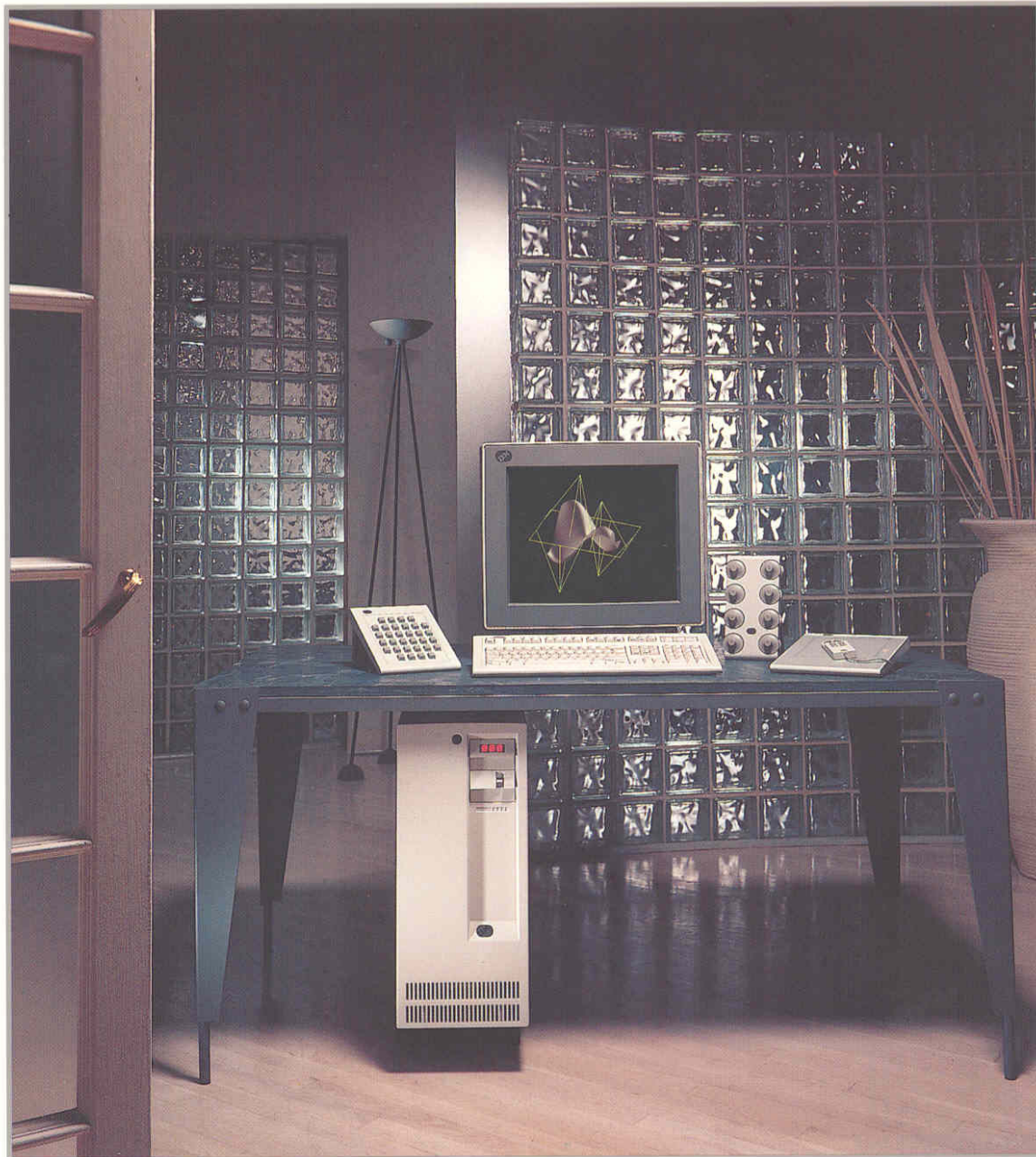
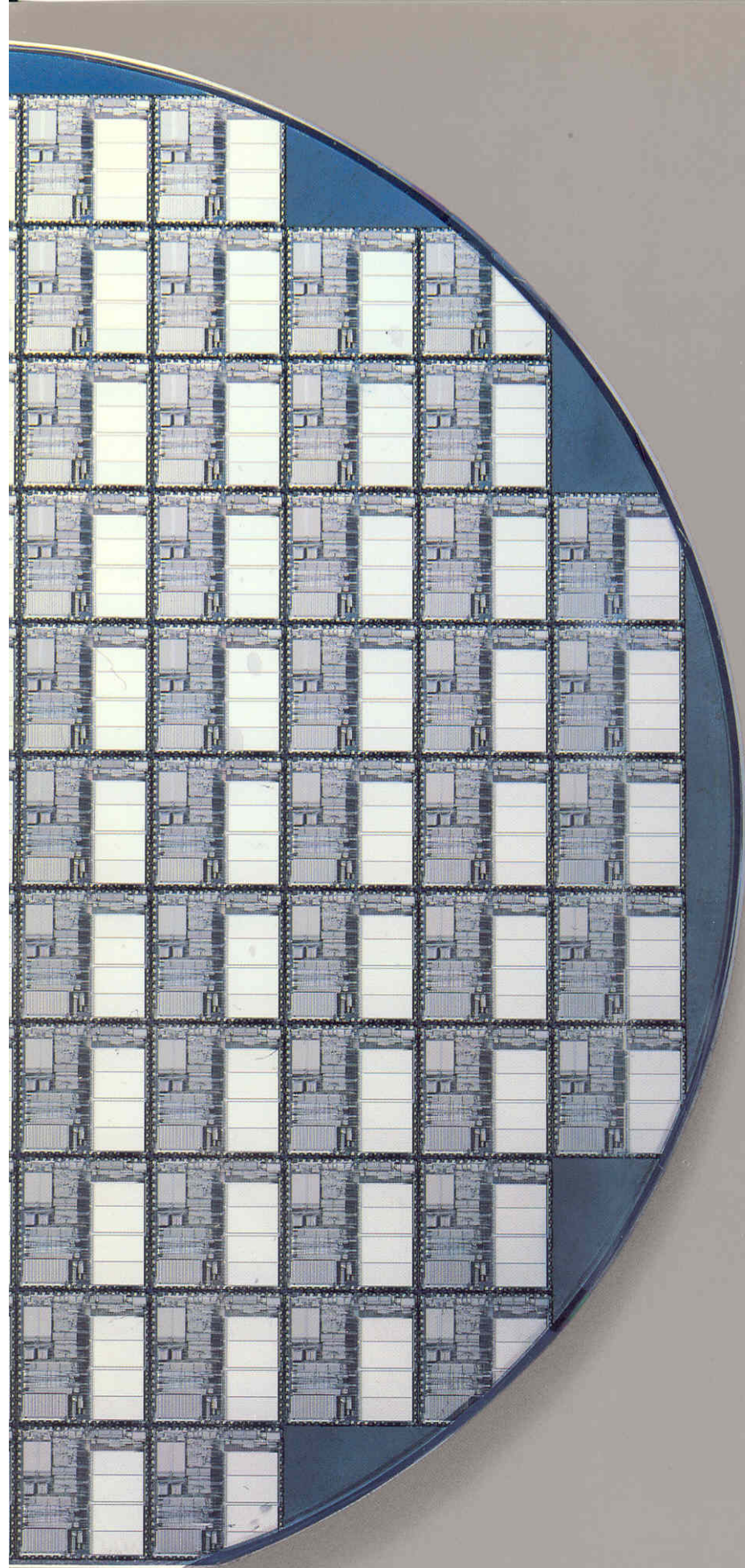


