Draft Exhibit
Text 9/5/84

Picture Window

Few locations offer such a dramatic vista of downtown Boston as Museum Wharf, several hundred yards across Fort Point Channel from the heart of the city. This urban panorama is a focal point for the Computer Image gallery. Even the technical wizardry brought together here can hardly upstage the magnificent image you see through our picture window.

Still, a number of individuals have felt challenged to see what they can make of this scene using their electronic arts. They have produced four intrepretations, each capturing, processing, abstracting and displaying the scene's visual data in distinctly different ways. Each of these stylized presentations has a different approach to describing the forms beyond the window, their structure, their lighting and their projections into our awareness.

From right to left our Picture Window wall harbors four illusions:

1. To show what it takes for a computer to capture a scene, and how it deals with an image's qualities according to its quantities, a Masscomp xxx system continuously processes the view as recorded by the video camera mounted in the window. You can switch filters and combine different versions of the image to get a sense of some of the ways in which digital images behave.

2. The next display to the right animates the image, taking it one step closer to fantasy, through the video artistry of Dean Winkler and ________. They shot the panorama on videotape from atop the museum, and from their studio has emerged a visualization blending video and digital techniques.

3. A portfolio of polygons pours forth from the pen plotter to the left of the window, all filled with patterns symbolizing aspects of the visual logic of the Curator Geoffrey Dutton created the demonstration, based on a photograph by Karin Rosenthal. Performance by Hewlett-Packard's plotter and HP150 professional computer.

4. To prove that we know that the real world outside the gallery has more than two dimensions, a weightless tour tour through some of our neighborhood's coordinates has been put together by Bruce Forbes of Jung Brannen architectural firm. The 3-D database was constructed and rendered by a Computervision architectural CAD system, and videotaped off its display.

Instructions for Restarting the IBM Plasma Demo

Geoffrey Dutton
The Computer Museum
20 November 1984

The orange plasma display in the Computer Graphics Technology section of the Image gallery is entirely self-contained and self-booting. However, it will not come up on its own should power be interrupted. The way to get it going again is simple but somewhat arduous. By the numbers:

1. Get the IBM keyboard from the back room;
2. Unlock the glass case if it is locked (key in back room);
3. Pick up the plasma panel (very heavy) and put it next to the PC/XT unit. Don't crush the cables.
4. Pick up the PC/XT very gently and put it on the floor; there should be enough cable to reach. If not, extract some from the hole it comes through.
5. Place the plasma panel on the computer;
6. Plug in the keyboard to the back of the PC if you haven't done so already.
7. Using the cable hole as a handle, lift up the formica panel on the bottom of the case. This may take a bit of wrestling -- it fits tight. You should be able to free the front so that you can lift it about 10 inches in front.
8. Inside the base of the case is a 4-outlet junction box with a light switch attached. Turn the switch off, then on. The floppy disk light will shortly flash, then the hard disk light. Within a minute the screen should come to life.
9. If this does not work, repeat step 8 once again.
10. Once the display begins, replace the formica panel in its slot and lift computer nd display (together if you can) back where it was. It should angle out toward the corridor.
11. Slide the glass panel closed and lock it, returning the key.

Should this fail, someone may have to attach a conventional monochrome monitor to the PC/XT to see what is going on. It has been quite reliable so far; keep your fingers crossed.

Auld Lang Syping
or something

Outline Proposal for a Gallery

THE COMPUTER IMAGE

At The Computer Museum
Boston

Oliver Strimpel
29.6.83

Notes

1. The story line is not gallery text but the gist of the message.

2. The material column is not complete but aims to give some idea of how one might get ideas over, where the 3D objects are likely to be and how many 'specials' in software or hardware might be needed.

3. The 'Images' section might well be integrated into appropriate places within the remaining sections. The entire proposal should be regarded as fluid, or as an invitation for criticism. Perhaps the art section does not fit in. Perhaps the historical part should also be integrated into the rest or become larger.

4. Design points: Interactive items should have space for people to watch each other

   An art section might need setting apart

   Windows are useful sources of raw images

5. Working exhibits require large resources to develop and maintain compared to static ones. They tend to be very popular. How many such items can be developed depends on the museum's resources as well as, of course, how many are deemed desirable. The number of 3D objects depends on how much collecting can be done as well as on what would be relevant.

6. In general exhibits should appeal on several levels- the expert should not feel that information is sparse, the superficially interested person should not be put off by dry text blocks. Most items listed here could be presented in this way. The appeal of the displays will be known to people who have been to computer graphics conferences and shows. But there should be a coherent point of view (slant?) throughout the gallery.

Section	Story Line	Material
beginnings	When computers reached a certain size and power, images could be made. Link up with 4 generations story and give feel for 1950's context.	films - TX-0 sketchpad objects : PDP 1 and spacewar pioneering efforts first vector tube? E & S prototypes?
images	An image is an illusion. Its 'realism' depends on spatial, contrast and colour resolution. (not talking about art here)	large dissected image user-controlled pixellation of Mona Lisa? vector version?
displaying an image	To display an image electrons and phosphors, light and film, and ink and paper are used.	exposed CRT and vector machines and plotters running interactive programs in which user makes each plot images via intermediate stage showing the process holograms?
storing an image	A picture is much more than a thousand words. But it <u>is</u> made of 'words'. Tape, video disk, RAM are convenient for computers to read. (the image is for the human eye)	model of section of video disk - put finger into pi model of tape FeO element model of part of RAM? each next to real thing get feel for storing property
inputing an image	Input of an image needs conversion to suit the machine and a convenient interface. Lines input by touch, pressure, pens. Machine vision will depend on television cameras	touch-sensitive screen tablet mouse digitiser TV camera all interactive, via program which reveals process whereby information gets in.

Section	Story Line	Material
images cont.		
movement	A sequence of similar images creates the cinematographic illusion. It takes time to generate images so they are strung together by time-lapse photography.	interactive control over frame rate simple animation
anipulating n image		
enhancing contrast colour deblurr HSI filter separation	Images, photographic or electronically produced can be altered to reveal structure not otherwise visible. Usually it is known what is'wrong'with the picture. It takes number-crunching to correct it.	interactive control of TV image of downtown Boston out the window: first alter contrast, colour, filter in abstract and then apply to image maybe best on video ta non-interactive before/after: Landsat astronomical multilayer paintings forensic manuscipts
creating effects	Once inside a computer, images can be transformed to suit our fantasy.	video tape or interactive manipulation of view out of window showing geometric distorsions, scene spinning ...

Section	Story Line	Material
synthesising an image from scratch		
the quest for photographic realism	To see things that never existed as if they were real the eye has to be supplied with cues: perspective, lighting, colour, near objects obscuring far objects. Why is it so difficult to approach the photograph? What is it for?	interactive synthesis of down-town Boston view out the window. showing different levels -polygons -texture -hidden line and surface -lighting -reflections and transmission maybe prepared video or random access series of frames if full interactive control not possible compare with real inverted image from a fast lens at window
	Entertainment and advertising appear to have replaced war as the driving engine for reallistic computer graphics.	'reallistic' examples eg Blinn Whitted cinema showing Loren Carpenter, Nelson Max and others excerpts from Tron? always some explanation of how and what was done advertising films video arcade game exposed and running in slowed mode?

