MPGS

Multipurpose Graphic System

Powerful interactive engineering post-processing

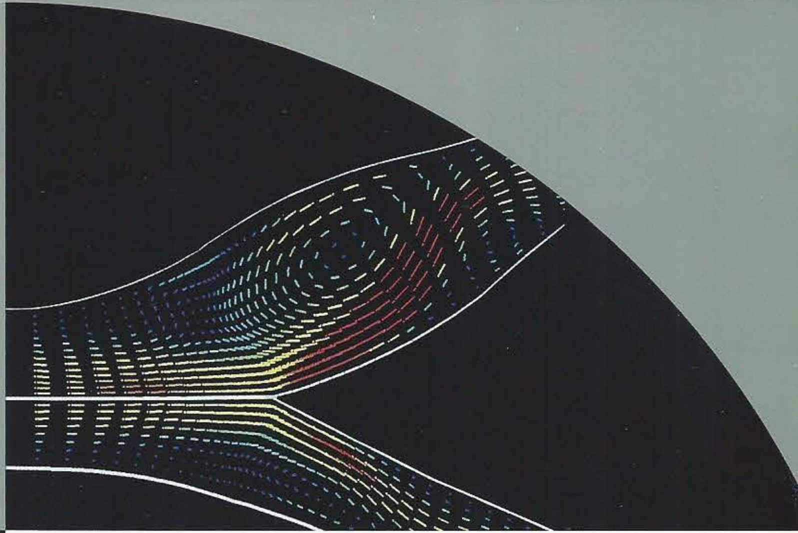
CRAY RESEARCH, INC.

Particle tracing of airflow around ascending space shuttle. Code: AIRPLANE. Data courtesy of Dr. Timothy Baker and Dr. Antony Jameson, Princeton University and the NASA Johnson Space Center.

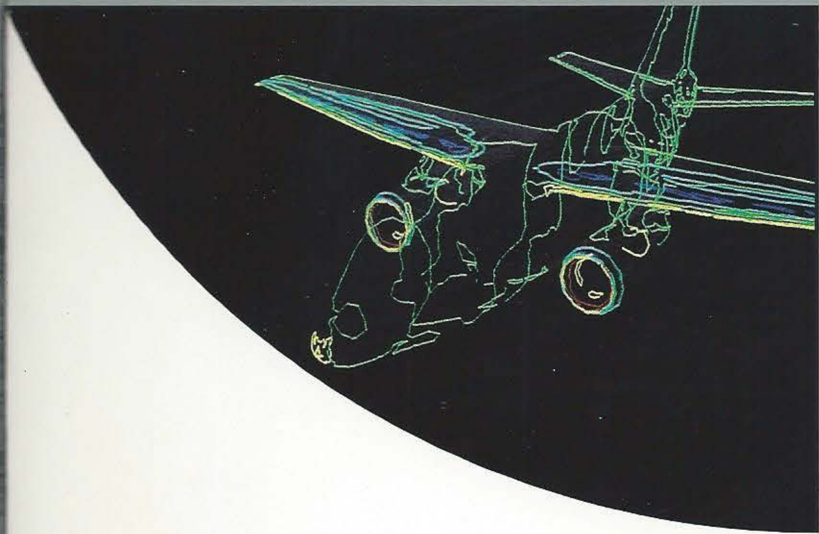
For the Aluminum Company of America (Alcoa), MPGS provides an effective way to visualize high-speed, liquid-metal injection casting. Injection casting operations typically are performed over a short period of time — within 20 to 40 milliseconds. By using a CRAY Y-MP8 system and MPGS to visualize the injection casting of a part prototype, Alcoa engineers were able to visually slow down the process to examine the fundamentals of flow.

To do this, the researchers geometrically modeled the shape of a cavity, imposing an inlet flow rate and placing a baffle at the outlet. Because MPGS integrates graphics processing capabilities with animation, the researchers easily could change views, examine many variables, and color-code images, according to Walt Wahnsiedler, a technical specialist at Alcoa.