# 6090 Graphics System

## Overview and Technical Highlights



IBM



Wafer of IBM's  
custom VLSI  
module used  
in the 6095  
Graphics  
Processor.



## 6090 Graphics System

The IBM 6090 Graphics System enables scientists, engineers and designers to interact with shaded, realistic 3-D images with a sense of real-time movement. IBM has incorporated the best of its technology and experience into the 6090 Graphics System, allowing you to execute computationally intensive graphics operations with floating point precision at new levels of performance. The system also offers enhanced communication capabilities for cost effective network solutions.

A basic mainframe configuration consists of a 6095 (Model 1 or Model 2) Graphics Processor, a 6098 Model 1 Channel Control Unit, and a 6098 Model 1R Remote Control Unit for remote communications. In addition, the 6090 family provides an extensive selection of attractive and versatile peripheral devices.

### Molecular Modeling

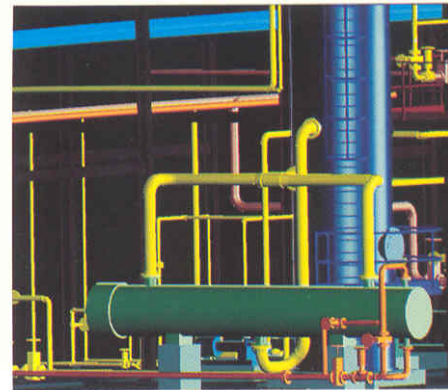
Displayed on IBM's 23 inch monitor. Data courtesy of Polygen Corp.