Section	Story Line	Material
synthesising an image from scratch cont.		
		films and stills:
fleshing out ideas	How do materials or artifacts behave in circumstances so extreme that they cannot be reproduced?What does a topologically interesting surface look like? How do genes get expressed?	science: space simuln. molecular biology topology particle physics galaxy models
		technology: materials deformation weapons
	What will a house look like and where should it go?	arhitectural simulation
	Which design looks right, fits best?	CAD: one interactive example (Ontario?)
	What are the consequences of a business decision?	motor industry computer architecture rug design chip layout Chips&Changes material
	Computer-synthesised images can lead our imaginations into new domains.	examoles of CAD products graphical visicalc representation of data
	Real time simulation allows us to develop skills by practice. There is a continuum between 'serious learning' (flight simulator) and 'fun' (video game).	maximise feel for playing with possibilities while revealing just what computer is doing flight simulator film video game film

Section	Story Line	Material
images from scratch cont.		
art	"de gustibus non disputandum est" -at least probably not here.	Cohen, Resch and others (international) quotes by artists technical notes a more 'artistic' approach here
		END

Computer Graphics Technology

Most general-purpose computers can store and manipulate graphic and image data. Yet, even the most powerful computer cannot visually communicate information unless equipped with appropriate input and display devices. Special input devices are needed to enter postional information into a computer; special output devices, capable of rendering points, lines, color and shading are needed to draw images. The objects displayed here are a sampling of the many unique input and output devices invented over the past twenty-five years. As diverse as these devices may appear, they perform a limited number of functions and use a limited number of strategies to accomplish them.

This chart summarizes computer graphics technology according to the functions the devices serve and the strategies used to create graphic images. Its major categories are:

FUNCTIONS:	Tasks to be performed
Input	Entry of graphic data, gestures and commands
Display	Screen output of drawings and images
Hardcopy	Tangible output you can walk away with

STRATEGIES: Ways of organizing information

Raster	Scanning (input) or painting (output), such as video or photographic images
Vector	Tracing (input) or plotting (output), such as mechanical drawings or contour maps
Refresh	Continuous regeneration of a screen image; the computer must remember the picture
Storage	Once-only creation of a screen image; the screen itself remembers the picture

These distinctions are fundamental, at least for current technology; however, new devices which combine more than one strategy and function appear almost daily. To understand what they can do and how they do it, it helps one to be familiar with the language, concepts and principles underlying computer graphics technology.

List of Display Devices

NAME	TYPE	DIMENSIONS	STATUS
SAGE Tube	Crt	20"d x 40"l	At CM
SAGE Light gun	input	5"l x 4"h x 2"w	At CM
Sectioned Tek	CRT	20"l X 5"h x 4"w	At CM: Gift of Textronix, Inc
Tek 564	Scope	24"l x 14"w x 18"h	At CM: Gift of Textronix, Inc
Calcomp 565	Plotter	18"w x 10"h x 18"d	Promised
Plasma panel	display	16 x 16 x 2 ???	IBM?
LCD panel	Display	16 x 16 x 2 ???	???
Shadow mask tube	CRT	15 x 13 x 18 ???	NEC???
MCS 3d dig.	Input	14"w x 16"l x 10"h	At CM: Gift of Micro Control Systems, Inc on 9/7/84
Summa bitpad	Input	12"w x 12"l X 2"h	probable
Numonics dig.	Input	?	probable
Rand Stylus	Input	6"w x 4"h x 2"l	At CM
Mouse ?	Input	2 x 3 x 4 ???	?
Tek Joystick	Input	3 x 4 x 3 ???	requested
Light pen	Input	6"l x .5"d ?	requested
Crystal Ball TX-0	Input	6"d x 8"h	At CM
Transparent tablet	Input	14 x 14 x 14???	To be donated by

			Scriptel Corp. in October
Intell. dig cursor	Input	4 x 5 x 2 ???	Altek may send
Etch-a-sketch	Working	8"w x 10"l x 2"h	Bought for $9.28 on 9/12/84

In addition there will be an unknown number of photographs and line drawings of devices too big or too hard to get. If any of the above items fail to materialize, a photo of one can be installed in place of the artifact itself. In general, input and output devices are in separate sections (except for the SAGE light gun, next to the SAGE CRT.

SAGE Graphics

Upon entering The Computer Museum, you walked by a large vacuum tube computer; built for the U.S. Air Force between 1958 and 1962, the Semi-Automatic Ground Environment (SAGE) computer was designed for air defense command and control, and represents a milestone in the use of interactive computer graphics. Each SAGE site kept watch over a part of North American airspace. From their consoles the SAGE operators could identify and follow all aircraft within their region, with no need for typing commands. Indeed, their consoles had no keyboards; all interaction was through pointing at information on the screens and setting switches. The interactivity, resolution and reliability of the SAGE system remained unmatched by all but a few commercial graphics systems until well into the 1970's.

SAGE Cathode Ray Tube, Hughes Charactron (1958?)

Each SAGE site had several dozen operator's consoles displaying data on 20-inch cathode ray tubes (CRTs) like the one displayed here. Operators viewed line drawings of coastlines and radar blips of planes which was continually updated on their console screens. Information about aircraft and their flight paths could be called up by pointing to a blip with a light gun and setting switches to indicate the type of information desired, such as aircraft identifiers, compass headings, velocities and destinations.

SAGE Light Gun, IBM (1958?)

This input device was used by console operators to interact with the SAGE system -- one of the earliest uses of the light pen. Its active portion is a tube containing a photosensitive element mounted behind a lens. Pointing the gun at a spot of light on the screen and pressing its trigger caused the device to generate a pulse; the program monitoring the light gun would then look up the current position of the beam on the screen. By matching this location to one in the list of coordinates currently being displayed, the computer could identify the object selected by the operator.

Storage Tube Oscilloscope, Tektronix model 564 (19??)

An oscilloscope is an electronic instrument which graphically displays the oscillations of electrical signals fed into it. Up until the advent of the direct view storage tube (DVST), users of oscilloscopes had difficulty in observing rapidly changing waveforms. The DVST allowed technicians to freeze a waveform on the screen, enabling a more accurate presentation of its details. DVST technology was adapted to computer-controlled displays starting around 1969, and remained the predominent and most economical interactive display technology throughout the 1970's. While the size, speed, accuracy and brightness of DVST displays have been improved over the years, they continue to use the basic technology developed for the Model 564.

Here the Model 564 is displaying audio signals being generated by the microphone in front of you. Change the pitch and volume of your voice as you speak into the microphone to shape the waveforms on the screen.

Sectioned Direct View Storage Tube, Tektronix, 19??

