THE COMPUTER AND THE IMAGE

OUTLINE PROPOSAL FOR AN EXHIBIT

AT THE COMPUTER MUSEUM BOSTON

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INTRODUCTION

Computer imaging is an exploding field. The price of hardware has sunk to the point where pictures at good resolution can be stored and manipulated by equipment costing thousands rather than hundreds of thousands of dollars. This brings graphics within reach of almost all types of users, from the home hobbyist to the professional businessman, artist and scientist.

Why is computer imaging so popular? The reason must be linked to the fact that vision is our dominant sense. We think of the world primarily as images and we interpret information most readily in graphical form. With the computer harnessed to this medium powerful applications emerge. The flexibility familiar in word-processing can be used to paint pictures. Fast computation can be used to enhance raw images and reveal features invisible on the original. Flexibility and fast computation combined make interactive computer-aided design possible. Objects that do not exist can be displayed looking real enough to touch. Lighting, texture and viewpoint can all be chosen to help our imagination.

The aim of the exhibit "The Computer and the Image" is to convey to the interested public some of the power and sense of opportunity that this new form of imaging holds. The exhibit will display many types of imaging, from the light-hearted world of games to the serious number-crunching world of digital image-processing of satellite images. Wherever possible, displays will be interactive so that the visitor can experience for himself some of the versatility of the medium.

But the exhibit should do more than present marvellous results. Many of these can be seen at trade shows, computer stores or at conferences. It should make an attempt to get behind the results to reveal the process. Simple processes often have dramatic effects on an image. For example,false colouring and spatial filtering, though straightforward as ideas, can radically alter a picture. The public should be able to interact with the process to affect an image and thus grasp the concept involved. This demystification can be applied to most forms of imaging, even the realistic scenes generated on large mainframes for motion pictures.

The exhibit will start with pioneering efforts in computer graphics, both as films and pictures of results as well as hardware. The evolution of graphics will be set in the context of the wider development of computing which will be displayed in adjacent galleries at the Museum.

A section on the nature of the computer image will introduce the types of image - vector and raster - and allow visitors to alter spatial and contrast resolution of images. Hardware for displaying, storing, inputing and outputing images will be on show. The aim is get over the idea of an image as a form of

information, like numbers or letters, and of how such information is handled by the hardware.

Examples of computer imaging can be divided into those that start with an image and manipulate it and those that synthesise an image from scratch. The former will include image-processing, from the Voyager Mission to Jupiter and Saturn to the view of downtown Boston from the gallery's window. In the latter category, the steps towards photographic realism will be shown as well as the use of images in design, simulation and the visualisation of invisible objects from molecules to the hypercube.

The exhibit should appeal to the curious layman, with information presented on several levels of sophistication. The expert should not feel that information is sparse but the superficially interested person should not be put off by dry blocks of text.

The following pages give an outline of the proposed exhibits. The story line presents the main message of each section while the 'material' column lists proposed display material explicitly.

SECTION	STORY LINE	MATERIAL
beginnings	When computers reached a certain power, images could be made. Link up with the evolution of computers exhibited in adjacent galleries and give a feel of late 1950's and early 1960's computing.	image of Jacquard woven on Jacquard loom films: SAGE TX-0,2 ESL ('Kludge') objects: first tubes or prototypes SAGE console ARDS terminal early mice, light pens PDP-1 & space-war
making a computer image	Computer images are composed of lines or of coloured squares. The realism depends on spatial and colour resolution. The importance of our perception of edges enables us to make sense of vector drawings but emphasises jagged edges in raster images.	large pixellated image of familiar figure eg Lincoln; working program displaying fixed image at different spatial resolutions and with varying numbers of colour shades; hardware pan and zoom on an image compared to pantograph first surface models with Coons patches
displaying an image	To display an image electrons and phosphors, light and film, ink and paper and other recently developed display technologies are used.	the hardware of graphic output devices: exposed CRT, plotter, film-writing device, liquid crystal, gas plasma. Parts labelled and principles explained. Early or prototype tubes and links to other fields eg flight control invention of storage tube