It can be used with numerous scientific and technical applications requiring fast, high resolution, 3-D graphics capabilities including:

- Molecular Modeling
- Computational Fluid Dynamics
- Finite Element Analysis
- Visual Simulation
- Industrial and Product Design
- Animation
- Rendering
- CAD/CAM
- Mechanical Computer Aided Engineering

The 6090 system enables the user to visualize these complex images with the perception and detail required to make subtle modifications. It appeals to a broad range of industries as an essential tool to gain insight into problems, determine solutions . . . and to break into new frontiers.



**Plant Design**  
Data courtesy of CADCentre Ltd.



**Plastic Molding Simulation**  
Depicts temperature distribution during plastic cooling process. Data courtesy of Moldflow, Inc.

## Highlights and Benefits



6095 Graphics  
Processor

### System Architecture

### 6095 Graphics Processor

### Shading Processor (Standard in Model 2)

#### FUNCTIONAL/TECHNICAL CAPABILITIES

#### BENEFITS PROVIDED

32-bit floating point architecture	Speed and precision for advanced rendering
The graPHIGS™ Application Programming Interface (API) Architecture	Optimal performance and graphics capabilities
IBM 5080 compatibility	Investment protection and support of IBM's current graphics architecture
Parallel and pipeline design	Efficient graphics processing
Proprietary technology	Innovative design for graphics solution
Non-Uniform Rational B-Splines (NURBS)	The tool to model curves, surfaces and trimmed surfaces quickly and precisely
Automatic tessellation	Accurate and efficient curve and surface rendering
Dual frame buffers	Smooth transition between display updates
Optional 24-bit planes	16.7 million colors for realistic image display
Up to 32 megabytes of memory storage (Model 1 and Model 2 have a base memory of 2 and 8 megabytes, respectively)	Ability to work with large and complex 3-D models
Off-loading graphics functions to the 6095	Faster interactive response times and reduced demands on the host
Flat and Gouraud shading	Choice of lighting algorithms
24-bit Z-buffer	Hidden line/surface removal for accurate 3-D viewing
Up to eight light sources that include ambient, directional, positional and spot	Various illumination effects

**FUNCTIONAL/TECHNICAL CAPABILITIES**

**BENEFITS PROVIDED**

**Display Capabilities**

**6098 Model 1  
Channel Control Unit**

Depth cueing

Lighting models, including ambient reflection, diffuse reflection, specular reflection (Phong lighting) and transparency

1280 x 1024 resolution

16, 19, and 23 inch monitors

Channel speed of up to 4.5 megabytes per second

Multiple and independent processors

Optional integrated T1 line interface

Optional 19-inch rack mount

Hardware features that offer selective combinations of local (coax, twisted pair) or remote (T1, V.35) attachments

Relative perception of distances

Enhanced realism

Visual sharpness

Display versatility

Enhanced performance capabilities

Parallel processing of specialized tasks such as S/370 channel, coaxial and remote processing

Reduced remote hardware costs and high speed communications

Compact installations

Flexible configurations



**6098 Model 1  
Channel  
Control Unit**

**6098 Model 1R  
Channel Remote  
Control Units**

Up to 192 graphics addresses

Parallel processing

Block polling when used with the 6098 Channel Control Unit

Optional integrated T1 line interface

Optional 19-inch rack mount

Up to 16 remote graphics processor attachments

Configuration flexibility for growth of installation

Concurrent movement of data in and out of the remote controller

Increased efficiency on the TP link

Reduced remote hardware costs and high speed communication

Compact installations

Configuration flexibility and growth of installations



**Combined  
Local/TP Port  
Feature**

Includes 4 coax, 4 twisted pair, V.35 and T1 connectors providing 32 local and 16 remote graphics addresses. Supports 1 to 4 cards for up to 192 addresses.



## Here's How it Works



Jet engine modeled with two NURBS surfaces and rendered with four light sources.

### Specialized Processors that Provide the Muscle

The internal structure of the 6095 includes dedicated processor boards that are packed with IBM's advanced technology and proprietary components. Graphics data is processed by four specialized subsystems before being displayed on the monitor. They are the:

#### SYSTEM CONTROL PROCESSOR

This processor is the control point that manages information flow and internal operations. It is the central brain, including system storage, that controls data exchange between the communications processor and the geometry processing/rendering pipeline.