This Direct view storage tube (DVST) is derived from the one developed for the Tektronix Model 564 Oscilloscope, and used in subsequent generations of vector display terminals, such as the ARDS terminal and the Tektronix 4000 series of terminals. Like a mechanical pen plotter, DVST's draw points or line segments with arbitrary positions, orientations and sizes, leaving a trace of light on the face of the tube wherever the beam has drawn. The screen itself remembers the traces, without requiring the computer to redraw them. To erase an image, the screen is flooded with electrons; this causes a brief but bright flash of green light, followed by a pause of a second or so as the screen stabilizes. Although a DVST can draw fast enough to create the illusion of movement, the "green flash" effect when erasing the screen makes the display unsuitable for screen animations.

Plasma Display Panel, IBM, 19xx

Plasma displays are light-emitting raster display screens, as are video cathode ray tubes. Unlike CRTs, hoever, they are true flat panel displays. Lightweight, thin and rugged, plasma panels are suitable for use in vehicles and portable computers. They contain a transparent plate etched with a fine grid of holes, sandwiched between a pair of transparent layers. The holes in the grid are filled with low pressure gas, which emits points of light when activated by electrical impulses directed at them through a grid of fine wires. Once lit, a cell remains glowing until it is deliberately extinguished. Each cell in a plasma display, therefore, can "remember" its (on or off) state, like the screen of a DVST. Unlike storage tubes, however, plasma panels can be selectively erased, pixel by pixel. Plasma screens are still fairly costly, and cannot render fine detail as well as CRTs, but their costs are coming down, size is going up and multicolor displays may soon be available.

Already done see previous sheet

Input Device Text: by GHD 9/18/84 OS: ^ KS: 9/19 GD:

Input of Graphic Data

stronger sentence needed

Computer graphics is (are?) almost always used to represent data of one sort or another. Sometimes graphic data can be generated by evaluation of mathematical formulas (some simulation systems do this); usually, however, images or measurements must be made to record the shapes of 2-D and 3-D objects. ~~The act of entering~~ Graphic data as entered into a computer as a set of ~~numerical spatial~~ coordinates describing the position of points to be drawn. This process is called digitizing. Like data display, graphic digitizing can be performed either in vector or raster mode. To illustrate the great variety of graphic input devices that have been developed, a modest sampling of digitizers has been assembled here. All of them are used to enter vector data. To see raster-mode digitizing in action, visit the "Anatomy Of an Image" exhibit near the entrance to the gallery.

Already done OS

Rand Tablet Stylus, Rand Corporation, 1962

One of the earliest freehand input devices, the Rand Tablet was developed at the Rand Corporation in 1962. The 10-inch square unit was capable of discerning locations at an accuracy of 100 points per inch (see photo). Electrical pulses are continuously cycled through the ~~tablet's~~ printed circuit grid under the drawing surface of the tablet. The stylus acquires an electrostatic charge as the pulses pass by its tip; s~~S~~ensing this charge enables the computer to determine the nearest intersection of the 1000 horizontal and 1000 vertical grid lines. The pen's stylus also can activate a microswitch, allowing its user to select locations to digitize merely by positioning the pen and pressing down to click the stylus, much like a retractable ball point pen.

but what does it do?

does this mean the user can also draw points?

Donation of the Rand Corporation, 1984.

Already done

BitPad One, Summagraphics Corporation, c. 1975

The digitizing tablet became a common component in interactive computer graphic systems during the 1970's, as firms like Altek, GTCO, Summagraphics and Talos brought down the cost~~s~~ of manufacturing accurate and reliable digitizing tablets. The Bit Pad One by Summagraphics is representative of the range of page- sized tablets used in many graphic workstations and as accessories to microcomputer systems. It has a ~~nominal~~ resolution of 0.001 (?) inch across its 11-inch working surface, and can transmit coordinates either continuously or upon demand, when its user presses down on the stylus.

Resolution should be consistently described. I Recommend that it be represented as points per line (row) and column.

What does this mean in terms of how the device is used?

Donation by Summa Corporation, 1984.

Will this have the [illegible] in its [illegible]?

Space Tablet, Micro Control Systems, c. 1980

As Computer-~~a~~Aided Design (CAD) grew to dominate the computer graphics industry, the need to enter shape data for three-dimensional objects grew more urgent. Digitizing even a small 3-D object, such as mechanical part, is difficult to draw if the input device can record ~~in~~ only two dimensions at a time. A number of different 3-D digitizing devices have been developed; some employ ultrasonic sound reflections using sonar principles; others project a grid onto a solid object, and process a stereo pair of video images to compute 3-D displacements of the projected grid. This instrument uses a simpler approach: A ~~high-precision~~ potentiometer occupies each of the four joints of the digitizing arm. Rotating any one of them changes its resistance in proportion~~ally~~ to the angle of rotation. Given this data for each of the joints, plus the lengths of all the arms, the device can compute the 3-D position of the tip of its stylus.

The angles

vocabulary is too technical. The same principles should be communicated with simpler words/sentences.

Donation of Micro Control Systems, Inc., 1984

This device enables the shape of three dimensional objects to be measured and fed directly into a computer. ~~It~~

Simplify! It does this by ... etc and so on

Will this have the [illegible] in its jaws?

Space Tablet, Micro Control Systems, c. 1980

As Computer~~-a~~Aided Design (CAD) grew to dominate the computer graphics industry, the need to enter shape data for three-dimensional objects grew more urgent. Digitizing even a small 3-D object, such as mechanical part, is difficult NO to draw if the input device can record ~~in~~ only two dimensions at a time. A number of different 3-D digitizing devices have been developed; some employ ultrasonic sound reflections using sonar principles; others project a grid onto a solid object, and process a stereo pair of video images to compute 3-D displacements of the projected grid. This instrument uses a simpler approach: A~~high-precision~~n potentiometer occupies each of the four joints of the digitizing arm. Rotating any one of them changes its resistance in proportion~~ally~~ to the angle of rotation. Given this data for each of the joints, plus the lengths of all the arms, the device can compute the 3-D position of the tip of its stylus.

The angles

Vocabulary is too technical. The same principles should be communicated with simpler words/sentences.

Donation of Micro Control Systems, Inc., 1984

This device enables the shape of three dimensional objects to be measured and fed directly into a computer. ~~It~~

Simplify! It does this by ... etc and so on

2EL53-9001

Check this. Was it used on the TX-0 or on the TX-2 only?

Crystal Ball MIT TX-0 Computer, 1963-65

This is an early prototype of what has come to be called a joystick control. It has three axes of rotation and can generate 64 possible output states (four encodings for each axis). The rotation of cams causes groups of four microswitches to click on and off at certain points as the shafts are moved. By sensing the on-off states of the 12 switches, the TX-0 computer could approximate the globe's three-dimensional orientation. The Crystal Ball was used to indicate rates of rotation or translation of simulated 3-dimensional objects, rather than as a source of data describing their shapes.

