

## **2024 VGTC Visualization** Lifetime Achievement Award

Hans-Christian Hege, Zuse Institute Berlin (ZIB)

The 2024 VGTC Visualization Lifetime Achievement Award goes to Hans-Christian Hege for his fundamental technical contributions to visualization and visualization software with a focus on applications in the natural sciences, medicine and engineering.

Hege pursued studies in physics, mathematics, and philosophy at the Free University of Berlin from 1977 to 1984. Thereafter, he served as a graduate research assistant in computational physics until 1989. In 1986, he cofounded Mental Images, a software company specializing in rendering and 3D modeling, which later became part of NVIDIA. In 1989 he joined the Zuse Institute Berlin (ZIB), where he initially advised physics users on the development of programs suitable for supercomputers. In 1991, he established the Visualization Department at ZIB, which he headed until his retirement in 2020.

Hege's research initially focused on developing methods and software for treatment planning in oncology, in particular for regional hyperthermia. In this context, he encountered a number of problems that were still unsolved at the time, including the registration and segmentation of medical images, the geometric reconstruction of complex anatomies and their approximation by finite element meshes, and the visualization of vector fields. His research led to a number of fundamental methods, including the generalized Marching Cubes algorithm for generating separating non-manifold interfaces in multi-materials and methods for intuitive visualization of vector fields (Fast LIC, Surface LIC, and Illuminated Field Lines).

Together with PhD student Detlev Stalling and postdoctoral researcher Martin Seebaß, he developed Hyper-Plan, a visually supported, clinically applicable system for planning hyperthermia treatments. As the world's first system of its kind, it was sold by ZIB to a manufacturer of hyperthermia treatment devices in 1996. Hyper-Plan was the starting point for the development of a much more broadly applicable visual analysis software, initially used in neurobiology, fluid dynamics, and astrophysics, and over time in numerous other subfields of the natural sciences, medicine, materials sciences, engineering, and geosciences. In 1999, Hege founded a spin-off company together with Detlev Stalling and Malte Westerhoff, which developed this academic software into a commercial product under the name Amira. Together with Avizo, a specialized version for materials science, it has been used in about 50,000 scientific papers to date.

Other software developed in his research group includes *SoPlex* (optimization package for solving linear programming problems), Doc++ (the root of the widely used code documentation system *Doxygen*), *Lenné3D-Player* and *Biosphere3D* (interactive modeling and rendering of complex landscapes with vegetation), and *iCon.text* (a customizable iPad app for museums).

His further scientific work includes fundamental methods for the (1) reconstruction of geometric/anatomical objects from 3D image data, (2) extraction and visualization of features and structures in scalar, vector and tensor fields, (3) quantification and visualization of uncertainties in fields, (4) visualization of molecular systems (quantum effects in molecules, structure of biomolecules, subcellular biological entities), (5) rendering of landscapes with natural vegetation, and (6) statistical analysis of geometric shapes. Together with students and colleagues he received 3 best paper awards at IEEE, ACM and EG conferences.

In collaboration with domain scientists, he brought these methods to useful applications in (1) medicine (reconstruction/analysis of anatomy and therapy planning in orthopedics, angiology and oncology), (2) biology (reconstruction/analysis of microscopic structures, creation of atlases in neurobiology and plant biology), (3) material sciences (reconstruction/analysis of crystallographic, microstructural, pore and fiber structures), (4) engineering sciences (analysis of flow structures and features), (5) meteorology (identification/analysis of atmospheric structures, and transport processes), (6) archaeology (reconstruction/visualization of ancient sites, virtual unrolling of papyri, quantitative shape analysis), (7) landscape planning (visualization of landscape redesigns) and (8) astrophysics (visualization of general relativistic phenomena).

Hege founded the conference series Visualization & Mathematics together with Konrad Polthier and the EG Symposium on Visual Computing for Biology and Medicine (VCBM) together with Bernhard Preim and Charl P. Botha. He chaired 18 international conferences, workshops and summer schools, including IEEE/EG Volume Graphics (twice), EG/IEEE EuroVis and IEEE VIS. Together with Konrad Polthier he founded the Springer book series Mathematics + Visualization and the video & DVD series VideoMath.

Hege's research has benefited immeasurably from the contributions of his colleagues, collaborators and especially his students, who have gone on to successful careers in academia and industry and have also founded successful companies. He is deeply grateful to all of them.