storing an image	A picture really is worth thousands of words. Large capacity devices are needed to store the bulk of information. Tape, video disc and RAM are convenient media for computers to read. The image itself is usually convenient for the human eye alone.	model of pitted video-disc surface, of iron oxide elements in tape, of RAM with examples of the real thing. Computer controlled video-disc (Aspen sequence?)
inputting an image	Interfaces allow graphical information to be input by touch, pen and tablet, mouse, scanning digitising devices and TV cameras. Machine vision will depend on the high speed afforded by the TV camera.	examples of the different input devices in interactive operation with programs explaining the process. Armouring will be needed for many devices: touch-sensitive screen; tablet; mouse; digitiser; TV camera. Film of AI scene recognition.
movement	A sequence of slowly changing images creates the illusion of motion. Computer images for animation are usually generated slowly and strung together by time-lapse photography. Fast computers can show images in real time and for simple scenes even compute the images in real time.	zoetrope, arcade game with variable speed, animation and in-betweening- either interactively or with a film.

manipulating an image enhancement	Images, photographically or electronically produced can be enhanced to reveal structure not initially visible. Usually it is known what is "wrong" with an image. It takes number-crunching to correct it. Explain processes of contrast stretching, false colouring, deblurring, spatial filters and mathematical transformations such as the hue, saturation, intensity transform.	manipulation of TV image of downtown Boston out of window. Interactive control of contrast, colour, filters on a stored image with process explained. digital image-processing of satellite images - Landsat, Voyager, and radar images from Seasat and of Venus from Pioneer. medical images: X-ray, tomograms. astronomical, forensic and art applications.
creating special effects	Once inside a computer, simple mathematical rules can alter an image in fantastic ways.	video tape of view out of window distorted, spun, zoomed ...
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?	paint system being used to synthesise view of Boston from window; scene being drawn at different levels of realism: simple polygons, texture, hidden line and surface, lighting, reflections and transmission. SIGGRAPH slides and films. the entertainment and advertising industries: the use of fractals for irregular objects. cinema showing extracts of computer-generated scenes from Nelson Max's molecules to Tron. state-of-the-art video game.

synthesising an image from scratch continued: an aid to visualisation	How do materials or artifacts behave under conditions too extreme to be reproduced in reality? What shape do molecules have? What does a hypercube look like?	films and still pictures: molecular biology topology particle physics galaxy models
		interactive program to manipulate a hypercube
	Computer-synthesised images can lead our imaginations into new domains.	town planning: plotter showing plan of Boston with and without new development scheme
	Real time simulations are valuable training tools and also make excellent games.	product designed by computer such as aircraft wing or turbine blade with CAD program drawing variations
	Computer-aided design - the exploration of possibilities with no commitment.	design a car program from Ontario Science Centre and film of GM DAC-1- early use of CAD
		examples of CAD in computer design
		interactive rug design program from Shelbourne Museum
		interactive flight simulator

END

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THREE DIMENSIONAL EXHIBITS

TITLE	DESCRIPTION	SOURCE/STATUS
Jacquard looms	19th century Jacquard sales model illustrating punched card principle-	in museum collection
SAGE	one console from SAGE: static display with adjacent stills of screen. 18"x18"x3'6"	from NMST,Ottawa
Rand Tablet	early graphical interface (not working)	requested from Willis Ware, Rand
Project Sketchpad	simulation of TX-2 running Ivan Sutherland's Sketchpad program	project for summer intern may require prompting screen, hardware not identified
early pointing devices	mice, track balls, light pens, joysticks, tablets, digitisers	Doug Ross, Doug Engelbart & others
MIT ESL 'Kludge'	crystal globe used to control cursor movement	John Ward, MIT has agreed to loan
Whirlwind Williams tube	transparent glass storage tube with grid visible - same principle as storage tube displays	to be donated by Bob Everett
ARDS display	static display of first commercially available storage tube display	ARDS located and offered by Gordon Pask, Architectural Association, London
first storage tube as used in storage oscilloscopes	Tektronix 564 5" tube	Tektronix confirmed