This is meaningless to me without a diagram of the cams & camshafts

This should be re-phrased & stated up front

Can you condense this part and put more illustrations [illegible] * on separate page.

~~Donation of~~ Donated by Massachusetts Institute of Technology, 1984

The Crystal Ball was ~~used with the~~ one of ~~among~~ the first devices

~~A~~ For

Until [illegible]

The Crystal Ball, 'Kludge' terminal and TX-0/2 was the first ~~[illegible]~~ computer system that could take direct geometric input. (As opposed to keyboards ~~[illegible]~~ or SAGE light pen used only for selecting coordinates of displayed objects, ~~not for capturing form & shape~~

COMPUTER GRAPHIC HARDWARE

STRATEGIES	Things to ... **FUNCTIONS** ... be done			
Ways of Organizing Information	**Input**	**Display**		**Hardcopy**
		Refresh	**Storage**	
Vector	tablet mouse light pen joystick	stroke crt penetration crt segmented lcd	DVST crt COM plotter	pen plotter film plotter turtle n.c. machine
Raster	vidicon camera ccd camera facsimile laser scanner	video monitor shadow mask matrix lcd	plasma panel	Ink Jet Dot Matrix Screen Camera Electrostatic Phototypesetter

COMPUTER GRAPHIC HARDWARE

STRATEGIES	Things to ... **FUNCTIONS** ... be done			
Ways of Organizing Information	**Input**	**Display**		**Hardcopy**
		Refresh	**Storage**	
Vector	tablet mouse light pen joystick	stroke crt penetration crt segmented lcd	DVST crt COM plotter	pen plotter film plotter turtle n.c. machine
Raster	vidicon camera ccd camera facsimile laser scanner	video monitor shadow mask matrix lcd	plasma panel	Ink Jet Dot Matrix Screen Camera Electrostatic Phototypesetter

COMPUTER GRAPHICS HARDWARE

STRATEGIES	FUNCTIONS			
	Input	Display		Hardcopy
		Refresh	Storage	
Vector				
Raster				

COMPUTER GRAPHICS HARDWARE

STRATEGIES	FUNCTIONS			
Ways of Organizing Information	Input	Display		Hardcopy
		Refresh	Storage	
Vector	tablet mouse light pen joystick	stroke crt penetration crt segmented lcd	DVST crt COM plotter	pen plotter film plotter turtle n.c. machine
Raster	vidicon camera ccd camera facsimile laser scanner	video monitor shadow mask matrix lcd	plasma panel	Ink Jet Dot Matrix Screen Camera Electrostatic Phototypesetter

COMPUTER GRAPHIC HARDWARE

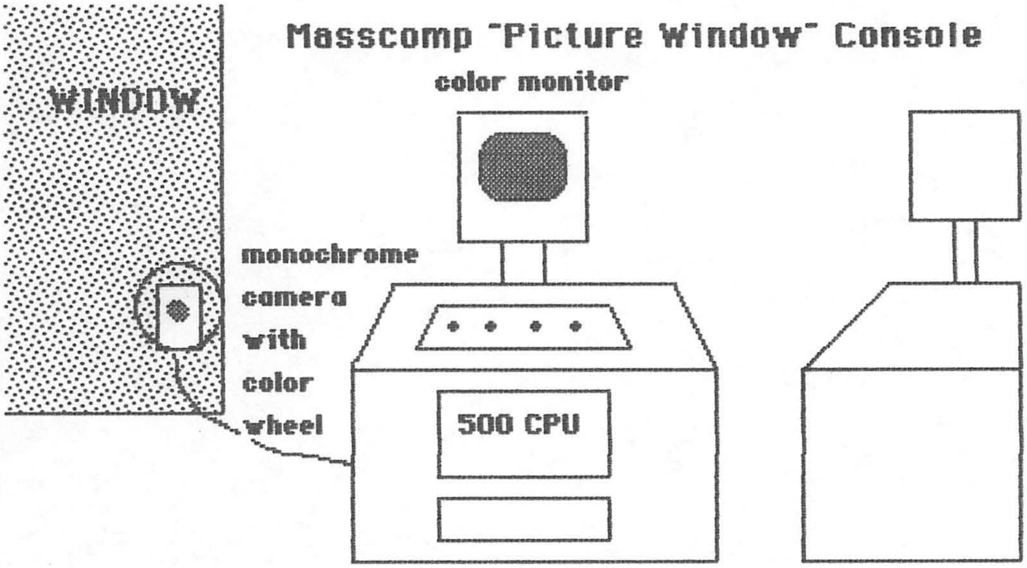
STRATEGIES	Things to ... **FUNCTIONS** ... be done			
Ways of Organizing Information	**Input**	**Display**		**Hardcopy**
		Refresh	**Storage**	
Vector	tablet mouse light pen joystick	stroke crt penetration crt segmented lcd	DVST crt COM plotter	pen plotter film plotter turtle n.c. machine
Raster	vidicon camera ccd camera facsimile laser scanner	video monitor shadow mask matrix lcd	plasma panel	ink Jet Dot Matrix Screen Camera Electrostatic Phototypesetter

Call Sadowski; Rehak; Levine, Papert

Rob Cornet – Chorus Data Systems ← Will Frenz

MODE	~~Ref~~Input	Refresh	Storage	Copy
Vector	Tablet/table mouce Joystick Light penwand Laser Follower Trackball	Beam pen. Stroke LCD segmented	DVST	Plotter NC Turtle com
RASTER	VIDICON Light pen CCD MSS Laser Scanner Facsimile	Shadow mask LCD Array	Plasma	Ink Jet Electro Laser Matrix Comp Camera

	Input	Processing	Display
~~Input~~ Vector	Following	Splining Filtering Connecting Scaling measuring	Drawing Filling Lettering
Raster	Scanning Sampling	Smoothing Thinning Edging Interpolations ~~Anti aliasing~~ ~~Shading~~ Classifying	Shading Anti-aliasing Coloring Shading



Geoffrey Dutton/ The Computer Museum/ 9-5-84

Tempest about a Teapot

In 1974, needing real-world data with which to test computer methods for automatic recognition of three-dimensional objects, Allan Newell chose an everyday object, a teapot from his kitchen. After sketching several views of the vessel, Newell selected several dozen points, measured their locations on the drawings, and entered their coordinates to approximate the teapot's shape.

Other computer graphic researchers soon began to borrow this set of data, usually to test their own surface-rendering procedures. During the late 1970's it seemed that no one could publish a paper on 3-D shaded computer graphics without illustrating it with an obligatory teapot, made shiny, dull, metallic, textured or spotted with reflections.

To your left, a cabinet houses Newell's original ceramic teapot itself, illuminated by three sets of colored lights in a miniature stage set. Each light source's color is controlled by a corresponding dial on the control panel in front of you. On your right is a color monitor upon which an Adage 3000 display controller renders Newell's original data describing the teapot as a smoothly shaded image, with simulated colored illumination.