"I'm familiar with other animation systems that require users to store a static sequence of frames," said Wahnsiedler. "Once that is done, you have to rerun the entire simulation or the



Blood flow in a blood vessel bifurcation flow field. Image shows velocity vector arrows colored by velocity magnitude at one instant of time during a pulse. Code: FIDAP. Data courtesy of Dr. Clement Kleinstreuer of North Carolina State University.



Pressure contours (iso-lines) of Lockheed S3 Viking aircraft. Code: AIRPLANE. Data courtesy of Lockheed Aeronautical Systems Company, and Dr. Timothy Baker and Dr. Antony Jameson, both of Princeton University.

The Multipurpose Graphic System (MPGS) brings real supercomputer power to your desktop with the click of a mouse button. With this processing power at your fingertips, you can visualize three dimensional, more complex simulations and achieve better solutions in less time.

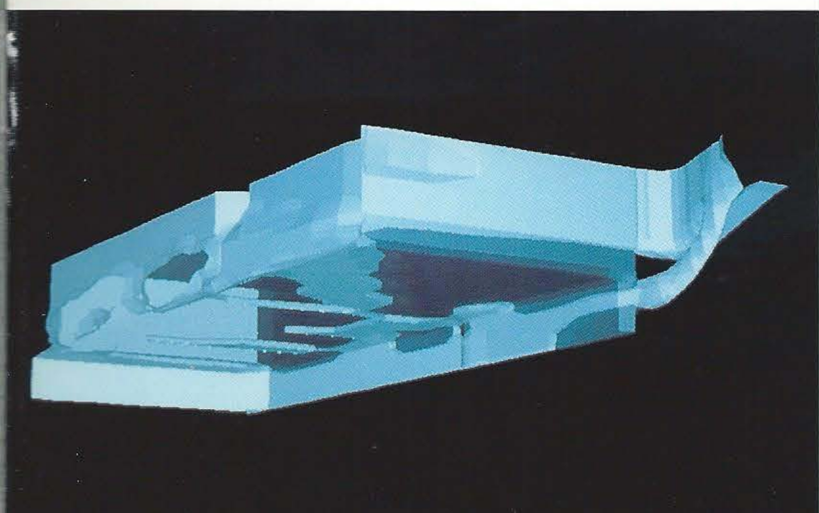
Designed by engineers for engineers

The MPGS system is an interactive menu-driven visualization tool for use on Cray Research computer systems. The MPGS system is the first advanced-graphics visualization tool that uses distributed processing to support supercomputer applications. Using TCP/IP network protocol, the MPGS system distributes graphics processing between a UNIX-based workstation and any Cray Research system running the UNICOS operating system.

The MPGS system offers true distributed processing that allows you to look at your data without removing it from the Cray Research system. Memory and CPU-intensive tasks are processed on a Cray Research system, while the user interface and local graphics manipulations are processed on the graphics workstation. This workload distribution ensures the efficient use of both computer systems and minimizes network data transfers.

Post-processing supercomputer problems

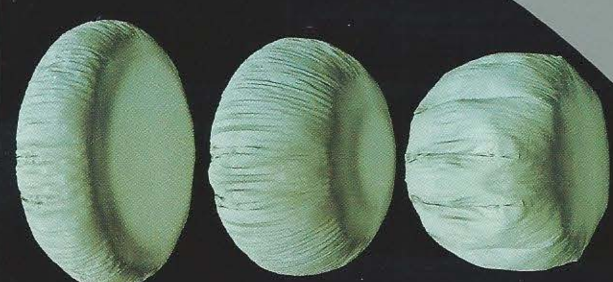
The MPGS package post-processes supercomputer simulations from many engineering fields. The MPGS package is used for post-processing by users in industries such as aerospace, automotive, electronics, and petroleum as well as in academia.



