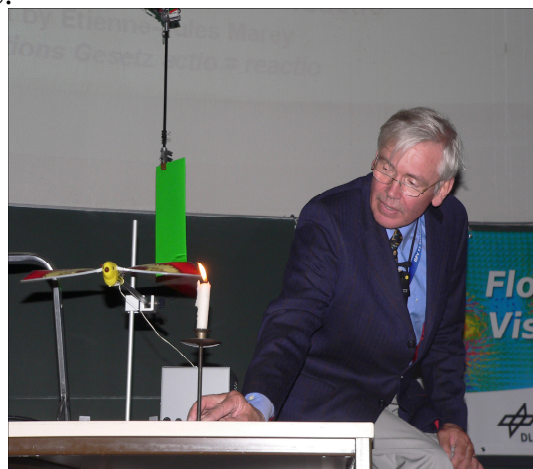


Fig. 6. Public Lecture with experiments (W. Send).

Poster Presentations

Posters have been on display in the foyer of the conference center for two days, including a dedicated poster sessions where authors were given the opportunity to explain their work in detail.

Public Lecture

As Public Lecture announced in the local newspaper and aiming at a general audience a lecture with

experiments related to the history and present understanding of vortical flows has been given as well: *The Da Vinci Vortex* by Wolfgang Send, Germany.

Awards

Two awards, the *Asanuma Award* and the *Leonardo Da Vinci Award*, have been presented at the 12th International Symposium on Flow Visualization. These traditional awards in the series of the International Symposium of Flow Visualization are bestowed for *Outstanding Achievements in the Field of Flow Visualization*. The laureates of ISFV12 are:

- *Prof. Cameron Tropea* (TU Darmstadt, Germany) - The Asanuma Award
- *Prof. Kazuyoshi Takayama* (Tohoku University, Japan) - The Leonardo Da Vinci Award

Young Scientist Awards

Young Scientist Awards were conferred upon three young scientists for an outstanding contribution to the 12th International Symposium on Flow Visualization. At total 63 young scientists indicated their interest in the Award, which was announced for the first time from an ISFV committee. The award's purpose is to act as a motivation for young scientists to present their work at ISFV and to honor the effort spent on preparing the paper and the presentation. The 'Young Scientist Award' winners are as follows:

- *Takanobu Yagi* (Waseda University, Japan) - Real-Time Planar Spectral Analysis of Instantaneous High-Frequency Stress on Blood Cells Downstream of an Artificial Heart Valve
- *Markus Honkanen* (Tampere Univ. of Technology, Finland) - High-Speed, Stereoscopic Multiphase PIV/PTV Technique to Study the Interaction of Bubbles and Vortices
- *Josué Sznitman* (ETH Zürich, Switzerland) - Optical Density Visualization and Reconstruction of Negative Buoyant Vortex Rings & PIV Investigation of Internal Recirculating Flows in Thin Liquid Shells.

Technical Exhibition

During the symposium nine companies exhibited their products for flow visualization: lasers, cameras, visualization software, wind tunnels, and complete systems, mainly for Particle Image Velocimetry.

Technical Excursion

After the Closing Ceremony of ISFV12, a Technical Excursion to companies and research organizations located in Göttingen (*La Vision*, *Laser-Laboratorium Göttingen*, *LINOS Photonics*, and *DLR Center Göttingen*) took place.



Fig. 7. Visit of DLR test facilities.

4. Supporting Program

A symposium of a size such as ISFV with several parallel sessions, requires space and time for scientific and non-scientific exchange of ideas between the participants coming from the most different areas of the world (from Algeria to USA) with the most different background (from shock waves to arts). A social excursion, the symposium banquet and an experimental exercise have been prepared to stimulate discussion between attendants in small informal groups.

Social Excursion

Participants could select between five different tours to the *European Bread Museum*, the *Wilhelm-Busch-Mill* (story of "Max and Moritz"), the *Grenzlandmuseum* (museum explaining the history of the division of Germany), *Duderstadt* (half-timbered medieval town) and *Burg Hardenberg* (ruined castle).

Symposium Dinner

The ISFV12 symposium dinner took place at the Graf Isang restaurant nearby the Seeburg lake, about 20 km from Göttingen. The warm and very pleasant weather allowed having the dinner outside at the shore of the lake, accompanied by the music of a marching band and a quartet, playing coffee-house style music.

Experimental Exercise

As warm-up for the attendants an experimental exercise has been organized at the end of the first day of the symposium. Under the guidance of *Andreas Schroeder* (DLR Göttingen) the participants jointly investigated a number of differently colored liquids representing different types of multi-phase flows, as traditionally produced in Germany, and were asked to exchange their assessment of the different specimen as far as color, bubbles, foam, composition, flavor etc. are concerned.



Fig. 8. Symposium dinner by the lake.

5. Outlook

The International Organizing Board has confirmed that ISFV13 will take place in Nice, Acropolis Congress Center, from June 30th to July 4th, 2008. The symposium (<http://isfv13.univ-fcomte.fr>) will be organized by the French Committee on Flow Visualization. Jean Pierre Prenel of the University of Franche Comté will act as Chairman of ISFV13.

Acknowledgements

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We would like to thank all of the participants, guests, exhibitors, and session chairs, as well as the Honorary and International Organizing Board, the Local Scientific Advisory Board and the Local Organizing Committee for their help. Special thanks go to the editor of the CD ROM Proceedings and to the editors of the scientific journals *Experiments in Fluids*, *Journal of Visualization*, *Measurement, Science and Technology*, and *Shock Waves - An International Journal*, who will prepare issues of the respective journal focusing on the 12th International Symposium on Flow Visualization. The excellent support of the conference secretariat and the technical assistance team has been highly appreciated by the participants of ISFV12.

References

- Grant, I., Electronic Proceedings Editor, Proceedings of ISFV12, (2006), Optimage Ltd., Edinburgh, UK, CD ROM (ISBN 0-9533991-8-4)
 Mueller, T. J., The 11th International Symposium on Flow Visualization, *Journal of Visualization*, 8-2 (2005), 187- 191.

Author Profile



Jürgen Kompenhans: He received his doctor's degree in physics in 1977 from the Georg-August University of Göttingen. Since 30 years he is working for DLR in Göttingen, Germany, mainly developing and applying non-intrusive measurement techniques for aerodynamic research. At present he is head of the Department of Experimental Methods of DLR's Institute of Aerodynamics and Flow Technology. Within this department image based methods such as Pressure Sensitive Paint, Temperature Sensitive Paint, Particle Image Velocimetry, model deformation measurement techniques, density measurement techniques, acoustic field measurement techniques etc. are developed for application as mobile systems in large industrial wind tunnels.