#### COMMUNICATIONS INTERFACE PROCESSOR

This processor controls data that flows in and out of the Graphics Processor through coax or twisted pair connections. It is the passageway into the world of data and applications that reside in the host.

#### GRAPHICS CONTROL PROCESSOR

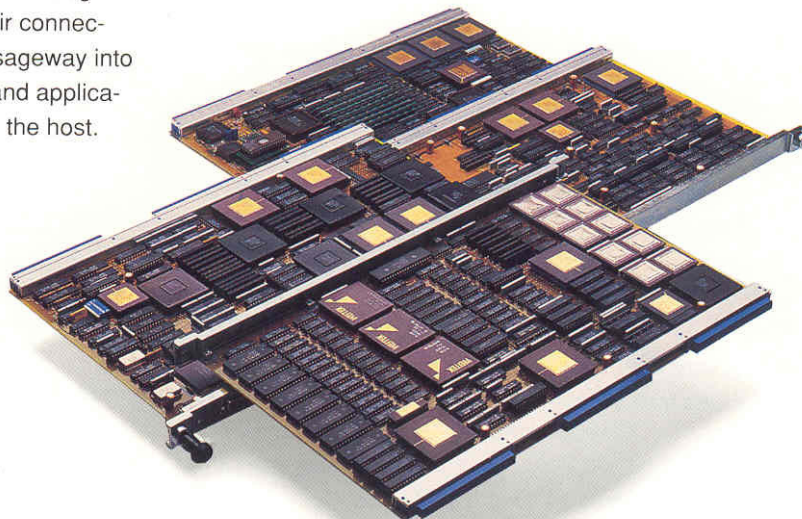
This processor is the entrance into the rendering pipeline. It interprets the graphical primitives and attributes from system storage, applies transformation and clipping and passes the primitives to the drawing or shading processor. It provides local curve and surface evaluation and tessellation based on IBM's advanced hardware implementation of NURBS.

#### DRAWING PROCESSOR

This processor rasterizes the fully transformed and clipped graphical primitive and places them into the frame buffer for display on the monitor. It supports drawing operations such as vector generation, area fill and bit-block transfer. It supports such visual attributes as true color, preselect highlighting, linestyles and fill patterns.



Design of an artificial heart  
Data courtesy of Dassault Systemes.



### Specialized Processors

Dedicated processor boards that are packed with IBM's advanced technology and proprietary components.



Teapot rendered with one white ambient and three colored directional light sources.

#### SHADING PROCESSOR

The shading processor, a fifth specialized subsystem, is standard with the 6095 Model 2 and optional with Model 1. It includes a 24-bit Z-buffer and up to eight light sources with surface properties, supporting Gouraud shading, hidden line/surface removal and depth cueing.

#### Dual System Bus

A high speed dual system bus structure allows these processors to efficiently communicate with one another. Block transfer of graphics data can attain an internal performance rate of 40 megabytes per second, allowing for fast interactions.

#### Expansion Features

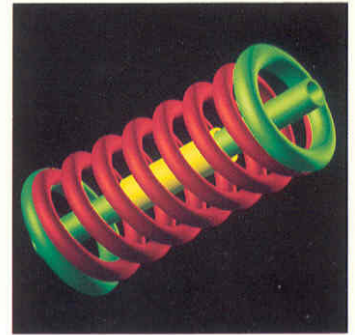
You may expand the base system of the 6095 with two additional features. They are:

#### EXPANSION SYSTEM STORAGE

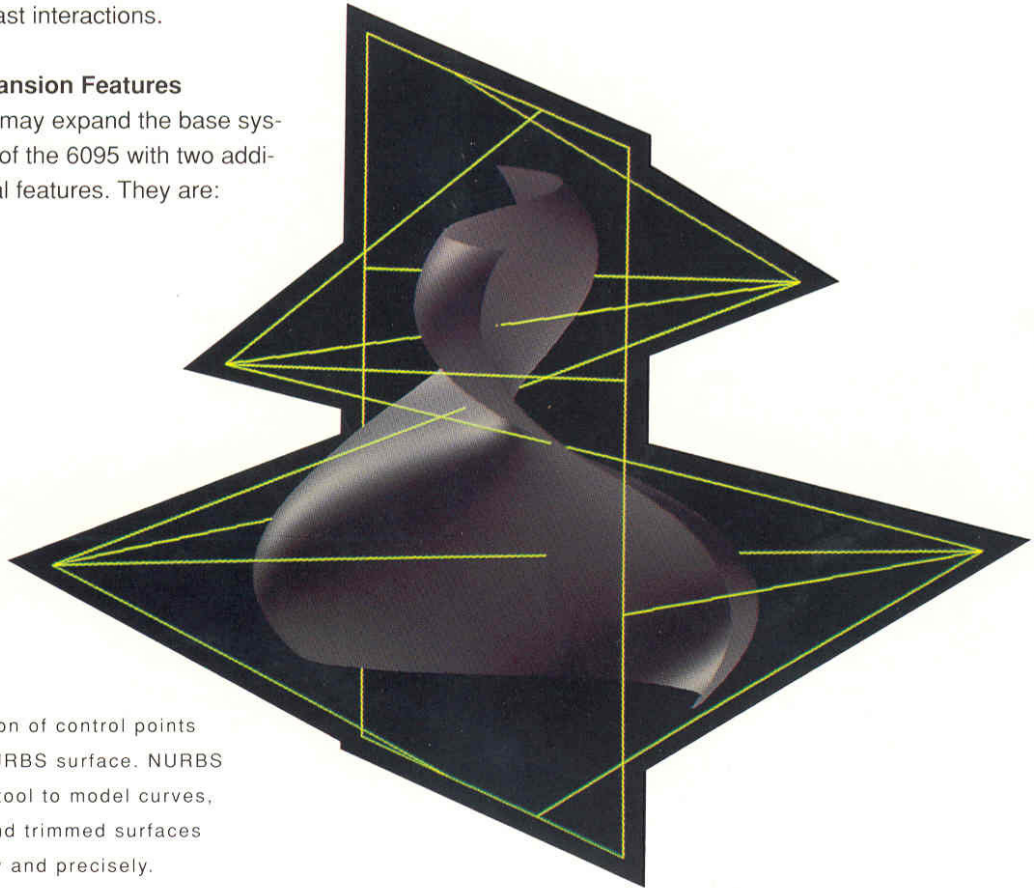
This feature allows the user to expand the base memory storage. There are three increments of eight megabytes of additional memory available that provides a maximum storage capacity of 26 megabytes for the 6095 Model 1 and 32 megabytes for Model 2 to accommodate future demands.

#### 16 MILLION CONCURRENT COLORS

This feature expands the base 8-bit planes on the drawing processor to 24-bit planes to allow the capability of displaying up to 16.7 million available colors for maximum image quality.



Spring modeled with five NURBS surfaces.



Manipulation of control points defining a NURBS surface. NURBS provide the tool to model curves, surfaces and trimmed surfaces quickly and precisely.



## Technical Advantages of the 6090 System



Wafer of IBM's  
custom VLSI  
module.

IBM's custom technology, proprietary components and exclusive patents are incorporated throughout the design of the 6090 Graphics System.

Technical advantages of the 6090 system include:

### IBM's Patents

Numerous IBM patents directly related to the 6090 have been issued or are pending. These patents describe unique graphics functions and algorithms that are contained in the 6090 hardware. Some examples include pixel generation, area fill, pick processing, clipping, and processing of NURBS.

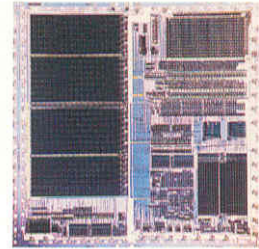
### Forty-three Proprietary ASIC Modules in the 6095

There are a total of forty-three IBM proprietary Application Specific Integrated Circuit (ASIC) modules in the 6095 with a shading processor. (An additional seven to thirteen modules, depending on the number of port features, are in the 6098 Channel Control

Unit.) They provide the compute power to help drive 3-D complex images in real-time. These 43 ASIC modules, comprised of 19 IBM unique designs, are incorporated within an innovative architecture that allows the 6095 to respond with dramatic performance. They implement advanced graphics capabilities in the hardware that include bus interfacing, vector formatting, pick processing, multiple pixel generation, area fill, shaded vector interpolation, hidden surface/line processing, frame buffer memory control and channel interfacing.

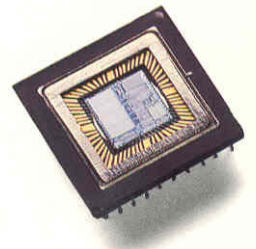
### Eighteen IBM Custom VLSI Modules in the 6095

In addition, an IBM custom VLSI module populates the Graphics Processor. Eighteen of these unique modules are contained in the 6095 with a shading processor. This custom designed CMOS chip contains over 280,000 transistors and has dedicated program and data storage facilities. Each module is capable of 10 million floating point operations



### Inside IBM's Custom VLSI Module

This custom designed CMOS chip contains over 280,000 transistors.