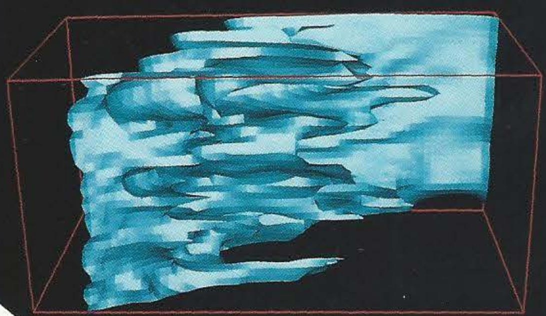
postprocessor if changes are needed. With MPGS, as long as the information has been computed, it can be reviewed any way you like."

He added, "MPGS enabled us to experiment quickly and more efficiently than other graphics systems I have used. In a day and a half we were able to try several different methods for viewing the data and produce about five minutes of animation with what we considered to be the best forms of graphics."

Automotive airbag simulation. These images depict the transient data generated from a generic model of the deployment and inflation of an air bag. The model shows the second order effects of wrinkling, creasing, and tearing due to over-inflation. Code: DYNA3D. Data courtesy of Mike Long, Cray Research, Inc. and John Hallquist and Doug Stillman of Lawrence Livermore Software Technologies, USA.



Iso-surfaces of carbon dioxide in petroleum. Data courtesy of Gene Shiles, Cray Research, Inc. and British Petroleum.



The MPGS system is being used in the following engineering applications:

- Computational fluid dynamics
- Structural analysis (including crash simulation)
- Electromagnetics
- Thermodynamics
- Petroleum engineering

The MPGS package also has been used for general graphics rendering and meteorology applications.

Broad analytical capabilities

The MPGS package can process geometry, scalar, vector, and discrete particle files for visualization. The required geometry file describes all geometric entities, such as nodes, lines, elements, and solids. The geometry file assumes completely unstructured problems and can thus be used with numerous types of analysis codes including:

- Finite element
- Finite difference
- Finite volume
- Boundary element

The optional scalar file contains one scalar value for each node in the geometry file. This file can be used to visualize scalar quantities such as temperature, stress, and pressure.

The optional vector file contains one three-dimensional vector value for each node in the geometry file. This file can be used to visualize vector quantities such as displacements and velocities.

The optional discrete particle file contains the position and size of each particle. The file also contains scalar and vector values that are attached to the particles. This information can be used to visualize particles together with their scalar and vector properties.

Capability with diverse application packages

The MPGS system reads files in its own native format, or in a MOVIE.BYU data format. Data from the following commercial packages can be post-processed using MPGS by passing the data through translators supplied with the MPGS system:

- ☐ ABAQUS
- ☐ AIRPLANE
- ☐ ANSYS
- ☐ DYNA3D
- ☐ MSC/EMAS
- ☐ FIDAP
- ☐ FLOW3D
- ☐ FLUENT
- ☐ FLUENT/BFC
- ☐ GENERAL FEM FORMAT
- ☐ KIVA
- ☐ MARC
- ☐ MSC/NASTRAN
- ☐ PAM-CRASH
- ☐ PATRAN
- ☐ PHOENICS
- ☐ PLOT3D
- ☐ RADIOSS
- ☐ RAMPANT

A complete post-processing tool kit

The MPGS system has the following features:

☐ *Dynamic transformations.* Users can easily perform graphical manipulations such as rotating and scaling.

☐ *Flexible parts structure with attributes tied to each part.* The system lets users control how they view computational models by making parts transparent, changing line widths and shading, and using symmetry to visualize an entire part when only a portion has been computationally modeled.