You are invited to experiment with lighting both the teapot and its computer simulation: Select one of seven colors for any of the three light sources by rotating its dial on the control panel to the hue you want to use. Then press the button marked "RENDER" to cause the computer to simulate the lighting condition you have just created, redrawing the image with appropriate coloration and highlighting.

The demonstration illustrates some of the potential of computer graphics as a tool for simulating the lighting of theater and motion picture sets, which normally entails very labor-intensive and time-consuming experimentation. Even with this simple set of three light sources, each capable of displaying a single intensity of seven colors (or turned off entirely), there are 512 different lighting effects possible.

(other effects possible: rotation; texture mapping; transparency; bump mapping; variations in specularity; backdrops)

Credits:

Teapot; donation of Allan Newell, 1984.
Teapot Data; donation of James Blinn, JPL, 1984.
Display Hardware; Adage 3010 display controller and color monitor donated by Adage, Inc., Billerica, Mass.
Software; FSS and Solid 3000 software packages donated by Adage, Inc.
Software implementation; Allan Sadoski, Maynard, Mass.

"A Window full of Polygons"

A number of panoramic views of downtown Boston greet visitors as they go through The Computer Museum. The one seen from The Computer and the Image Gallery is in fact a starting point for several videos and demonstrations there. One of them, known as "A Windowful of Polygons", features a large pen plotter which continuously draws the view from the gallery as a suite of variations in four colors. As visitors look on, the plotter picks up a fiber-tipped pen from a rotating carousel, using it to outline and shade one or more features in the scene before exchanging it for one of a different color. In twenty minutes the drawing is complete, annotated with the museum's logo, a title, sequence number and creation date.

Visitors often ask if there is a TV camera attached to the plotter to capture the vista. A nearby demonstration does in fact do this, displaying a live view of the city on a monitor for visitors to "color in" like a coloring book. "A Windowful of Polygons", however, has no eyes and is not interactive. Its drawings are based on data derived from a photograph taken from the gallery in July, 1984, a print of which is displayed next to the plotter. The photo was hand-traced onto vellum over a light table, to outline the major features in it, simplifying most of them in the process. This tracing itself was then traced, but this time on an electronic digitizing table, using a stylus that yielded not lines on paper but their coordinates as the contents of a computer data file.

The digitizing process recorded the coordinate location of each point where a traced line started, stopped or changed direction. The lines had been traced so that all of them formed closed figures, most of them irregular in shape, called polygons by computer graphics programmers. Being closed figures, polygons can be "filled" in with lines, patterns or colors, which can be selected randomly or deliberately to represent properties of the polygons. The demonstration proceeds to do the latter, referring to a file of numeric attributes associated with the polygons.

Each of the 185 polygons stored in the database represents a face of a building, part of a street or walkway, body of water, or a miscellaneous object such as a bench, flagpole, bridge or the giant milk bottle that stands on Museum Wharf. A number is recorded in the attribute file to identify the kind of object the polygon represents. Three other attributes are also encoded for each polygon: its height, distance from the viewer, and direction in which it faces. Each attribute has four categories, represented by the digits 1 through 4; these codes control the shading of the polygons.

The program which directs the plotter works with one polygon at a time, in the order in which they were digitized. It must decide four aspects of rendering; shading density, color, angle and whether to use single-direction or crossed shading lines. For any single drawing, all decisions are made identically for all the polygons. For example, color can be chosen to represent the distance from the viewpoint, density to represent surface orientation, angle to represent height, and line type to represent the type of object being drawn. The values of the attributes dictate the outcomes of these decisions, and the rules used can be inferred by looking at the patterns on the finished plot.

There are twenty-four different ways (or permutations) in which four shading characteristics can be assigned to portray four polygon attributes. In due course the program cycles through all of them, generating 24 different "mappings" of symbolism to attributes. Not all are equally pleasing, and their esthetics also depend upon the colors chosen for the pens, and the order in which they were loaded into the plotter's carousel (which the program cannot know). The permutation used in a particular plot is labelled below it; the ninth permutation, for example, is denoted as 9/24. This "serial number" identifies plots with identical shading patterns. However, as they may have different sets of colors, plots with the same serial number may not look the same or be equally attractive.

The demonstration has been tailored to take advantage of some of the "intelligent" features of the Hewlett-Packard 7586B drafting plotter. In particular, the plotter itself calculates all shading lines, based on parameters for their spacing, angle, color and type. Software embedded in the plotter computes the beginning and end points of each shading line from the coordinates of the polygon that contains it. This relieves the host computer (a Digital Equipment Corporation Vax 11/750) and software from this highly repetitive task, and probably reduces the amount of data that must be transmitted to the plotter by at least an order of magnitude. The lettering is also formed by the plotter itself, which has several styles of a number of typefaces stored in its read-only memory. Thus, only the text of labels -- not the coordinates for their penstrokes -- need be communicated to the plotter.

The program which controls the plotter is written in the Fortran language, and was created especially for the demonstration. It is similar, however, to the type of software frequently used for drawing "thematic" maps, or maps which portray statistical data such as population densities or land use. The polygons in this particular graphic represent an urban scene. It is not hard to imagine the same scene viewed from directly overhead; this would eliminate the effects of perspective and transform the view into a thematic map, one depicting four independent variables as one graphic ensemble.

Hardware

Hewlett-Packard 7586B 8-pen, 36-inch drafting plotter, donated by Hewlett-Packard, Inc. DEC Vax 11/750 computer, donated by Digital Equipment Corporation.

Software

VMS Operating System, donated by Digital Equipment Corporation. Fortran Compiler, Donated by Digital Equipment Corporation. Fortran applications programs created by Geoffrey Dutton for The Computer Museum. DCL operating environment created by Geoffrey Dutton for The Computer Museum.

Photography

Photograph of downtown Boston created and donated by Karin Rosenthal, Watertown, MA.

Input Device Text: by GHD 9/20/84 OS: KS: GD:

Input of Graphic Data

Computers can build up graphic images by combining descriptions of simple objects such as cubes, spheres and cylinders into more complex shapes. Most real objects, however, are too irregular to be convicingly described this way. To capture their shape, they or drawings of them must be traced by hand. This results in representing points, lines and areas as sets of spatial coordinates, a process generally known as digitizing. A variety of devices for the input of vector data are displayed here. In general, they measure distances down and across a flat surface (although several work in three dimensions), generating a series of coordinate pairs as one traces drawings or objects. Not shown here are devices which digitize images in raster form, such as video cameras. You can see one in action at the "Anatomy if an Image" exhibit by the gallery entrance.

Light Pen, Interactive Computer Products, 1984

Light pens are used to locate, draw and move objects displayed on video terminals. They are one of the simplest, and, due to their mode of use, one of the most interactive types of graphic input devices (see the story "Sage Graphics", opposite, for details). Because they must be in contact with the screen of a CRT to work, light pens are not easily used to digitize documents. They do allow freehand drawing, however, as demonstrated originally by Ivan Sutherland's seminal "Sketchpad" system created on MIT's TX-2 computer in 1962.

