Cover Photo

Visualization of Two-dimensional Flows by a Liquid (Soap) Film Tunnel

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This image represents a two-dimensional jet produced in a soap film tunnel (Gharib and Derango, Physica D, Vol.37 pp.406-416, 1989). The small variation of the film thickness results in interference patterns, thus, providing an excellent means for flow visualization. The figure shows a laminar jet (Re number = 25), but the jet fluid has a lower surface tension than the ambient fluid, which results in a large growth rate for the jet.

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Melt Flow Control in the Czochralski Single Crystal Growth Process

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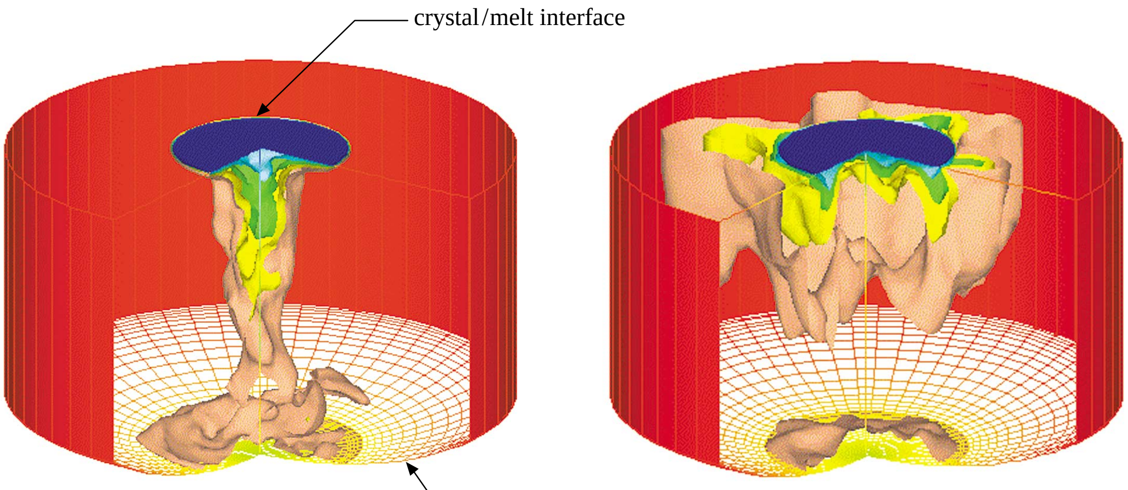
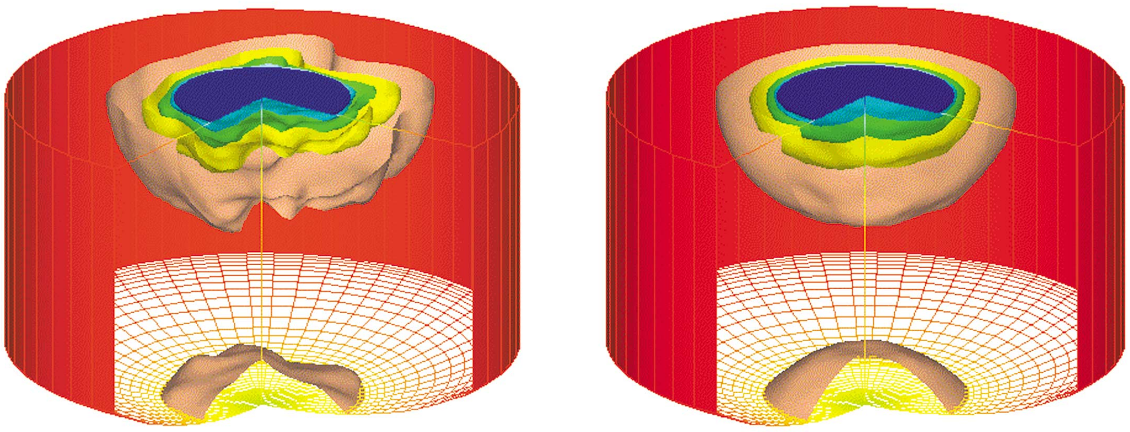


