

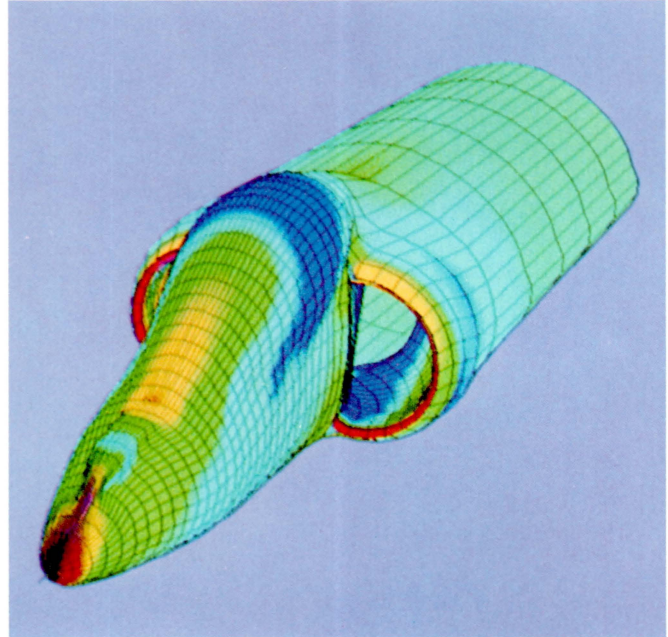


CONVEX

COMPUTATIONAL FLUID DYNAMICS: An Applications Profile from Convex Computer Corporation



This simulation, which is based on a Navier-Stokes analysis, depicts surface pressure predictions for the F-15 Eagle at Mach 0.9.



This simulation shows surface pressure predictions for the AV-8B Harrier II forebody at Mach 0.8.



Supercomputer simulations permit the engineer to observe phenomena that wind tunnels cannot produce.



The AV-8B Harrier II can operate from small, unprepared sites and roads close to front lines.

Supercomputing performance brings large-scale simulations into the aircraft designer's repertoire. While not expected to replace such traditional design tools as wind tunnels and test flights, computer simulations offer the manufacturer a cost-

effective resource for innovation, evaluation and enhancement of aircraft design.

Design development using supercomputing simulation proceeds from a systematic knowledge base rather than from

conjecture or surmise. At the same time, computer simulation increases the scope for design innovation and enhancement. The use of simulations makes iterative design experimentation cost-effective. Moreover, simulations point the way to improvements in design.

Supercomputer simulations also permit the engineer to observe details of fluid flow phenomena that wind tunnels cannot produce. These include surface pressure distributions, shock wave locations and strengths, streamline paths and boundary layer behavior. In addition, simulations provide critical guidance — before costly wind tunnel testing — concerning the need and location for specific flow diagnostic measurements.

Finally, computer simulation has extraordinary value in training.

The novice engineer who works with simulations quickly acquires direct experience with a broad range of design alternatives and develops a lasting appreciation of the impact of design changes.

The result, for companies that exploit this new technology, is superior design.

THE PROBLEM

In 1984, McDonnell Aircraft (MCAIR), a division of McDonnell Douglas and a leading manufacturer of state-of-the-art military aircraft, undertook a search for a computer system that would improve its capabilities for development of computational fluid dynamics code. The primary users of the new resource would be MCAIR's aerodynamics and propulsion-thermodynamics departments.

The requirements involved were exacting. The principal need was a system that would allow MCAIR to sustain its outstanding development program while controlling its costs. MCAIR prides itself on its commitment to investing in the future while achieving better quality, higher productivity and reduced costs.

To call a halt to the continuing expense of time-sharing on a Cyber™, the company resolved to make a sound capital investment in a machine that could be located on-site and fully loaded without incurring user fees. Because work in computational fluid dynamics is CPU-intensive, even in test cases, MCAIR also demanded a machine that was top-rated on a dollars per calculation basis.

In addition, since the planned system would be used to develop code that would run on the Cray-1™, MCAIR needed a powerful vector processing machine.

THE SOLUTION

These requirements considerably narrowed the range of alternatives. Their high costs quickly put Cyber machines out of the running. Their slower speeds ruled out minicomputers. After

investigating the possibilities, MCAIR selected the Convex C1, the first affordable supercomputer. Its strong price/performance ratio proved decisive.

The C1 combines memory and vector processing capabilities previously found only on large-scale supercomputers with the software and price advantages of minicomputers. MCAIR found that the C1 completed in 30 minutes runs that required hours on a minicomputer.

Installed in September 1985, this 64-bit integrated scalar and vector processor with a Cray®-like architecture ensured MCAIR a superior resource for developing and testing code to run on the Cray.

The C1's large physical memory, up to 128 megabytes, provided the capacity to handle larger models.

The C1 at MCAIR is linked to a VAXcluster™ which in turn is linked to the Cray.

In day-to-day use, MCAIR has found that the C1 delivers performance up to 20 times that offered by the VAX™ 780. Moreover, having supercomputing power on-site enables MCAIR to avoid the lengthy turn-around times frequently associated with time-sharing.

The C1 operating system, Convex UNIX®, is enhanced for scientific and engineering users. In addition, Convex can supply an attractive library of third-party software, math libraries and software tools.

The C1's I/O processors ensure that CPU time is not occupied with user and other I/O. A high I/O bandwidth to disk and a disk striping facility enable the C1 to sustain high I/O performance levels.

THE ORGANIZATIONS

McDonnell Aircraft Corporation manufactures high-performance aircraft for military customers including the U.S. Navy, the U.S. Marine Corps, the U.S. Air Force, the National Guard, the Royal Air Force, and the governments of Australia, Canada, Israel, Japan, Spain and Saudi Arabia. MCAIR is the home of the F-15 fighter, which recently achieved the millionth flight-hour milestone with the best safety record of any fighter in the history of the U.S. Air Force. Based in St. Louis, Missouri, McDonnell Aircraft is part of McDonnell Douglas Corporation.

Convex Computer Corporation, headquartered in Richardson, Texas, was founded in September 1982 to design, manufacture, market and service affordable supercomputers. The Convex C1, which features a Cray-like architecture, combines 64-bit scalar and vector processing capabilities of large-scale supercomputers with software and price advantages of minicomputers. Offices worldwide ensure service and support to customers using Convex systems for geophysical research, computer-aided engineering and design, defense, aerospace and general research.

“Computational fluid dynamics is more complex for military aircraft than for transport aircraft, and we've found the C1 equal to the challenge. It's an ideal platform for development of code to run on the Cray: it's a vector machine, it's open and it's interactive. The C1 is also easy to manage, even in an environment such as ours in which two departments are sharing CPU time.”

**Dr. August Verhoff,
Section Chief, Technology —
Aerodynamics, McDonnell
Aircraft Company**

“We have to maintain a quality development program within stringent budget limitations, and that's what makes the C1 such a winner here. We save tremendously in not having to do time-sharing for code development. In fact, I get \$800,000 in value each year from the C1, and I only account for half of its use. What's more, we expect the C1 to be able to handle the development load for at least another two years.”

**Raymond R. Cosner,
Unit Chief, Propulsion —
Thermodynamics
Department, McDonnell
Aircraft Company**

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