Donation of Interactive Computer Products, Inc., 1984.

Rand Tablet Stylus, Rand Corporation, 1962

The Rand Tablet was one of the first devices for the input of freehand drawings. Its pen-like stylus sensed pulses of electricity coursing through the tablet's fine grid of conductors, fixing a position within one one-hundreth of an inch across the tablet's 11-inch square surface. The user could enter lines or positions by pointing and enter their coordinates by pressing down on the stylus.

Donation of the Rand Corporation, 1984.

BitPad One, Summagraphics Corporation, c. 1975

The digitizing tablet became a common component in interactive computer graphic systems during the 1970's. The Bit Pad One by Summagraphics is representative of the range of page-sized tablets used in many graphic workstations and as accessories to microcomputer systems. It is approximately the same size as the Rand Tablet, but is capable of distinguishing points as close as one or two thousandth of an inch apart.

Donation by Summa Corporation, 1984.

"Intelligent" Digitizing Cursor, Altek Corporation, 1982

Digitizing documents such as electical schematics, mechanical drawings and maps is exacting, tiresome work. Errors in tracing lines are easily made and may be hard to detect. This prototype of Altek's Apache scanning cursor was the first hand-held cursor capable of correcting for small errors in tracing lines. Within its one-tenth inch "bullseye" is an array of photosensitive elements which ~~senses~~ detects the edges of lines being traced. As long as the operator can keep the bullseye on the line being followed, the cursor's electronics can compute the center of the line to an accuracy of two thousands of an inch. This enables most digitizer operators to use the full accuracy of their device, generate fewer serious errors and to suffer much less fatigue.

Donation of Altek Corporation, 1984.

Crystal Ball, MIT TX-0 Computer, 1963-65

This is an early prototype of what has come to be called a joystick control. Instead of moving a lever, however, the user grasped a plexiglass hemisphere which could be pushed or rotated in any direction. Like a joystick, its main use was to indicate directions and rates of movement, rather than serving as a drawing instrument; this permitted users to move objects around on the TX-0 display, and to orient them in three dimensions. Twisting the ball activated different switches organized in three groups of four, one group for each axis of rotation. Seven different positions could be sensed along each axis, letting the user specify 343 different positions.

Donation of Massachusetts Institute of Technology, 1984

Space Tablet, Micro Control Systems, c. 1980

As Computer-aided Design (CAD) grew to dominate the computer graphics industry, the need to enter shape data for three- dimensional objects grew more urgent. Digitizing even a small mechanical part is difficult if the input device can record only two dimensions at a time. To overcome this, a number of different 3-D digitizing devices have been developed: this instrument is one of the simpler approaches to measuring the shape of small objects. Each joint of the digitizer's arm houses a high-precision potentiometer. Moving the arm changes resistances proportionally to the amount of rotation. By Integrating the angle of rotation of each of the joints and the lengths of the arms, the space tablet can compute where its stylus is located.

Donation of Micro Control Systems, Inc., 1984

11

Introduction: List of Stories

1. Introduction to gallery and gallery plan
2. Frontispiece: New England Mosaic
3. Jacquard model and silk weave
4. Anatomy of an Image: Discern~~a~~ibility, Mandrills, Ravenna
5. Line drawings then and now (Porto)

1D

Image Processing: List of Stories

Introductory Stories:

✓ 1. Introduction

✓ 2. Moon c 1963

✓ 3. SEAC 1957/8 → to Display Tech

✓ 4. Ranger 7 1964 and Surveyor 7 footpad 1968

✓ 5. Mariner 4 Mars 1965

Principles:

x Contrast stretch wedges : To make up

y Fourier transforms :

Application Area: Astronomy

✓ 6. NGC 1097 HSI

✓ 7. Jupiter's GRS Voyager

✓ 8. Io's volcano Voyager

Application Area: Remote-Sensing, Oceanography, Sonar, Terrain

~~9. Haxby's Seasat geoid~~ geode? no, geoid

Behind MIPS

10. Coastal Zone Colour Scanner - phytoplantkton

11. Optimised use of bands in SF Bay Area image

~~12. Landsat/Seasat - Kobrick~~

13. MIPS

13a ✓ Rescuing an Image: Stand-alone story

Application Area: Medical, Anatomical, Biological

14. Selective disolution on CAT scan of heart

~~White blood ce~~ll

15. Electron micrograph from Chesley

Application Area: Archaeological, Art

17 ✓Van-Dyck -style crucifiction

~~Sonar wreck in lake Onta~~rio

18 ✓ Shroud of Turin

Focus: Window

1 Masscomp

2 Winkler video

3 HP Plotter

5 Jung Brannen video

10

14

Images for Design: List of Stories

We can find a better title than this, I trust.

✓ Jung Brannen: architectural video

~~Greenberg: Designing a Museum~~

Designing a circuit: taped PDP-8 flip chip, ASC plates, ASC copper sheet, ASC mother board with pcb, large chip plot

Xynetics plotter, mask and chip

Apollo/Mentorgraphics: Design an alarm clock

~~Xerox Star, foreign scripts~~

✓ Bitstream, designing letters

what is this?

Boeing: Desigining aircraft, pices and pictures

pieces?

McDonnell Douglas: aircraft designing before CAD
GE: video of turbine blade

Some early CAD from CADCENTRE

Nike: designing a running shoe

✓ Jung Brannen/SOM: architecture of One ~~Dewey~~ Financial Center Sq &/or Chicago skyline

Design a Bicycle

Design a Car

Cadcentre: Designing a road

~~Lexidata/Dartmouth: Design a house~~

✓ Large chip plot

9

13

Building an Image: List of Stories

In enclosure:

0 Intro

✓ 1. Blinn's goblet

✓ 2. Gouraud's wife

✓ 3. Newell's and then Phong's transparency

✓ 4. Ray tracing: checkerboard and sphere: real images

✓ 5. antialiasing, pencils from Cadcentre

✓ 6. early texture map and bump map → Voyager, Orange.

✓ 7. Teapot: Adage, teapot and images

✓ 8. Terrain: Symbolics, Weidhaas, Kobrick, Dutton

8a. Fractals: images (several stories) and Tektronix 4014 + VAX

8b. Cellular Automata : Toffoli/Multer and Wolfram

9. Siggraph slides + soft text on VT100+11/70: (put onto slides the composite sequence for Pt Reyes)

~~11. Venus from Pioneer radar altimeter~~ → video

12. Hologram of artificial scene Benton

13. Hologram of population Dutton

— 14. Trees, Aono

15. Adverti~~g~~zing video

File No: 29

Graphics for Simulation, Education and Games: List of Stories

1. Zoetrope

2. Plato

3. Education and Simulation Video

4. Flight Simulator on NEC

5. Macpaint

6. PDP-1 Spacewar + Spacewar by General Computer Co on the Mac

Katharine's Comments

Tempest_about_a_Teapot

In 1974, needing real-world data with which to test computer methods for automatic recognition of three-dimensional objects, Allan Newell chose an everyday object, a teapot from his kitchen. After sketching several views of the vessel, Newell selected several dozen points, measured their locations on the drawings, and entered their coordinates to approximate the teapot's shape.

