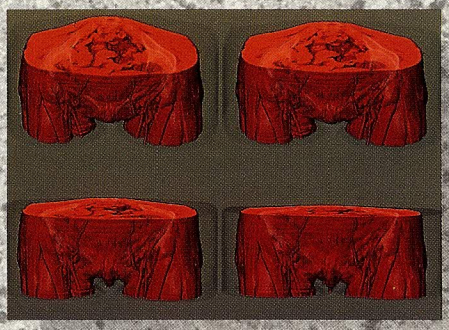
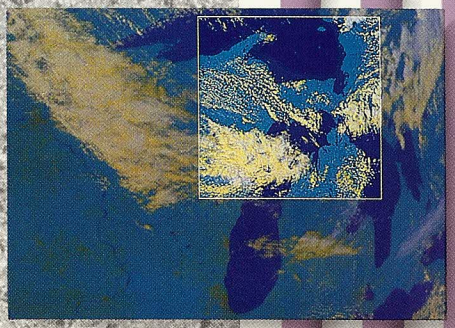
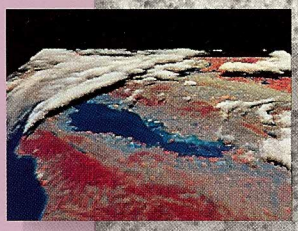
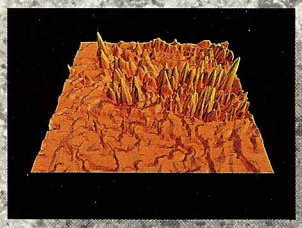
PIXAR IMAGE COMPUTER







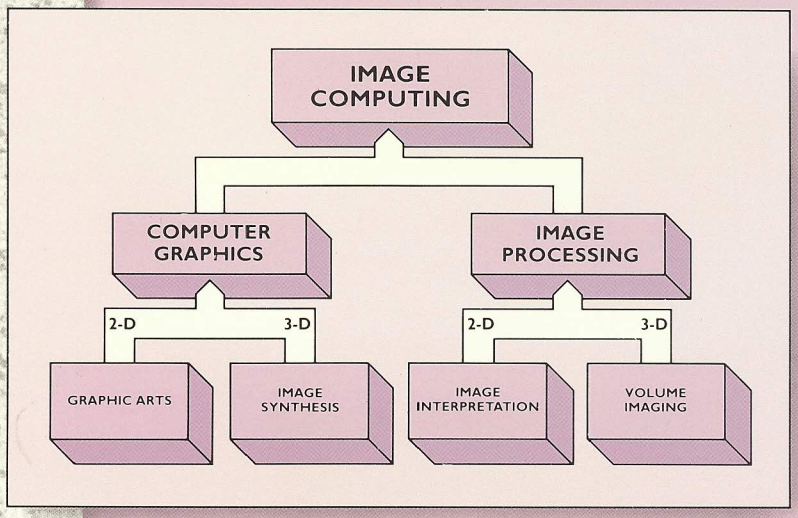


P · I · X · A · R

Recent advances in data-gathering technologies have generated large, complex datasets for many application areas. Interpretation of this information requires new visualization techniques that become practical only on high-performance hardware. The Pixar Image Computer™ provides both the processing power and the storage capacity to satisfy these demands. Pixar™ is establishing the foundation for these applications by pioneering the new field of image computing.

Image Computing is the fusion of two disciplines—computer graphics and image processing. By merging these capabilities, formerly available only in separate systems, the Pixar Image Computer makes many new applications possible. It offers the flexibility of general-purpose processing with supercomputer-class speed for image computing operations.

Image computing consists of a wide range of two- and three-dimensional data-visualization applications. The Pixar Image Computer supports traditional two-dimensional image processing



techniques such as convolution and filtering for interactive *image interpretation*. For remote sensing applications, the Pixar Image Computer goes beyond these 2-D capabilities with a powerful set of 3-D *image synthesis* techniques for mapping and terrain reconstruction. For product design and broadcast animation, these same 3-D capabilities streamline the artistic process providing high-quality renditions at high speed. In *graphic arts*, the system's high-resolution memory provides much-needed storage for pre-press, text, and image manipulation work. One of the most exciting new areas being explored in image computing is *volume imaging*. The Pixar Image Computer allows the visualization of volumetric data such as the tissue densities of the human body or the seismic densities of the earth. Image processing can be applied to enhance the data and then computer graphics can be used to generate views from any angle. This is only possible with a system that spans both disciplines.

HIGH-PERFORMANCE HARDWARE

The Pixar Image Computer is a raster-based, programmable device for generating and manipulating large digital images. It processes high-resolution picture data, displaying color or monochrome images. The key to the Pixar Image Computer's high performance is the Chap™ channel processor, which executes 40 million instructions per second (MIPS). Its four parallel processors are arranged in a single instruction, multiple data (SIMD) architecture, offering four times the performance of a conventional single processor device. When integrated with the large high-resolution memory, it far exceeds the limits imposed by traditional image processing devices.