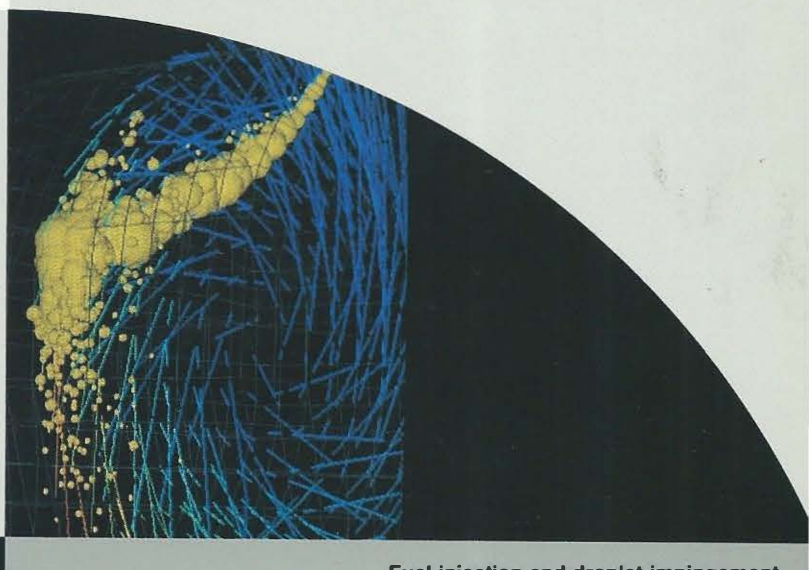
☐ *Hidden line drawings.* The system supports three-dimensional line drawings that help improve visualizations by concealing hidden lines, thereby reducing visual clutter.

☐ *Shaded images with or without a false color map.* Users can define colors to depict scalar or vector values such as pressure and temperature on computational models.

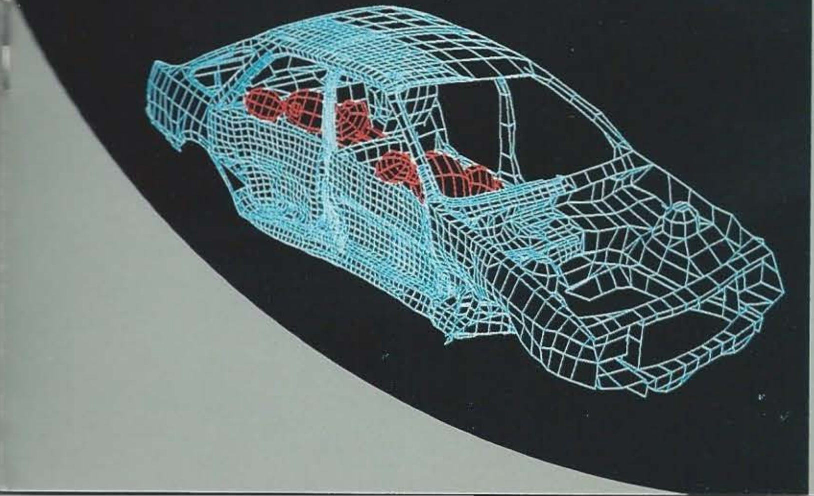
☐ *Contours (iso-lines).* The system enables you to visualize three-dimensional contour maps of constant scalar or vector values of computational models.

☐ *Vector arrows.* Vector arrows can show all or part of the components of the vector field. Vector arrows are sized according to the vector magnitude, and can be colored according to scalar or vector values.

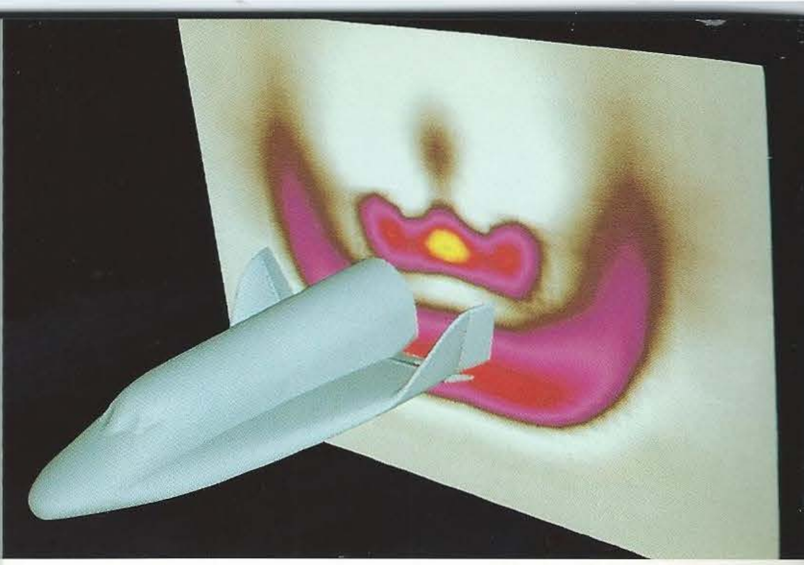
☐ *Particle traces.* Two-dimensional or three-dimensional particle traces can be steady state or time dependent. Traces can be colored according to the scalar field,