(a) 0 rpm (b) 5 rpm



(c) 10 rpm (d) 20 rpm

Isothermal surfaces

In the Czochralski crystal growth process, it is important to control silicon melt flows to produce a single crystal with high quality. As a diameter of the product becomes large, the melt flow structure gets easily turbulent because of the increase of Reynolds and Rayleigh numbers. However, the Coriolis' force generated by the crucible rotation also works strongly in the melt. Thus, to investigate the melt condition, three-dimensional numerical simulations are carried out with various rotation rates using GSMAC-FEM. Figs. (a) - (d) show the isothermal surfaces ($\Delta T = 3\mathrm{K}$) with different rotation rates obtained by assuming the adiabatic condition on the free surface. In Fig. (a), the melt temperature steeply varies under the crystal/melt interface according to the direction of the natural convection. When the rotation rate is set small, the flow structure gets complicated as shown in Fig. (b) because of the competition between the natural convection and the Coriolis' force. With the increase of the rotation rate, the effect of the Coriolis' force becomes dominant and the flow structure turns into a two-dimensional axisymmetrical flow as shown in Figs. (c) and (d).

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Vorticity and Streamlines in the Wake of a Marine Propeller

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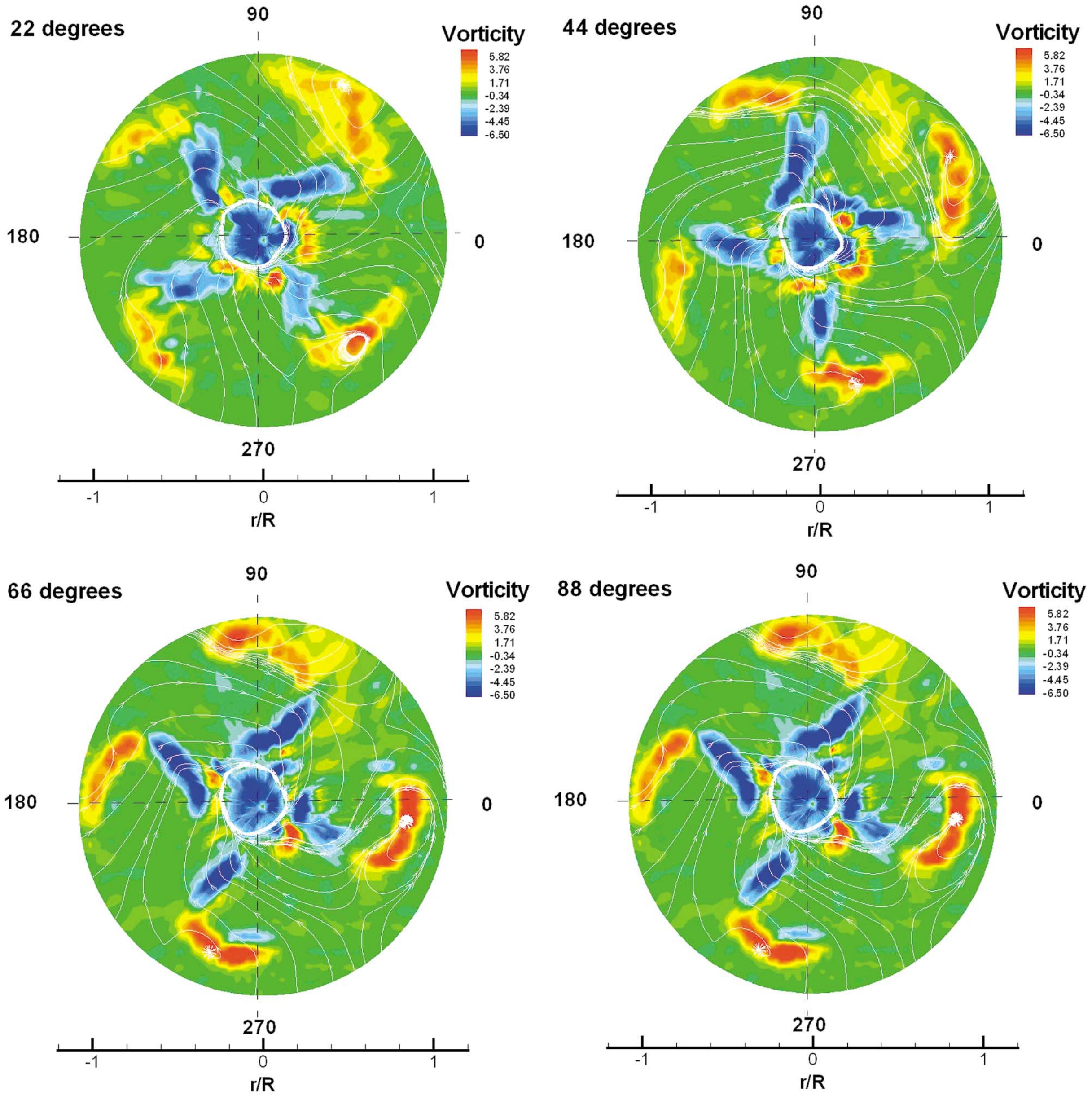