### ASIC Modules

Forty-three ASIC Modules are in the 6095 with a shading processor.





per second (MFLOPS) to handle the numerically intensive demands of sophisticated graphics applications. The floating point arithmetic unit contains adders, multipliers and multiple registers. An on-chip instruction store combined with input and output FIFO maximizes performance and simplifies interconnection. Because of its innovative architecture, these eighteen modules are connected in parallel and pipeline to boost performance to a potential of 180 MFLOPS of compute power for graphics functions that include 2-D/3-D graphics transformations, clipping, mapping and surface/spline generation, surface tessellation, light model calculations, pick window clipping, scaling, shading, and character/vector manipulation.

#### CMOS Technology

CMOS technology is extensively employed in the 6090 design. It allows the implementation of high performance graphics functions and algorithms directly in the hardware while providing compact space, low power consumption and minimum noise. Implementation of CMOS technology exists in the Primary System Bus Controller, IBM's custom VLSI modules and the Vector

Generator that is capable of generating up to one million transformed 3-D vectors per second.

#### ONE MEGABIT VIDEO RAMS

The frame buffer memory system utilizes one megabyte Video Ram Chips. In addition to providing compactness in the 6095, these chips are configured in parallel for multiple access to the frame buffer each cycle, allowing for high speed drawing operations.

#### FLOATING POINT GRAPHICS PROTOCOL (FPGP)

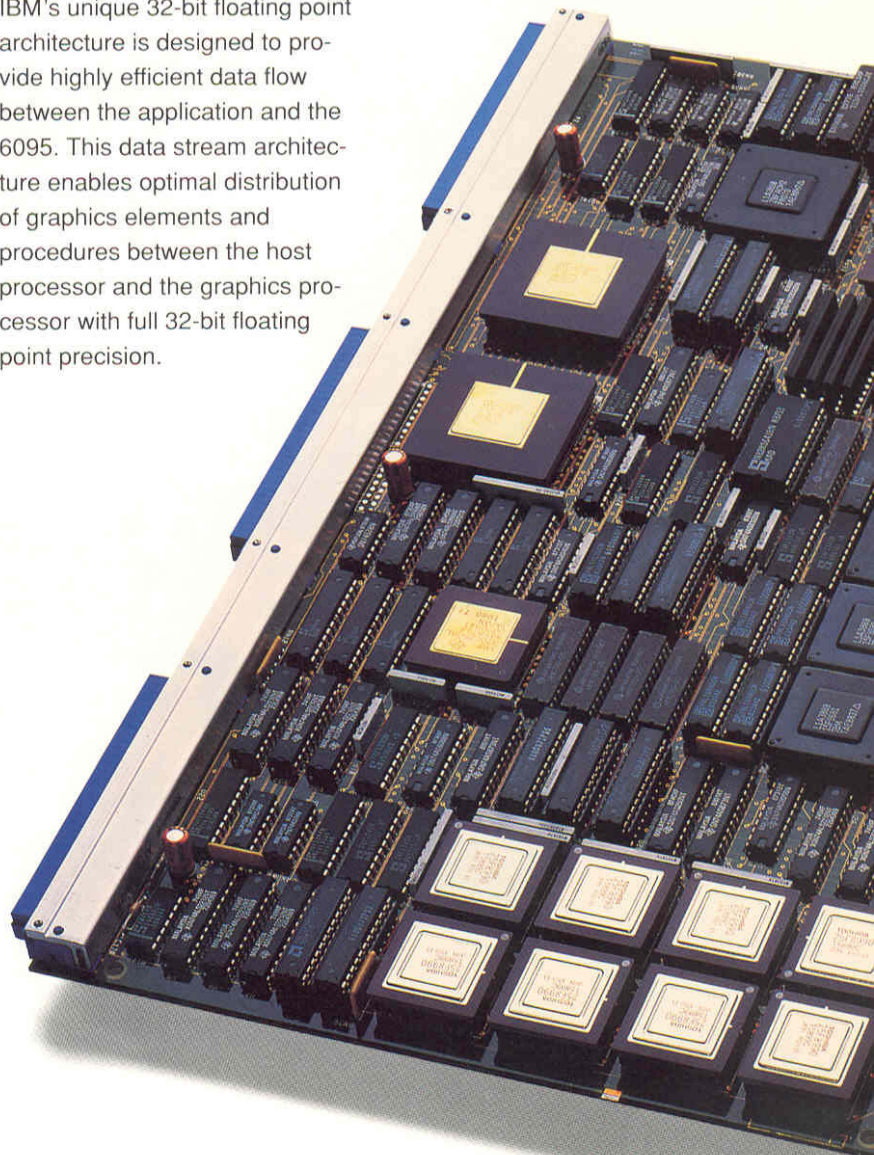
IBM's unique 32-bit floating point architecture is designed to provide highly efficient data flow between the application and the 6095. This data stream architecture enables optimal distribution of graphics elements and procedures between the host processor and the graphics processor with full 32-bit floating point precision.