raster technology	opened up TV tube	NEC?
video disc technology	magnified model of video disc section	detailed design obtained from Science Museum
interactive video disc	interactive movie map of Aspen	MIT Media Lab to be approached (Andy Lippman)
other display technologies	liquid crystal, gas plasma	IBM, Kingston for plasma
large CAD-designed object	fighter aircraft wing designed by computer accompanied by computer design plots. Note access constraints.	object promised via Bob Everett of Mitre
small CAD-designed part	gas turbine blade from GE approx 5"x2"x1"	GE approached via John Hsian and Bill Blundell. Object and video offered
circuit design before CAD	pencil & vellum, french curves and PDP8 module; Texas Instruments glass circuit layers for ASC- the limit of hand-drawing	in CM collection
CAD in VLSI	masks,chips under microscope and large colour plot of chip layout: plot 30'x8' Apollo running Mentor Graphics software of VLSI layout	Mike Brophy at DEC Hudson facility or IBM Essex Junction, VT 512k RAM colour Versatec plot; Apollo and Mentor Graphics support promised
CAD program	Ontario Science Center interactive program to design a car; user selects door,front,back etc and program computes drag. 3' square approx	OS to check hardware requirements at Ont Sci Ctr on visit

CAD in architecture	visualisation of new building in Boston: Dewey Square development; fly around site, show subway, go into building, change perspective	Computervision approached via Jeff Burger; reluctant because requires operator; software offered by Jung/Brannen Bruce Forbes
line printer	working line printer plotting out an image at different spatial resolutions, paper wound up near ceiling approx 4'x3'	Dataproducts approached via Erwin Tomash; positive reply received
image-processing	PDP-11 based MIPS system from USGS allowing visitors to manipulate Landsat image of Boston area. Also needs 20Mb of disc, tape drive and high res colour display such as Grinnell approx 5ft square	software free from Pat Chavez, USGS, Flagstaff, AZ; positive response from Grinnell;PDP11-45 ser no 1 available; disc & tape to be found; software modification required; NASA HQ supplying computer-compatible tapes of Landsat TM and Voyager (Saturn) data.
drawing instruments	set of drawing instruments, pantograph, rules	computer museum collection
plotter	HP 7585A pen plotter drawing town plan and other images related to adjacent displays approx:3'x2'x3'6"(h)	request being considered by HP tape system and possible programming and demonstrator required
fractals	interactive display of fractal curves and surfaces to be devised with B Mandelbrot possibly based on IBM PC-XT	awaiting reply from IBM and Mandelbrot
interactive simulation	flight simulator on IBM PC or other micro eg microsoft's program. size:	to be decided

LOGO	interactive logo machine	Papert or Atari?
graphical workstation	Apollo DN300 running Brown University's curve program restricted to shell-like curves-or Mentor Graphics -see above CAD in VLSI	Dave Nelson,Apollo confirmed DN 300;software would require modification.
pan and zoom	hardware allowing panning and zooming around large image. Possibly combined with above image-processing demo.	requires hardware eg Lexidata hosted by VAX
raster scan	demonstration of how image is built up on raster type displays: slowed down sweep of beam and slowed down fading of phosphor. Simulated on a micro? Programming project	requires large screen
resolution	'Discernability': digitised image of visitor's face used to alter spatial, contrast and time resolution	Ed Tanenbaum; exhibit to be constructed to order
three-D imaging	allow real time 3d interaction either with varifocal vibrating mirror display or with vector system with perspective hardware	approach Trivision Dick Shorthill for mirror, Adage Mick England for Adage RDS 3000; software to be donated by Henry Fuchs and the Computing Dept at UNC but requires UNIX (preferably Berkeley) on VAX. E&S to be approached via Gary Watkins and Ron Resch for PS 300 or colour system

zoetrope	cylindrical slitted wheel with images inside. User turns handle to see movement. Could be a phenakisticope or other similar device. approx 3ft square	requested from George Eastman House, Rochester. Awaiting reply.
PDP 1	PDP 1 running spacewar on a demonstration basis. size:	computer museum collection- Shag Graetz will get program up and organise original joystick controls
spacewar	micro or VT125 or other long-persistance phosphor screen eg HP 3500?	program to be written under supervision of Shag Graetz by summer intern
video game	slowed-down altered video game showing process-animation and interaction	either George Golson or Dave Nutting; requires some reprogramming and hardware awaiting meeting with Golson and response from Nutting
old electro-mechanical arcade game	opened up mechanical bar-game eg 'flipper' type	
paint system	advanced paint system demonstrated by skilled operator to sysnthesise scene out of window and alter exisitng image. Approx 5ft square If not available, use Macpaint interactively on Apple Macintosh	requested from NYIT, Louis Schure

END
OS 4.20.84

MARCH 1984 PROGRESS REPORT

The proposal for the gallery The Computer and the Image needs converting from a wish list into a list of confirmed exhibits. This represents my chief activity over the month.