Three-dimensional measurements of the velocity field downstream of a marine propeller were performed at the circulation channel at INSEAN by means of a submerged LDA system. The free-stream velocity was 2.3 m/s corresponding to a Reynolds number (based on the propeller radius R = 0.183 m) equal to about 420000. The propeller has four blades and works at about 10 rounds/s. In the figure, the vorticity (in s^{-1}) and the streamlines at 0.2 R at four angular positions (22°, 44°, 66° and 88°) are given. The position and motion of the four tip vortices and of the vorticity layers from the brackets are clearly pointed out. Further details on the experiments and on the measurements are in the Proceedings of the 9th International Symposium on Flow Visualization (Edinburgh, August 2000).

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Formation Process of Taylor Cells

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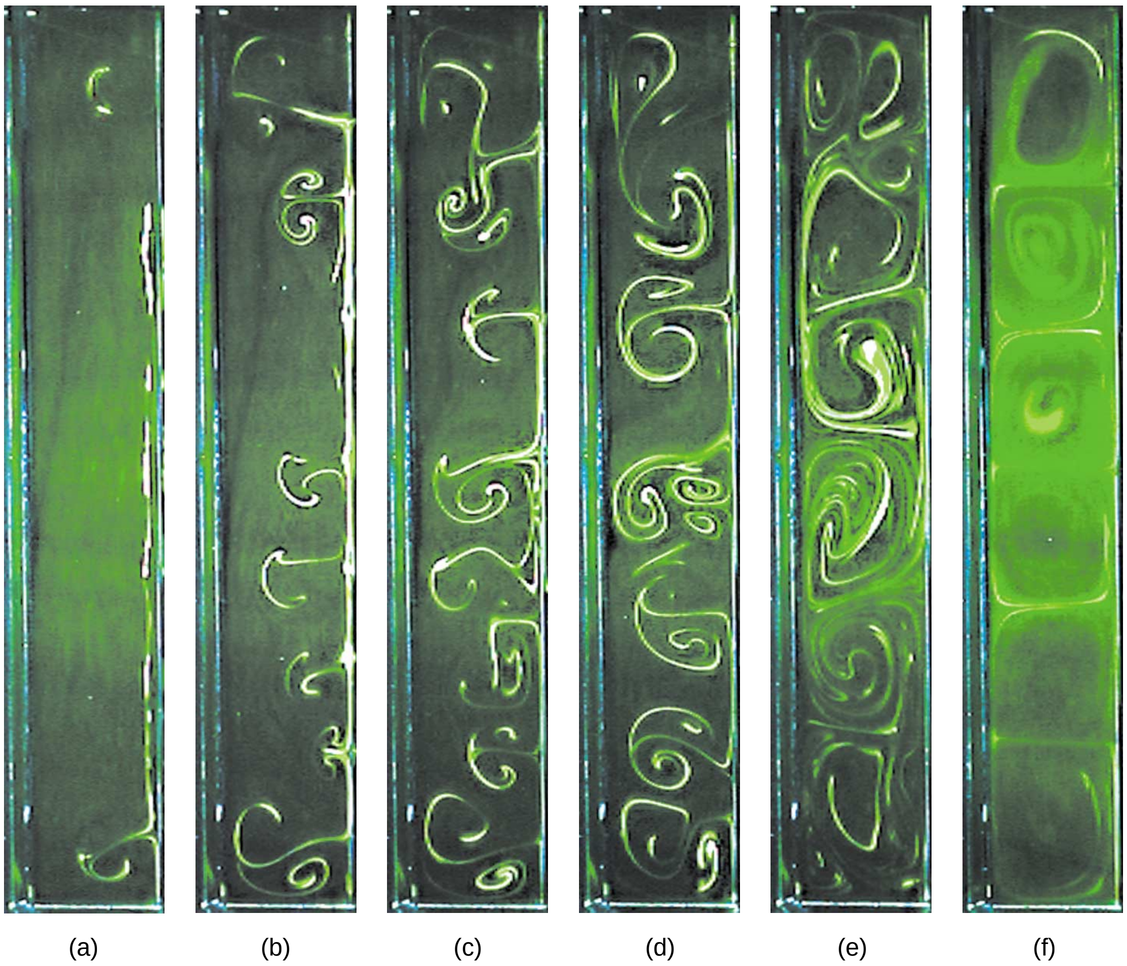

