Coalition of
Academic
Supercomputing
Centers

C A S C

THE IMPACT OF HIGH PERFORMANCE COMPUTING ON AEROSPACE AND DEFENSE

The aerospace and defense industries have come to rely on the speed, power and precision of high performance computing to design, develop and manufacture the safest and most advanced defense and aeronautical systems in the world. To maintain this competitive edge and protect our interests here and abroad, collaborations between the public and private sector remain a top priority.

The push for cost controls has made computer simulation a central component of product design and development in these industries, resulting in substantial savings and decreased development cycles. Because of their unmatched expertise and resources, university-based supercomputing centers and national research labs are consistently called into this arena by both government and the corporate sector.

Preventing Nuclear Accidents -- A multi-disciplinary team at the University of Utah (UU) is using high performance computing in support of a nationwide effort to provide scientific stewardship of America's aging nuclear arsenal. The team brings together theoretical chemists and computational engineers from UU, Brigham Young University, and the Utah State University with scientists from Thiokol Corporation. While their immediate goal is to prevent nuclear accidents, the project is also critical to other industries where explosions can occur, including aerospace, chemical and petroleum.

In 1996 UU received a five-year $26 million grant from the U.S. Department of Energy to establish the Center for the Simulation of Accidental Fires and Explosions (C-SAFE) as part of the federal Accelerated Strategic Computing Initiative (ASCI) -- a federal partnership aimed at ensuring that management of nuclear stockpiles is based on technology, not testing. Computational scientists at the UU have been given access to three of the world's most powerful computers used in U.S. nuclear weapons facilities to simulate such scenarios as the terrorist shelling of nuclear storage areas, burning of buildings containing high-energy material and fuels, and weapons caught in a fuel fire during an air crash.

High Speed Storage and Retrieval System -- The ability to access and organize reliable information at lightening speed is crucial to most defense situations. The High Performance Storage System (HPSS), a new software package providing the most advanced data storage and retrieval techniques yet available, has been designed and developed by the Center for Computational Sciences at Oak Ridge National Laboratory in partnership with three other national labs and the IBM corporation. The system melds high speed networking and parallel processing to achieve streamline data flow -- allowing vast amounts of information to be extracted, segmented, integrated, stored or retrieved in time-sensitive simultaneous operations that could only be performed sequentially in the past.

HPSS is another key component of the Accelerated Strategic Computing Initiative (ASCI) and holds promise for other fields with major date requirements, such as finance and health care. The system has been recognized by ***R and D*** Magazine as one of the top 100 new product inventions of 1997.

High Tech Training for the Department of Defense -- The Cold War may be over but the need for well-trained defense scientists and engineers endures. Through the Department of Defense Modernization Program, several academic supercomputing centers are helping the federal government ensure that its cadre of computational specialists stays strictly state of the art. Training defense personnel in the latest high performance computing techniques can solve problems with civilian as well as military implications. This includes developing better lubricants, fuels, explosives, propellants and chemical agents, more durable materials for weapons, more effective detection methods, batteries that stay viable in extreme conditions and improved de-icing equipment. Among participating centers are the Ohio Supercomputer Center (OSC), and the National Center for Supercomputing Applications (NCSA), and the Center for Research on Parallel Computation (CRPC) based at Rice University and Caltech.

Space Station Safety -- Researchers at the University of Texas at Austin are working with NASA to study the effect of "shielding" on the proposed U.S. Space Station. The purpose is to prevent damage to the Station and harm to its occupants from high-speed micro-meteorites. High performance computing and particle simulation techniques are being used to assess the impact of such events and the effectiveness of various materials in mitigating damage. The goal is to identify light-weight, cost-effective shielding solutions which can last for the Station's projected life-span orbiting the earth. Large-scale computer simulations involving as many as 100,000 particles have been carried out on state-of-the-art systems at The Texas Advanced Computing Center (TACC), located at UT-Austin.

Atmospheric Turbulence and Aircraft Safety -- Researchers at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado have developed very-high resolution simulations of moutain-induced turbulence -- both terrain and gravity-wave generated. Determining the sources and nature of such turbulence could have substantial benefit for aviation safety.

Advanced Target Tracking -- The Maui High performance Computing Center provides Department of Defense researchers with the expertise and resources to pursue computationally intense projects, such as testing new methods of advanced target tracking for the Air Force's Airborne Laser Challenge Project.

Minimizing Waste -- The Multi-disciplinary Analysis and Design Industrial Consortium (MADIC) brings together researchers from NASA, major aerospace companies, the Center for Research on Parallel Computation (CRPC), and other organizations to solve problems in aircraft development. Among its achievements has been creating computational templates that minimize waste in cutting sheet metal stock, a key material in aircraft construction.

Large Scale Battlefields Simulations -- Computational scientists at Caltech are showing how the lives of service personnel can be protected by using large-scale simulations for military training and tactical planning. Until now, the technology limited the modeling of battlefield scenarios to less than 100 entities per individual work station and only about 5,000 on a network of computers. The Caltech team developed a novel routing system linking nine computers and nearly 2,000 processors nationwide. In the Spring of 1997, using this system, they successfully created an unprecedented 50,000 unit battlefield -- the largest and most intricate such simulation performed to date. The project holds great promise for integrated military training, bringing in all levels and functions, from tank drivers and combat units, to division staff and top command. The simulations enable the testing of varying battlefield configurations, with external forces such as weather and terrain factoring into an operation.

The Delta II Rocket -- In August, 1995 a US Air Force Delta II rocket launched a commercial satellite into the wrong orbit. Using the most advanced resources of the Pittsburgh Supercomputing Center, engineers from McDonnell Douglas, the Aerospace Corporation and Caltech simulated the Delta II flowfield under "plume on" conditions -- with the rocket firing -- which cannot be modeled in a real-life wind tunnel. The computer results confirmed the source of the problem in time to correct it for a November 1995 launch.