#### Shading Processor

Includes a 24-bit Z-buffer and up to eight light sources with surface properties, supporting Gouraud shading, hidden line/surface removal and depth cueing.



Each custom module is capable of 10 MFLOPS.



## The graPHIGS™ API



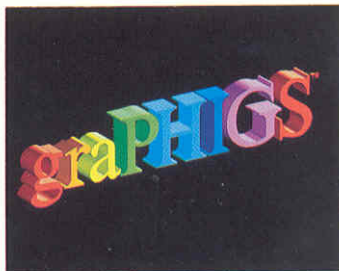
### System Assembly

Data Courtesy  
of Structural  
Dynamics  
Research Corp.  
(SDRC).

### Tapping into The Power

The graPHIGS API has been designed to provide an optimal coupling between applications and hardware capabilities. The graPHIGS API Version 2 is based on the American National Standard Institute (ANSI) and International Standards Organization (ISO) standard, Programmer's Hierarchical Interactive System (PHIGS), and the proposed standard extension, PHIGS+. It provides the 6095 user with a powerful tool kit of advanced graphics functions.

The API is divided into a graPHIGS API library, or shell, that interacts directly with the application, and a graPHIGS API nucleus that manages graphics data and end user devices. The 6095 floating point architecture supports the distribution of graphics function and data between the application/shell and the nucleus. This allows a nucleus in the 6095 to locally manage storage of graphical data and execution of operations on that data. This reduces demands on host storage and processor cycles.



Furthermore, the graPHIGS API is a family of compatible products providing support for applications on IBM 370 mainframes, IBM engineering workstations and the PS/2® within an AIX™ environment. This allows 6095 applications to be easily transported among these hardware platforms and operating systems thereby protecting the user's investment in application software.

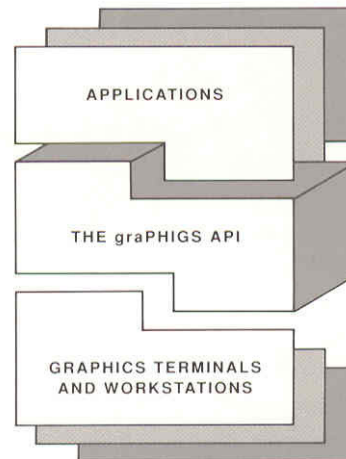
These advanced capabilities give you access to a wide range of graphics functions across a network, with increased speed and precision and decreased demands on host resources.



### Robotic Simulation

Robot is easily represented with graPHIGS hierarchical data structures.

## WHAT IS graPHIGS?



**3 DIMENSIONAL API FOR:**  
APPLICATION DEVELOPERS  
MULTIPLE PLATFORMS/DEVICES  
PROGRAMMING PRODUCTIVITY  
PROTECTS SOFTWARE INVESTMENT