These photographs show the formation process of Taylor cells between two coaxial cylinders for tap water. (a) 40 sec, (b) 60 sec, (c) 70 sec, (d) 80 sec, (e) 150 sec, (f) 180 min. The outer cylinder is rest and the inner cylinder is rotated. Flow visualization was carried out by means of the laser-induced fluorescence (LIF) technique. The aspect ratio Γ of the experimental apparatus is 6.15. The ratio of Taylor number *Ta* and the critical Taylor number *Tacrit* is *Ta* / *Tacrit* = 39.0.

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Comparison between PIV and LDV Techniques in the Analysis of a Propeller Wake

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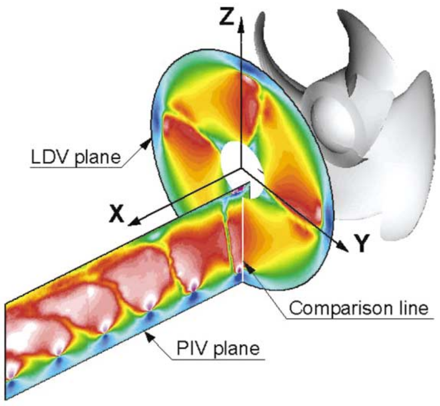
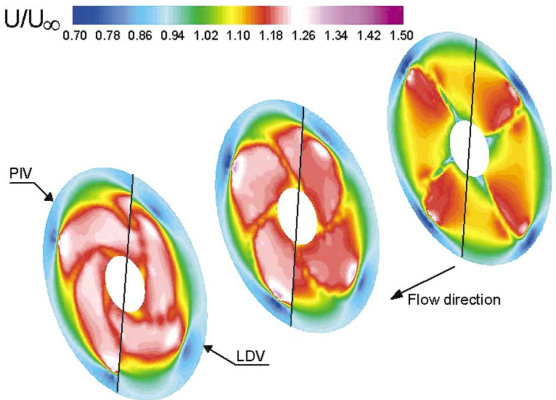
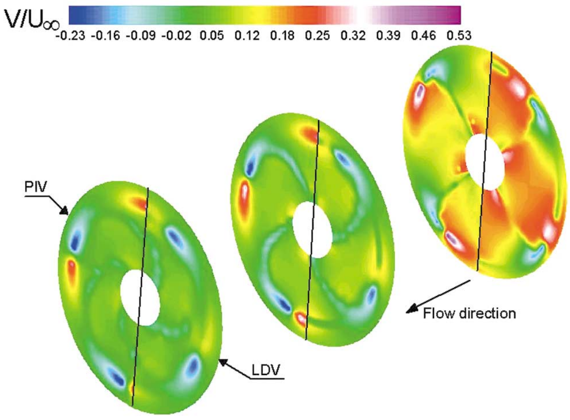