Fuel injection and droplet impingement on the wall of a diesel pre-chamber. The lines show air velocity vectors. Code: CRI/TurboKiva. Data courtesy of Reza Taghavi, Cray Research, Inc.



Side impact with crash dummies. Image depicts automobile and passengers in a side collision. Code: RADIOSS. Data courtesy of Ford Motor Company, United Kingdom.



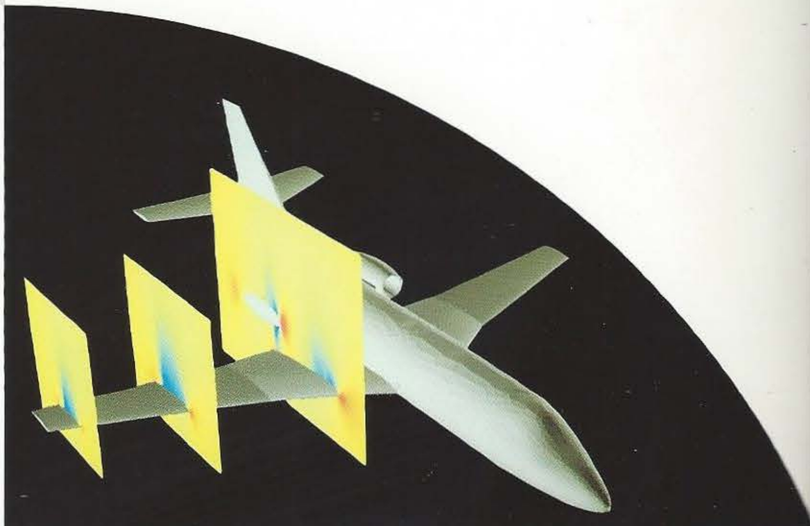
vector magnitude, or resident time. Users can interactively trace just one particle, a rake of particles, or an entire net of particles forward or backward in time. The traced particles can be stored on the workstation for interactive playback and can also be synchronized with transient data in the case of time-dependent particle tracing.

- ☐ *Interactively controlled two-dimensional clipping planes.* Users can clip and control arbitrary two-dimensional planes of geometry, scalar, and vector functions.
- ☐ *Iso-surfaces generation.* The system can generate iso-surfaces for scalar, vector, or constant x, y, or z values.
- ☐ *Discrete particle tracking.* Particles can be shown as points or spheres, and can be sized and colored according to particle size, scalar value, or vector magnitude.
- ☐ *Text annotation.* Users can interactively size and place a text string, which in turn may be dependent on transient data.
- ☐ *Full transient data support.* Users can swap to different time steps, or load up transient data for playback. The geometry, scalar, or vector files may change over time.
- ☐ Key frame animation with transient data support. Users can create animation, preview it on the workstation, or record it on supported animation recorders.
- ☐ *Unlimited separation of the Cray Research system and the workstation.* The required TCP/IP protocol ensures that information can be transmitted between a Cray Research system and the user's workstation over any distance.

