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Background on fluid dynamics study funded by Department of Defense and headed by Henry Abarbanel of the Institute for Nonlinear Science

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BACKGROUND ON FLUID DYNAMICS STUDY

Up to $3.6 million of the Department of Defense University Research Initiative (URI) funds is designated for the beginning of an in-depth study of fluid dynamics by an interdisciplinary group headed by Henry Abarbanel, acting director of the Institute for Nonlinear Science at UCSD.

If the program is fully funded as expected, Abarbanel and a team of engineers and scientists from UCSD and its Scripps Institution of Oceanography (SIO), will receive an estimated $13.5 million over five years to build a major center for the study of complex fluid motion. Abarbanel is a research physicist at the SIO marine physical laboratory.

Fluid dynamics is a branch of physical science that deals with the effects of a variety of forces--heat, movement or pressure, for example--on water, air and other liquids and gases. The focus of the investigation, which will be broken down into 17 separate but related research projects, will be the transition of fluid from a smooth, regular type of flow to turbulent behavior.

That transition can occur in the wake of a ship moving through the water. At first a steady, coherent stream, at critical speeds it suddenly turns chaotic. Or it can be the natural upwelling, or mixing, of different layers of the ocean, a complex process that affects water temperature and the distribution of nutrients for marine populations.

The results of the research will serve as the groundwork for numerous practical applications to civil, commercial and defense problems.

Two industries that stand to benefit are aeronautics and marine engineering.

One of the problems researchers hope to solve is how to control drag, the forces that slow down a ship or a plane as it moves through the water or air.

In a second project, scientists are investigating the dynamics of bubbles, which are a scourge to a number of industries, particularly transportation and power. An understanding of how bubbles are generated and explode, damaging the blades of ship propellers and turbines, ultimately may save these industries money by prolonging the lives of this precision machinery.

To the computer industry, turbulence at the edge of large, hard rotating discs limits data storage. Investigators, jointly affiliated with the UCSD Center for Magnetic Recording Research and the Institute for Nonlinear Science program, will seek ways to improve the design of mass storage devices.

In attacking these and other fluid dynamics problems, Abarbanel and his colleagues plan to use every scientific tool at their disposal--mathematical analysis and modeling, laboratory experiments, computational studies, and graphical analysis.

The program will require some of the most sophisticated computing technology available, including the celebrated San Diego Supercomputer Center at UCSD and a parallel processor device called "hypercube." Through powerful graphics workstations and high speed image-processing equipment, Abarbanel and his colleagues plan to establish a state-of-the-art graphics analysis center, which will be available to all researchers associated with the project.

A heavy emphasis will be placed on the training of graduate students and postdoctoral fellows as well as interactions with DOD and industrial scientific laboratories.

The management of the scientific and educational activities of the program will be the responsibility of an executive committee, headed by Abarbanel. Members are Manuel Rotenberg, professor of electrical engineering and computer sciences, Hassan Aref and Charles Van Atta, both professors of applied mechanics and engineering sciences, and Geoffrey Vallis, assistant research meteorologist at Cal Space of SIO.

The DOD's Defense Advanced Research Projects Agency (DARPA) will provide the funds for the fluid dynamics study.

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