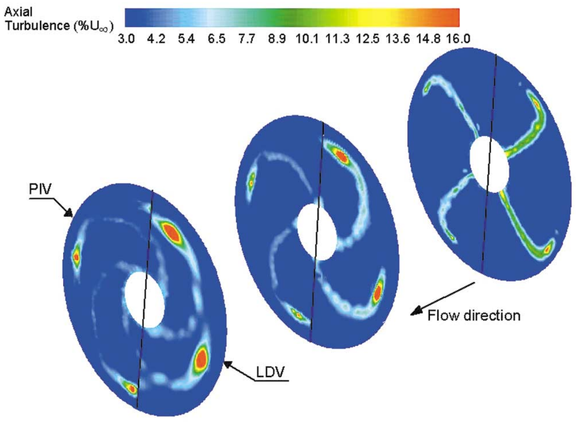
Comparison line identification



Axial velocity comparison



Radial velocity comparison



Axial turbulence comparison

Figures show the results of a propeller wake analysis by means of PIV and LDV techniques. Tests were performed at the propeller angular speed of 25 rps with the tunnel water velocity of 5 m/s, corresponding to an advance ratio $J = 0.88$ and a blade Reynolds $Re_{0.7R} = 1.2 \times 10^6$. Because of the availability of PIV and LDV measurement respectively along a longitudinal and a transversal plane of the wake, comparison was carried out just along the intersection line, in three sections of the downstream wake. Comparison points out a substantial agreement with a maximum error just along the blade and tip vortex traces.

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3D-PTV Measurement Results for the Wake of a Cylinder - Temporal Evolution of Turbulent Kinetic Energy

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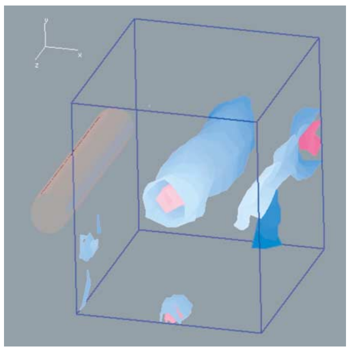
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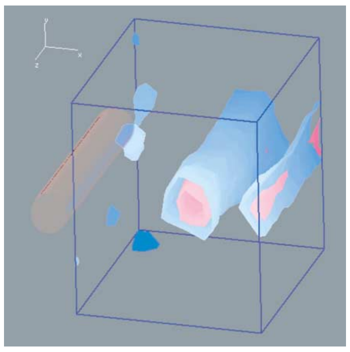
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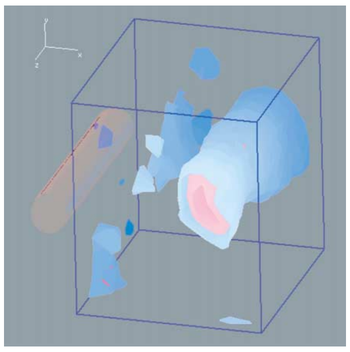
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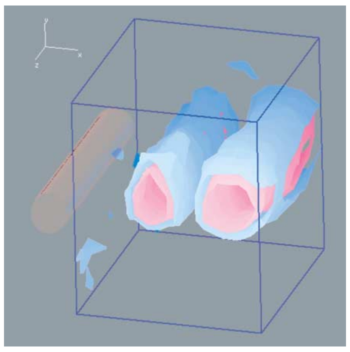
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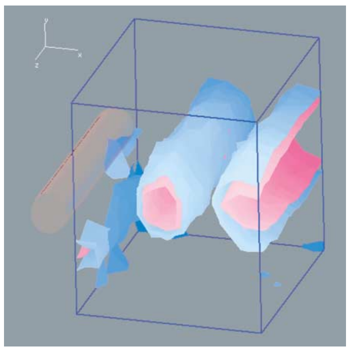
t = to + 20/60 sec

These figures show a temporal evolution of the turbulent kinetic energy measured by a Genetic Algorithm (GA) based 3D-PTV technique. Two iso-values (red ones and blue ones) of turbulent kinetic energy are presented. Reynolds number is 420 with the diameter of the cylinder 10mm. These quantities were obtained by using the spatial distribution of instantaneous three-dimensional velocity vectors that were obtained by the GA based 3D-PTV. A spanwise distribution of turbulent kinetic energy is conspicuously seen. This roll cake-like distribution becomes larger with time increases maintaining its shape, which implies that most of the turbulent kinetic energy generated by the cylinder is convected downstream maintaining a constant distance (abut 1.5D) between the two spanwise distributions without a big change. One can imagine that main shapes of the spanwise vorticity (I component) are the same as the shapes of the distribution of turbulent kinetic energy.