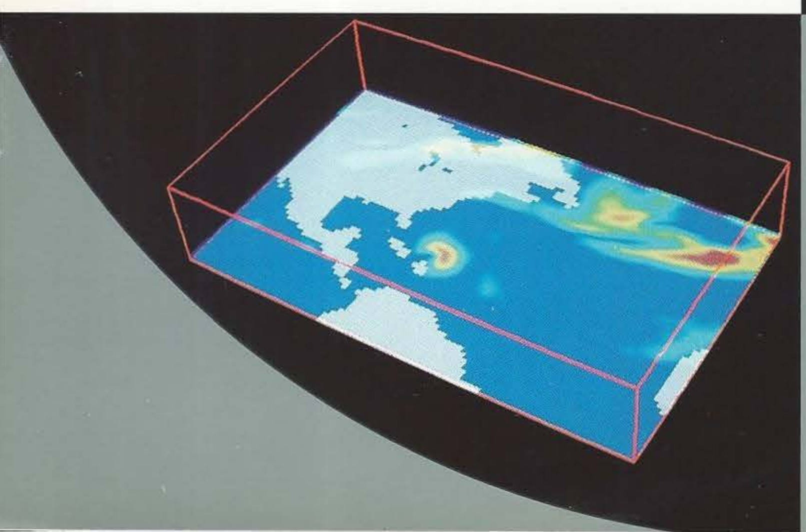
Support and Licensing

MPGS is a fully supported software product of the Industry, Science & Technology department of Cray Research. Documentation, training, and demonstration copies of the software are available. User assistance is provided through the extensive Cray Research software support organization.

For pricing and licensing information, please contact the nearest Cray Research sales office.



AMD/BA Falcon aircraft pressure contours. The pressure coefficient distribution is shown in clipping planes. Data courtesy of J. Peiro, Jaime Peraire and K. Morgan, Imperial College of Science, Technology and Medicine.



Wind speeds of Hurricane Hugo. Shaded image with false color map depicts high (red) and low (blue) wind speeds two days before landfall in South Carolina. Code: SPM. Data courtesy of Tony Meys and Anders Grimsrud, Cray Research, Inc., in association with European Center for Medium Range Weather Forecasting (ECMWF).

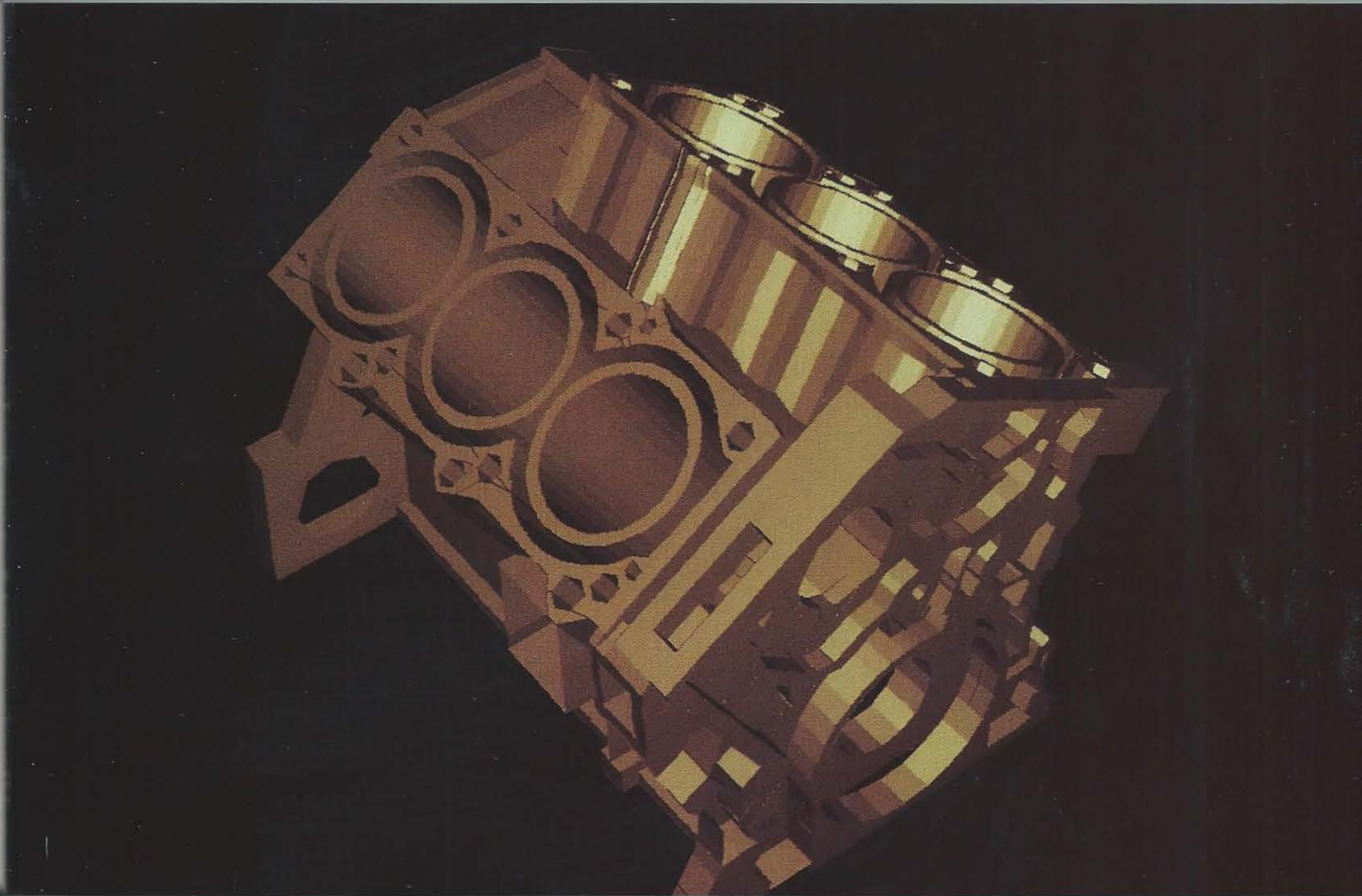
With MPGS, Princeton University researchers Timothy Baker and Antony Jameson can visualize aerodynamic flow around entire air- and spacecraft, such as the U.S. Space Shuttle and European Hermes vehicle.