Other computer graphic researchers soon began to borrow this set of data, usually to test their own surface-rendering procedures. During the late 1970's it seemed that no one could publish a paper on 3-D shaded computer graphics without illustrating it with an obligatory teapot, made shiny, dull, metallic, textured or spotted with reflections.

To your left, a cabinet houses Newell's original ceramic teapot itself, lit illuminated by three sets of colored lights in a miniature stage set. Each light source's color is controlled by a corresponding dial on the control panel in front of you. On your right is a color monitor upon which an Adage 3000 display controller renders Newell's original data describing the teapot as a smoothly shaded image, with simulated colored illumination.

You are invited to experiment with lighting both the teapot and its computer simulation: Select one of seven colors for any of the three light sources by rotating its dial on the control panel to the hue you want to use. Then press the button marked "RENDER" to cause the computer to simulate the lighting condition you have just created, redrawing the image with appropriate coloration and highlighting.

The demonstration illustrates some of the potential of computer graphics as a tool for simulating the lighting of theater and motion picture sets, which usually normally entails very labor-intensive and time-consuming experimentation. Even with this simple set of three light sources, each capable of displaying a single intensity of seven colors (or turned off entirely), ~~there are~~ 512 different lighting effects are possible.

(other effects possible: rotation; texture mapping; transparency; bump mapping; variations in specularity; backdrops)

Credits:

Teapot; donation of Allan Newell, 1984.

Teapot Data; donation of James Blinn, JPL, 1984.

Display Hardware; Adage 3010 display controller and color monitor donated by Adage, Inc., Billerica, Mass.

Software; FSS and Solid 3000 software packages donated by Adage, Inc.

Software implementation; Allan Sadoski, Maynard, Mass.

Computer-animated Holographic Map, 1978

"American Graph Fleeting" is a computer-generated animation of 18 decades of population growth and change of the United States. It may be the first animated map to be produced as a hologram. To generate the images, census counts of population by county were mapped as surfaces, with their height proportional to population density. One surface was computed for each year during the period 1790 to 1970; this set of 181 maps was shot as a 16-millimeter film animation, which was then optically transformed into an assemblage of minute holograms. Each of the 1,000 frames in the 45-second sequence occupies a thin vertical strip on the hologram mounted inside the plastic cyclinder. This "multiplexed" or "integral" hologram format, invented by Dr. Stephen Benton of Polaroid, can be used to exhibit any film clip without the need for laser light to display its contents.

Produced by Geoffrey Dutton, Laboratory for Computer Graphics and Spatial Analysis, Harvard University. Museum purchase.

Comments by OS

Need photo of system in use

SAGE_Graphics

a large

Upon entering The ~~Computer~~ Museum, you walked through ~~the~~ (~~IBM AN/FSQ7~~) vacuum tube computer, built for the U.S. Air Force in ~~between~~ 1958 ~~and 1962~~. was Designed for real-time air defense ~~command and control~~, The Semi Automatic Ground Environment, or (SAGE) ~~SAGE~~ computer and featured the first operational use of interactive computer graphics. Each ~~of the (seven)~~ SAGE sites ~~maintained~~ kept watch over surveillance of a ~~portion~~ part of North American airspace. From their consoles the SAGE operators could identify and follow all aircraft within their ~~purview, with a minimum of effort and without the need for typing.~~ region. ~~In fact~~ There was no need for typing and indeed there were no keyboards ~~were included in the SAGE consoles~~; all interaction was through pointing at information on the ~~console displays~~ screens and setting switches. The interactivity and resolution of this workstation remained unmatched by commercial graphics systems until the early 1970's.

is this really true? Are you thinking of E+S?

(No underlining just bold)

SAGE_Cathode_Ray_Tube,_Hughes_Charactron_(1958?)

Each SAGE site had several dozen operator's consoles displaying data on 20-inch cathode ray tubes (CRTs) like the unit shown here. Operators viewed line drawings of coastlines and radar blips covering their sectors of airspace. Information about aircraft and their flight paths could be called up by pointing to a blip with a light gun and flipping switches to indicate the type of information desired, such as aircraft identifiers, compass headings, velocities and destinations.

SAGE Light Gun, IBM (1958?)

This input device was used by SAGE console operators to interact with radar data. It is one of the earliest uses of the light pen ~~(also~~ see video film on ~~exhibits concerning Ivan Sutherland's Sketchpad program and MIT's TX-0 computer)~~. The active portion is ~~simply~~ a tube containing a photosensitive element mounted behind a lens. Pointing the gun at any spot of light on the screen and pressing its trigger caused the device to generate a pulse; the program monitoring the light gun would then look up the current ~~X and Y~~ position of the beam on the ~~display~~ screen. By matching this location to one in the list of coordinates currently being displayed, the computer could identify the object selected by the operator.

As of 10/8/84

Computer Graphics Technology

Computers need special input devices to take in postional information, and special output devices, capable of rendering points, lines, color and shading in order to draw images. Some of the many unique input and output devices invented over the past twenty-five years are displayed here.

SAGE Graphics

Upon entering The Computer Museum, you walked through the AN/FSQ 7 (SAGE air defense system) computer. This machine represents a milestone in the use of interactive computer graphics. From their consoles the SAGE operators could identify and follow all aircraft within their region through pointing at information on the screens and setting switches, with no need for typing commands. The interactivity, resolution and reliability of the 1958 SAGE system remained unmatched by all but a few commercial graphics systems until well into the 1970's.

SAGE Cathode Ray Tube, Hughes Charactron, c. 1958

Each SAGE operator console displayed data on a 20-inch cathode ray tube (CRT) like the one displayed here. On their screens operators viewed continuously updated radar blips of planes on a regional map. Information about aircraft and their flight paths could be called up by pointing to a blip with a light gun and setting switches to indicate the type of information desired, such as flight identifiers, compass headings, velocities and destinations.

SAGE Light Gun, IBM, 1958

This input device was used by console operators to select aircraft displayed on their screens -- one of the earliest uses of the light pen. Its active portion is a tube containing a photosensitive element mounted behind a lens. Pointing the gun at a spot of light on the screen and pressing its trigger caused the device to generate a pulse; the program monitoring the light gun would then look up the current position of the beam on the screen. By matching this location to one in the list of coordinates currently being displayed, the computer could identify the object selected by the operator.

Storage Tube Oscilloscope, Tektronix Model 564, 1955

An oscilloscope is an electronic instrument which displays electrical signals graphically. The Tektronix 564 was the first oscilloscope to incorporate a display that could freeze rapidly changing waveforms on the screen, the direct view storage tube (DVST). Images are stored as patterns of electrical charges on a metal grid behind the face of the tube. The screen itself thus remembers the image -- no external memory is required.

