Research and Graduate Education in Computational Engineering at UTC

THE UNIVERSITY OF TENNESSEE
SimCenter *at Chattanooga*
Computational Simulation and Design Center • Graduate School of Computational Engineering

Computational Engineering uses advanced analysis and design software to perform computer simulations that are increasingly effective as a supplement to conventional experiments and testing. Such simulations can produce competitive advantages in price, time-to-market, life-cycle costs, and overhead: advantages that are becoming increasingly important for the design of globally competitive products.

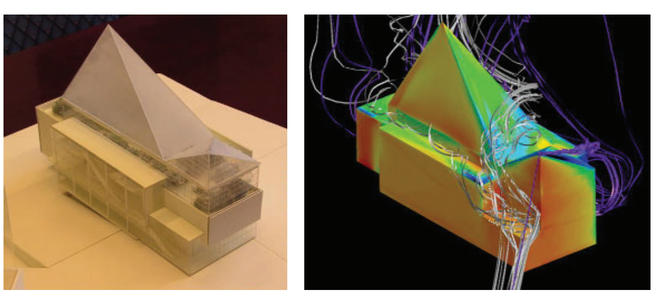
In the fall of 2002, UTC established the UT SimCenter at Chattanooga and the Graduate School of Computational Engineering, whose mission is *to serve U.S. government and industry through integrated research and education in computational engineering*. The SimCenter faculty and staff (now nineteen in number) comprise a multidisciplinary team that is nationally and internationally recognized for its research on development of advanced computational simulation and design systems for solution of complex, real-world engineering problems.

UTC now offers a M.S. concentration in Computational Engineering and is seeking approval to offer a Ph.D. in Computational Engineering beginning in 2004. This multidisciplinary graduate program is open to qualified students with undergraduate degrees in *engineering, mathematics, computer science or a physical science*. Graduates will help supply the nation's future needs for computational engineering professionals capable of developing and applying advanced computational simulation and design software for real-world engineering analysis and design problems.

Dr. David L. Whitfield is the SimCenter Director and Associate Dean of the College of Engineering and Computer Science. Before coming to UTC, he founded and directed the ERC SimCenter at Mississippi State University and was a William L. Giles Distinguished Professor of Aerospace Engineering. He was also one of three co-founders of the National Science Foundation Engineering Research Center (NSF/ERC) for Computational Field Simulation at MSU (1990-2001).

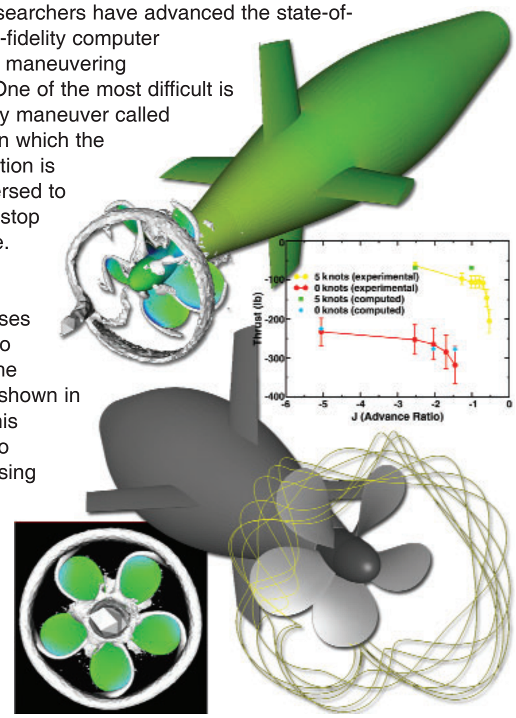
Dr. Henry McDonald, UTC Chair of Excellence in Computational Engineering, also helps lead the SimCenter. In 2002 he completed two three-year terms as the Director of NASA Ames Research Center at Moffett Field in California, where he established the NASA Center of Excellence in Information Technology. He is a member of the National Academy of Engineering and has received numerous other honors and awards.

SimCenter capabilities are illustrated by a recent simulation of wind flows around the planned new addition to the Tennessee Aquarium. A scale model of this unusually shaped building is shown here in the first of two images. One of the structural design requirements for the new addition is that the structure be able to withstand aerodynamic forces on the exterior walls caused by high winds. The UTC SimCenter was asked to perform computer simulations that reveal the airflow patterns caused by wind coming from a given direction, and computed results for these simulated airflow patterns are shown in the second image. Such simulations can provide design engineers with aerodynamic wind-loading distributions to help design the aquarium structure.



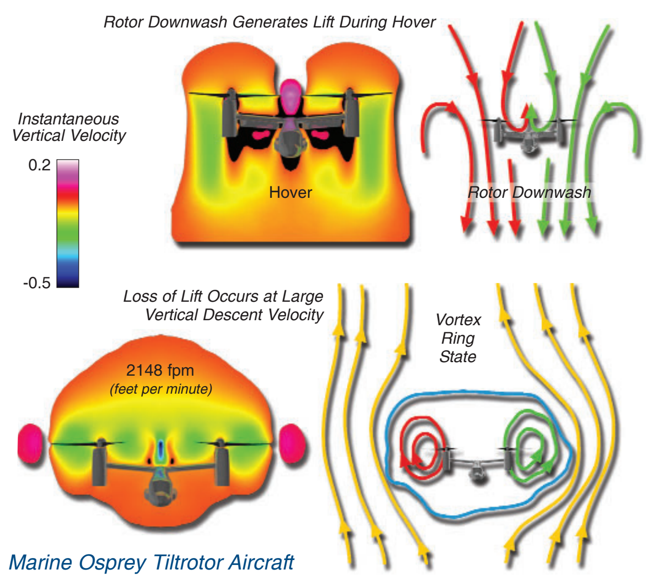
Tennessee Aquarium Addition: Scale Model (Left) and Computer Simulation of Wind Patterns (Right)

Two other examples are typical of previous research by the SimCenter research team. In work sponsored by the U.S. Navy, SimCenter researchers have advanced the state-of-the-art in high-fidelity computer simulations of maneuvering submarines. One of the most difficult is the emergency maneuver called "crashback", in which the propulsor rotation is suddenly reversed to slow down or stop the submarine. The reverse rotation of the propulsor causes a ring vortex to form behind the propulsor, as shown in this image. This vortex tends to "wobble", causing side forces that can cause the submarine to behave unpredictably and with possible dangerous changes in depth.



Submarine Emergency Crashback Maneuver

In work sponsored by NASA, SimCenter researchers have performed leading-edge flow simulations for the Marine Osprey tiltrotor aircraft. Such simulations are important because tiltrotor aircraft can be difficult to land on ship decks with crosswinds, and they also undergo complicated maneuvers during transition from aircraft mode to helicopter mode during landing. The images shown here illustrate different flow patterns that arise during vertical descent of the aircraft at different velocities. If the descent rate is too large, the aircraft can enter the dangerous condition known as "vortex ring state", which causes loss of lift and possible control problems.



Marine Osprey Tiltrotor Aircraft

For further information and instructions on how to apply for graduate study in Computational Engineering, see the UTC SimCenter website ***http://www.utc.edu/simcenter***.