Using the AIRPLANE fluid dynamics code on a CRAY-2 system, the researchers generate a mesh of tetrahedra, which they use to solve the equations that describe inviscid flow. "The output provides complete information about the flowfield, flow variation, density, and pressure on the surface of the aircraft and at points in space," said Baker.

"But to digest this wealth of information, we need the help of a high-performance graphics capability," says Baker. "MPGS enables us to visualize the flow at any plane in the field. We can examine contours of pressure or Mach number and look at particle traces in the flowfield."

"MPGS actually provides insight," Baker adds. "It is a valuable tool for aerospace companies to interpret data and demonstrate computational results."

This image shows the European Hermes space vehicle and the flow in the plane of symmetry. Color-coded contours of Mach number show variations in the flowfield and reveal the bow shock, canopy shock, interference created by the vehicle's flaps, and a region of separated flow behind the vehicle.



Engine block depicted with shaded images. Code: MSC/NASTRAN. Data courtesy of General Motors Corporation.

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On the cover, clockwise from upper right:

Airflow around ascending space shuttle. Data courtesy of Dr. Tim Baker and Dr. Antony Jameson, Princeton University and the NASA Johnson Space Center. Code: AIRPLANE

Airflow through a computer cabinet. Image depicts the geometry and particle paths in a four-processor HP 9000 Model 850 computer cabinet. Data courtesy of Kent Misegades, Cray Research, Inc. Code: FIDAP

Particle tracing around Honda NSX. Data courtesy of Honda Motors R&D.

Simulation of crystal growth using the Bridgeman Technique. Image shows complex convective flow of molten mercury cadmium telluride, simulating the transient solidification of the crystal. Data courtesy of Dr. Michael Engleman, Fluid Dynamics International. Code: FIDAP

The product specifications contained in this brochure are subject to change without notice. For the latest information, contact your Cray Research representative.

Printed in the U.S.A.

MCPB-202-0691