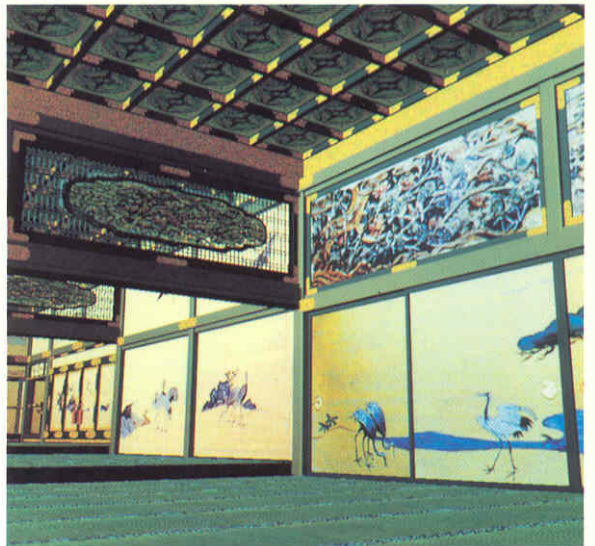
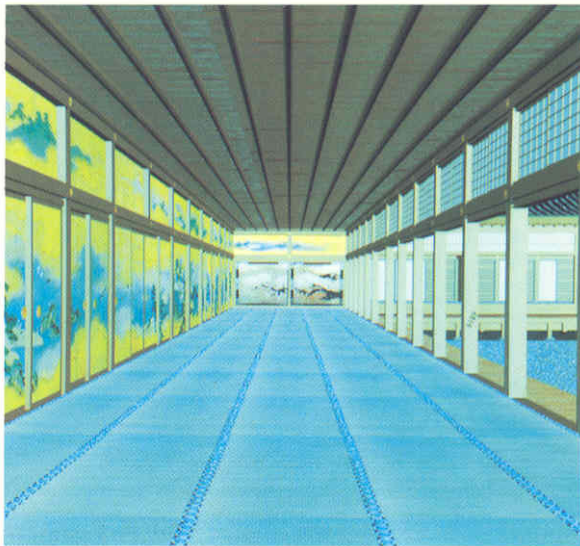
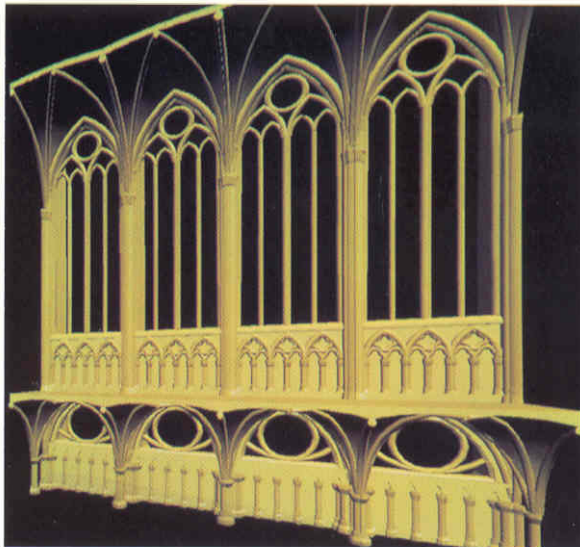
**INDUSTRY DIRECTION IS PHIGS/PHIGS+:**  
PROGRAMMER'S HIERARCHICAL INTERACTIVE GRAPHICS SYSTEM  
ANSI/ISO STANDARD

**IBM'S PRODUCTS:**  
GDDM/graPHIGS™  
PERSONAL graPHIGS™



## *The Complete Graphics Solution*

Images illustrating the use of the 6090 system for visualization and rendering applications. Data courtesy Dassault Systemes (above) and Tokyo Research Lab., IBM, Japan (below).



### **The 6090 Graphics System offers ...**

- Innovative system design with specialized subsystems
- Proprietary technology, unique patents and custom VLSI design
- 32-bit floating point graphics architecture
- Specialization of graphics functions in dedicated hardware
- Advanced parallel and pipeline processing
- Versatile display capabilities
- Communication/network advancements and flexibility
- Hardware implementation based on PHIGS and PHIGS+
- Unique link between the hardware and the graPHIGS API products
- Decreased demands on the host

**... for your complete graphics solution.**

## Physical Specifications

	6095 GRAPHICS PROCESSOR	6098 MODEL 1 CHANNEL CONTROL UNIT	6098 MODEL 1R CHANNEL REMOTE CONTROL UNIT
<b>Width:</b>	250 mm (9.8")	486 mm (19.2")	483 mm (19.0")
<b>Depth:</b>	610 mm (24.0")	626 mm (24.7")	419 mm (16.5")
<b>Height:</b>	590 mm (23.3")	220 mm (8.7")	84 mm (3.3")
<b>Weight:</b>	25.0 kg (55 lbs.)	30.4 kg (67 lbs.)	13.6 kg (30 lbs.)

## 6095 Graphics Processor Model Comparison

	SHADING PROCESSOR	BASE SYSTEM MEMORY	MAXIMUM SYSTEM MEMORY
<b>Model 1:</b>	Feature	2 Megabytes	26 Megabytes
<b>Model 2:</b>	Standard	8 Megabytes	32 Megabytes

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International Business Machines Corporation  
Dept. 30S  
Neighborhood Road  
Kingston, NY 12401

Printed in the United States of America  
10/89

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GA23-2116-00