LARGE PICTURE MEMORY. The standard Pixar Image Computer has a 24-megabyte picture memory. Its four 12-bit memory channels can store 16 million monochrome pixels, or 4 million full-color pixels in the Red, Green, Blue (RGB) and Alpha channels. The RGB channels typically are used to store color information for pictures, while the Alpha channel allows each pixel to carry extra information for matting, compositing, overlays and anti-aliasing. The memory can be expanded to 48 megabytes of picture memory, providing storage for 8 million full-color pixels. A large picture memory is essential to handle the increasing volumes of information in sophisticated visualization applications.

FAST. The Chap processor accesses memory data through the Processor bus (Pbus) at 240 megabytes/second. This extremely high bandwidth eliminates the I/O bottleneck inherent in most systems. Up to two additional Chaps can be added for a total of 120 MIPS of power. The video controller accesses the memory through the 480 megabyte/second Video bus (Vbus), generating the video signal which can be software-selected for compatibility with NTSC, PAL, and 1024 x 768 RGB display monitors. This fast

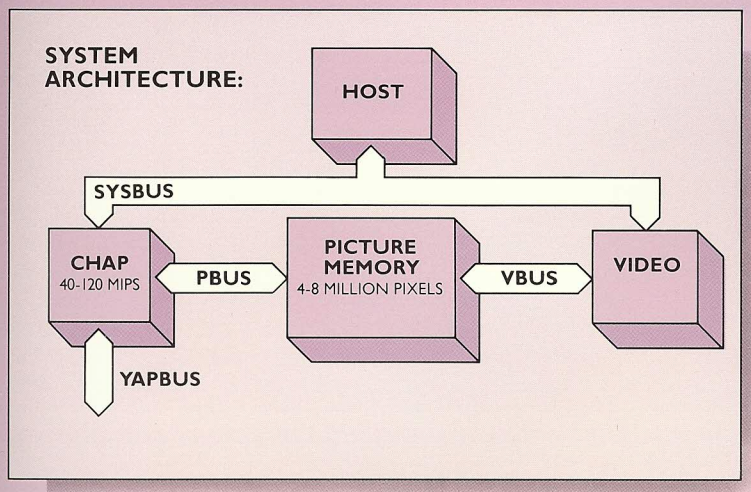


IMAGE PROCESSING: Top: "Raw" Landsat imagery of Death Valley, California at 2048 x 2048 resolution. Bottom: A section of the image after computing a linear "stretch" of the image's dynamic range. Images courtesy of Terra-Mar.

access to the picture memory is essential for manipulating large images quickly.

FLEXIBLE. Basic control of a Pixar Image Computer is accomplished from a host computer using the system bus (Sysbus). Pixar currently supports Multibus™, VME™ bus and Q-bus™ interfaces, permitting the flexibility to work with such machines as Sun™, Symbolics™, Digital™, and Silicon Graphics™ computers. The Yapbus™ provides high-speed data networking to external devices or other Pixar computers with a transmission rate of 80 megabytes/second.

PROGRAMMABLE. The Chap is fully programmable using a high-level language, with low-level control over the unique Pixar architecture to gain maximum speed and flexibility. The host computer provides the program development environment, network access, and general resources required by applications programs. Programmability ensures that the Pixar Image Computer can be tailored to meet a wide range of applications.

EXTENSIVE SOFTWARE

There is extensive software available for the Pixar Image Computer for execution on both the Chap processor and the host computer. This software utilizes the full capabilities of the hardware, performing a wide range of operations quickly and efficiently. It offers powerful development tools that allow additional software to be developed easily.

COMPLETE RUNTIME ENVIRONMENT. The ChapLibraries™ software package provides host-resident and Chap-resident libraries which form the basis for user-developed software. These libraries feature arithmetic functions, image manipulation functions, line drawing and text display operations, image processing functions, and more. This environment is supplemented with user programs for doing common image computing operations.

COMPREHENSIVE DEVELOPMENT TOOLS. For software developers and integrators, the ChapTools™ software package provides development tools including the Chap C compiler, an assembler, and a dynamic loader for efficient utilization of the Chap's instruction memory. Pixar further supports developers through extensive technical documentation and courses in programming the Pixar Image Computer.

REALISTIC RENDERING. Applications involving realistic views of 3-D models can benefit from the ChapReyes™ rendering package. ChapReyes accepts polygonal or patch-based input in a variety of file formats. It quickly produces fully anti-aliased images with multiple light sources, texture maps, reflection maps, and transparency at variable resolutions.

AND MORE. Many other software packages are under development at Pixar and at leading software companies to provide volume imaging capabilities, advanced image processing, sophisticated design and animation workstations, and more.