In some cases the source of an object is known but the objects must be solicited. Sometimes this backfires as in the case of Boeing. As pioneers in the field of computer-aided design, I was hoping to acquire a large piece of a computer-designed aircraft wing- such as from the new 757 or 767 now facing cut-throat competition in the commercial airliner marketplace. Sadly, no wings were available but a very user-friendly cruise missile was on offer instead.....

In fleshing out the early history of the field (this means all of 20 years ago) I am trying to locate landmark pieces of hardware. The first storage tube (cut the price of graphics tenfold), called ARDS was mass-produced in the late 60's and early 70's. Alas of about 50 I've hunted for, all have been thrown out. Quite by chance at a talk given by the contemporary composer Herbert Brun I heard about two in London, and they're ours if we pay the shipping costs.

At the University of North Carolina, Chapel Hill I saw 3D images generated by looking at a display screen via a vibrating mirror as well as many wonderful views of biological molecules, all seen from any viewpoint at the twist of a knob. I'm working on getting more than a movie of this. On the way back from NC I visited the National Bureau of Standards in Washington where the first image processing was done on the SEAC in 1957. Unfortunately they have their own museum so all I can get is images. I also visited a software house specialising in artificially intelligent 'support systems' meaning that the machine tells ,for example, the captain of a submarine what he wants to know and then tells it to him. Being ex-MIT they had advice to give on implementing Sketchpad, the grandfather in interactive graphics programs, developed at MIT in 1963.

A short trip to give a talk at the Shelburne Museum near Burlington, VT gave me the chance to visit IBM's chip-making plant. If IBM's HQ never get to hear about it we may get a colour plot of the ultra-dense 512k RAM chip- it makes you gasp.

A third trip to the West took me first to see the mini image-processing system at the USGS at Flagstaff, Arizona. They think it's very user-friendly, but I think it would baffle all but a few; we shall recreate a much more friendly (lovable?) version in the gallery based on our PDP11/45. The idea is to let the visitor process an image of Boston from Landsat or one of Saturn's rings. Next stop was Lawrence Livermore Labs where I saw giant lasers, magnets and chambers for doing nuclear fusion

experiments. But my main contact was out sick that day and my passport was the wrong colour so I failed to see much of direct relevance. The following day I saw ultra-realistic computer-synthesised images at Lucasfilm. We shall get old and new images from them. And the pioneer of digital paint systems at Aurora Inc will give us videos of its first use on TV with the Pioneer Venus mission. Chips and Changes, a major exhibit at the Exploratorium was disappointing- it didn't work for me and I did not see evidence of it working well for others. But there is an excellent permanent exhibit there called 'Discernability' which allows you to play with a TV picture of your own face- changing the spatial, contrast and time resolution. A version of this will fit very well into the image gallery. I also saw more rendering of molecules, many in stereo, at Robert Langridge's lab in San Fransisco. The challenge here will be to make film or even some interactive demonstration meaningful to the lay visitor. Perhaps the most productive day was the last one at the Jet Propulsion Lab at Pasadena. I picked up many space-probe images, in various states from raw to processed, pictures in which the images from many satellites had been massaged together to give effects resembling a relief map and identified some historic 'firsts'. One is the first digital picture of the surface of another planet- Mariner 4 and Mars. It remains to be seen if this gem can be prised off their director's lobby wall (9th floor in a very earthquake-prone area...). A final session with Jim Blinn, a pioneer of many of the tricks now standard in computer graphics yielded some good first attempts of the mid 70's.

Do ask if you want to see any of the material referred to above. I shall also be viewing some movies of computer simulations of Voyager fly-bys- let me know if you want to see them too.