Here the Model 564 is displaying sound signals being generated by the microphone in front of you. Speak or whistle into the microphone to create waveforms on the screen.

Sectioned Direct View Storage Tube, Tektronix

The Tektronix Model 564 storage tube became the basis for a generation of vector display terminals, such as the ARDS terminal and the Tektronix 4000 series of terminals. Like a mechanical pen plotter, a DVST draws points or lines, leaving a trace of light on the face of the tube wherever the beam has drawn. The screen itself remembers the traces, without requiring the computer to redraw them. To erase an image, the screen is flooded with electrons; this causes a brief but bright flash of green light, followed by a pause of a second or so as the screen stabilizes. Although a DVST can draw fast enough to create the illusion of movement, the "green flash" effect when erasing the screen makes it unsuitable for dynamic displays.

Plasma Display Panel, IBM, 1984

Plasma displays are light-emitting raster display screens, as are video cathode ray tubes (CRT's). Unlike CRTs, however, they are true flat panel displays. Lightweight, thin and rugged, plasma panels are suitable for use in vehicles and portable computers. They contain a transparent plate etched with a fine grid of holes, sandwiched between a pair of transparent layers. The holes in the grid are filled with low pressure gas, which emits points of light when activated by electrical impulses directed at them through a grid of fine wires. Once lit, a cell remains glowing until it is deliberately extinguished. Each cell in a plasma display, therefore, can "remember" its (on or off) state, like the screen of a storage tube. Unlike storage tubes, however, plasma panels can be selectively erased, pixel by pixel.

Drawing Vectors

To locate the positions of points and lines, display devices divide their screens into a fine grid of squares, like invisible graph paper. One corner of the grid is called the Origin, and has the coordinate position of (0,0). The opposite corner marks the horizontal and vertical limits, and typically might have coordinates of (1024,780). One draws lines (vectors) by sending the device their endpoints, as a list of number pairs in the order in which the lines are to be traced. This is somewhat like communicating instructions for a connect-the-dots game over the telephone.

You can get a feel for drawing shapes using pairs of coordinates by simulating the process on this Etch-a-sketch tablet. The left-hand knob controls horizontal movement, the right-hand knob vertical. To draw in those four directions is simple, but to draw diagonally requires considerable coordination. Vector display devices do so by varying the relative speeds of horizontal and vertical motion according to the angle at which they are drawing.

Input Device Text: by GHD 9/26/84 OS: KS: GD:

Input of Graphic Data

Computers can build up graphic images by combining simple objects such as cubes, spheres and cylinders into more complex shapes. Most real objects, however, are too irregular to be convicingly described this way. To capture their shape, they or drawings of them must be traced by hand, yielding points, lines and areas in the form of numerical coordinates. This process is known as digitizing. A variety of devices for the input of vector data are displayed here. In general, they measure distances down and across a flat surface (although several work in three dimensions), generating a series of coordinate pairs as one traces drawings or objects. Not shown here are devices which digitize images in raster form, such as video cameras. You can see one in action at the "Anatomy of an Image" exhibit by the gallery entrance.

Light Pen, Interactive Computer Products, 1984

Light pens are used to locate, draw and move objects displayed on video terminals. Working on the same principal as the SAGE Light Gun, they are one of the simplest input devices. They are also one of the most interactive; graphic feedback is usually immediate, and in the same location that one is pointing. Light pens allow freehand drawing, as demonstrated originally by Sutherland's seminal "Sketchpad" system created on MIT's TX-2 computer in 1962.

Donated by Interactive Computer Products, Inc.

Rand Tablet and Stylus, Rand Corporation, 1962

The Rand Tablet was one of the first devices for the input of freehand drawings. Its pen-like stylus sensed pulses of electricity coursing through the tablet's fine grid of conductors, fixing a position within one one-hundreth of an inch across the tablet's 11-inch square surface. The user could enter lines or positions by pointing and enter their coordinates by pressing down on the stylus.

Donated by the Rand Corporation, 1984.

BitPad One, Summagraphics Corporation, c. 1975

The digitizing tablet became a common component in interactive computer graphic systems during the 1970's. The Bit Pad One by Summagraphics is representative of the range of page-sized tablets used in many graphic workstations and as accessories to microcomputer systems. It is capable of distinguishing points as close as two thousandth of an inch apart across its 11-inch surface.

Donated by Summagraphics Corporation

Transparent Digitizing Tablet, Scriptel Corporation, 1984

Rather than reading out locations from a grid of wires, this digitizer measures resistance across a conductive layer deposited on glass, producing a totally transparent digitizing surface. Transparency lets users place artwork or menus under the tablet, protected from being torn or stained. The tablet can also be laminated onto the display screen of an interactive workstation, or backed with frosted glass onto which slides can be projected for tracing.

Donated by Scritpel Corporation, 1984.

"Intelligent" Digitizing Cursor, Altek Corporation, 1982

The manual digitization of artwork such as electical schematics, mechanical drawings and maps is exacting, error-prone work. This Altek Apache scanning cursor was the first digitizer cursor capable of correcting for small errors in tracing lines. Its one-tenth inch "bullseye" contains a photosensitive array which senses the edges of lines being followed. The operator only has to keep the bullseye on the line being followed, and the cursor's electronics can compute the center of the line to an accuracy of two thousandths of an inch. This enables most operators to use the full accuracy of their digitizers, generate fewer serious errors and suffer much less fatigue.

Donated by Altek Corporation, 1984.

Crystal Globe, MIT TX-0 Computer, 1963

In 1963, MIT's Electronic Systems Laboratory created a graphic display system, nicknamed "Kluge". This was the first interactive graphics workstation, one which allowed both input and output of geometric information. This "crystal globe" was the input device -- an early prototype of what has come to be called a joystick control. Instead of moving a lever, however, the user grasped a clear plastic hemisphere, pushing and rotating it. Like a joystick, its main use was to indicate directions and rates of movement; this permitted users to move objects around on the TX-0 display, and to orient them in three dimensions.

Twisting the ball activated different switches organized in three groups of four, one group for each axis of rotation. Seven different positions could be sensed along each axis, allowing 343 unique positions to be encoded.

Donated by John Ward, Massachusetts Institute of Technology.

Space Tablet, Micro Control Systems, c. 1980

As Computer-aided Design (CAD) techniques became prevalent in mechanical engineering, the need to digitize the shapes of 3-dimensional objects became commonplace. Digitizing even a small mechanical part is difficult if the input device can record only 2 dimensions at a time. This instrument uses one of several approaches to measuring the shape of small objects. Each joint of the digitizer's arm houses a high-precision potentiometer which senses the angle between the arms meeting there. Knowing these angles, the lengths of its arms and a little trigonometry, the Space Tablet can calculate the 3-Dimensional coordinates of the tip of its stylus, and send this information to the computer.

Donated by Micro Control Systems, Inc., 1984