The Pixar Image Computer is the foundation for a new generation of digital visualization systems. We apply the same high standards to manufacturing as we have applied to research and development over the past years. From site installation to training classes and technical support, we are committed to working with our customers as partners in the development of their own products and applications.

Pixar—the company and its products—leads the way to new applications for the visualization of information.

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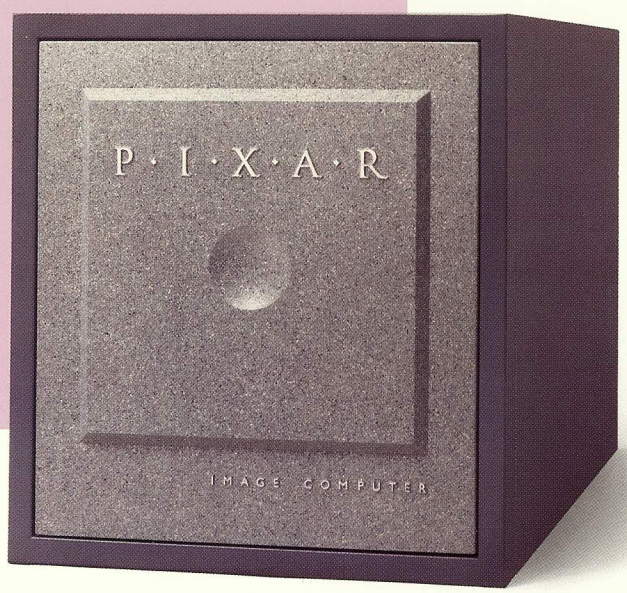

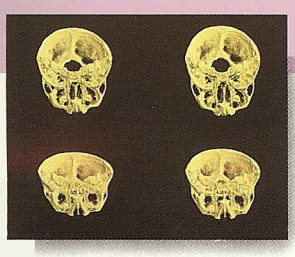

VOLUME IMAGING: A temporal bone reconstruction from 30 slices of CT data. Created by Pixar. Data courtesy of Philips Medical Systems, Inc.

SPECIFICATIONS

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CHAP CHANNEL PROCESSOR

Number of parallel processors per Chap:	4
Number of Chaps per system:	1-3
Data word width per processor:	16 bits
Clock cycle time:	<100 ns
Instruction duration:	1-4 clock cycles, pipelined
Control store memory:	16K words (96-bit words)
Scratchpad memory:	16K x 16-bit words x 4 (64K words total)
Memory bus bandwidth:	240 Mbytes/second
Yapbus bandwidth:	80 Mbytes/second

PICTURE MEMORY

Standard Memory:	4 million pixels/24 megabytes (48 bits per pixel)
Expanded Memory:	8 million pixels/48 megabytes (48 bits per pixel)
Organization:	linear address space with tesselation for access in X or Y or block; dual ported
Memory bandwidth:	480 Mbytes/second

DISPLAY SYSTEM

High resolution standard:	1024 x 768 interlaced
High quality broadcast standards:	NTSC (525 line RGB output); external sync PAL (625 line RGB output); external sync
Color lookup tables:	3 (10 bits in, 10 bits out)
Number of bits per DAC:	10
Video bandwidth:	480 Mbytes/second

PHYSICAL CHARACTERISTICS

Size:	21″ x 19″ x 30″, rack mounted
Weight:	100-150 lbs. (45-68 Kg.)
Operating range:	0-40 C.
Humidity:	5 to 95% non-condensing
Power:	190-260 Volts @ 20 Amps, single phase, 47-63 Hz.
Safety:	UL listed
RFI:	FCC Class A

HOST INTERFACES:

Multibus, VME bus, Q-bus

SOFTWARE LIBRARIES:

Utility Programs	Display, image input/output, image processing
Host Libraries	Resource management, picture file management, window manipulation, low-level Chap access
ChapLibraries	Image processing, geometric transformations, arithmetic operations, pixel arithmetic operations, pixel manipulation

COVER IMAGES (left to right, top to bottom):
VOLUME IMAGING: Reconstruction of a human pelvis from 48 CT scans. Created by Pixar. Data courtesy of Philips Medical Systems, Inc.
IMAGE SHARPENING: A 3 x 3 convolution filter is used to enhance a section of a satellite image. Data courtesy of NOAA.
GRAPHIC ARTS: This photographic image was digitized at 2000 x 4000 resolution.
SATELLITE IMAGE ANALYSIS: This image contains fractalized cloud data from GOES (infrared) satellite imagery suspended above a Landsat image of Silicon Valley. Both clouds and landscape were rendered with texture mapping using ChapReyes. Image courtesy of The Analytic Sciences Corporation (TASC).
SCIENTIFIC ANALYSIS: This image of a section of Oklahoma shows the effect of terrain on local gravity anomalies. The image required the computation of a million double integrals. Image courtesy of TASC.

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