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A High-resolution Model of the Inner Organs Based on the Visible Human Data Set

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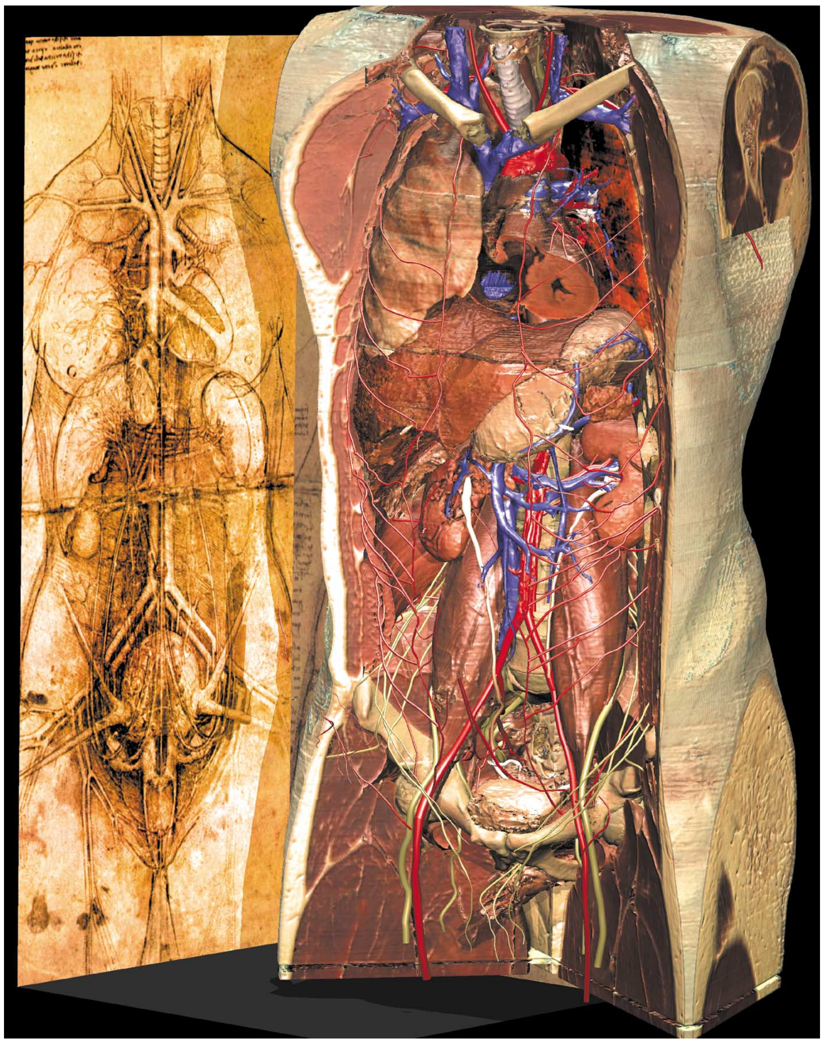

A 3D model of the inner organs was developed based on more than 1000 photographic cross-sectional and congruent computer-tomographic images of the male Visible Human. Its constituents were created using color-space segmentation and graphic modelling (especially for small objects like nerves and blood vessels) [1]. The thus generated volume containing multiple attributes and multiple modalities is rendered using volume visualization with subvoxel resolution [2]. The model contains a semantic network knowledge base allowing its interrogation. A three-dimensional atlas of anatomy and radiology with 650 objects based on this model is available as a PC-based program [3]. The shown composition illustrates the development from drawings (Leonardo da Vinci, 1490) to computerized models.

1. Andreas Pommert, Karl Heinz Höhne, Bernhard Pflesser, Ernst Richter, Martin Riemer, Thomas Schiemann, Rainer Schubert, Udo Schumacher, Ulf Tiede: Creating a high-resolution spatial/symbolic model of the inner organs based on the VisibleHuman. Med. Image Anal. 5, 3 (2001), 221-228

2. Ulf Tiede, Thomas Schiemann, Karl Heinz Höhne: High quality rendering of attributed volume data. In David Ebert et al. (eds.): Proc. IEEE Visualization 1998. Research Triangle Park, NC, 1998, 255-262.

3. Karl Heinz Höhne, Bernhard Pflesser, Andreas Pommert, Kay Priesmeyer, Martin Riemer, Thomas Schiemann, Rainer Schubert, Ulf Tiede, Hans Frederking, Sebastian Gehrmann, Stefan Noster, Udo Schumacher: VOXEL-MAN 3D Navigator: Inner Organs. Regional, Systemic and Radiological Anatomy. Springer-Verlag Electronic Media, Heidelberg, 2000. (3 CD-ROMs, ISBN 3-540-14759-4).