Fifth-generation CAD/CAM systems soon to be born

Like the evolution of computers themselves, CAD/CAM systems are entering their fifth generation of design, in which CAD/CAM software functions will reside entirely in a single microprocessor, according to Patrick Hanratty, president and founder of Manufacturing and Consulting Services, or MCS, a major developer of CAD/CAM systems for the last 15 years.

Hanratty is referring to the software components of analysis, numerical control, applications, geometry (including solids modeling), and drafting. "In the next two and a half years," predicts Hanratty, "you will see 100 percent of these components in a chip set, which will then reside in a workstation and will be able to communicate with any computer." The end result will be dramatic savings in time, as much as 90 percent of the design and machine-tool creation time needed to produce a finished product.

"Things that today take two to three hours to create will be created and analyzed on-screen in seconds," he said. "We're talking about going in and machining an entire surface—which today is a one-and-one-half-hour process—in less than thirty seconds."

The historical development of CAD/CAM technology. Featured as the keynote speaker in January's Cadcon conference, Hanratty reviewed the historical development of what we today call CAD/CAM technology. "The generations of computers are fairly well defined, but the generations of CAD/CAM systems are rather obscure," he said.

First generation. The first generation was born in the mid-fifties. A consortium of aerospace companies called the Aircraft Industries Association created the automatically programmed tool (APT). And engineers at GM, led by Hanratty, created a CAD batch language for producing loft lines for automobiles.

Second generation. The second generation didn't appear until more than ten years later, in the late sixties, early seventies. For the first time CAD/CAM systems became commercially available. Hanratty's newly formed company, MCS, came out with its first CAD/CAM system, "Adam." The system, much like all CAD/CAM systems at the time, made use of 16-bit computers and direct-view storage tubes, or DVSTs. The interactive graphics world was born.

Third generation. The third generation began to appear in the mid-seventies and was characterized by the complete integration of interactive graphic CAD and CAM systems. Users could design and analyze, list attributes (bills of materials, costs), annotate drawings, and set up manufacturing processes (down to the NC machine) on the same integrated system. System technology became more sophisticated with the introduction of wireframe and surface modeling capabilities, displays which were beginning to use color raster technology instead of DVSTs) and the ability to handle very large and complex parts. Typical hardware was such virtual 32-bit computers as the Vax, DGM 8000, HP 9000, and the new IBM series.

Fourth generation. The fourth generation—today's generation—is everything in the third generation plus solids modeling. Today's systems give the user the ability to represent a design of practically unlimited size with mathematical and geometrical precision. "We can create a space station in actual size, and it will be one solids model."

Today's systems. The problem with today's systems, says Hanratty, is the software. It is slow and hard to maintain. The designer spends much time waiting, and if the designer attempts to alter a section of code, this may cause disturbances elsewhere in the program.

"The obvious solution to the problems of computer software today in the CAD/CAM industry is putting a program on a chip."

Hanratty noted the products of display manufacturer Silicon Graphics as an example of the coming fifth generation. They put the most commonly used graphics routines—translation, rotation, scaling, formatting, and others—in a chip capable of performing six million floating-point operations per second. Hanratty praised this kind of innovation but held that much more extensive silicon coding is possible. Hanratty envisions, for example, the complete encapsulation on a centimeter-square chip of the almost one million lines of Fortran code in the MCS Anvil 4000 workstation.
Microcomputers as engineering workstations

"Personal intelligent workstations are the forerunner of a new revolution in computer-based design systems," according to Carl Machover, who spoke at the January Cadcon conference in Anaheim, California. By inexpensively providing the engineer a window into the total engineering environment, with access to databases, electronic mail, word processing, and CAE and CAD tools, the micro-based workstation promises to be the central hardware in the engineering workplace in the near future. Machover, president of the CAD/CAM consulting firm Machover Associates, led a forum discussion that explored the growing presence of the microcomputer in design environments.

Fifteen thousand PC-based CAD systems were installed in the last two years, Machover asserted. This compares with the 15,000 minicomputer- and mainframe-based systems (with 64,000 terminals) installed in the previous 14 years. The trend is toward reconfiguring the workplace around the microcomputer. Machover estimates that in three years approximately 1.25 million micro-based systems will have been installed. "We're seeing some basic economic changes based on the micro," he said.

The attractiveness of the micro-based engineering system derives primarily from its low price, claimed another speaker at the conference. "The return on investment is extremely short, so there are no real cost justification problems," according to Jim Richards, president and founder of Vermont Microsystems, Inc. (VMI).

Average productivity increases. Richards' company currently uses 30 microcomputers in addition to three DEC minis for the design and testing of graphics circuit boards for OEM clients. The 110-person company uses the micros across the board for such applications as product testing, software development, schematic entry, and administrative tasks. Richards claims that the micros are central in generating an average productivity of $300,000 revenue per employee.

But the low price of the micro does not necessarily mean reduced graphics quality. The animation sequences for spaceship control panels in the science fiction film 2010, noted Machover, were created with a Cubicomp system based on an IBM PC.

Hardware features. Typical hardware features of today's engineering micro begin with a central processing unit, such as the Motorola 68000 or the Intel 8086. Additionally, the device contains a separate display controller to allow for greater system speed and efficiency when manipulating graphics data. Other common features are large mass storage (around 300M bytes), virtual memory capability, and networking capability.

Software obstacles. However, the obstacles to overcome in building a micro-based workstation lie not in the hardware, agreed the speakers, but in the software. The software "must address the total spectrum of tasks in an engineer's day," said Littleton Daniels, ex-president of Bruning CAD and now president of the recently formed Endevors Group. According to Daniels, less than half of the engineer's time is spent on the traditional task of analysis and design. Thirty-five percent is devoted to management and 15 percent to document preparation. Furthermore, taking the engineering team as the unit of measurement, Daniels reported that 45 percent of their time was spent on documentation. The workstation "doesn't need a tremendous amount of power, because it isn't optimizing any one task," he said.

In addition to a complete set of traditional CAD tools, the engineer requires the "work" tools of word processing, spreadsheet analysis, electronic mail, scheduling, slides/graphics production, and the ability to annotate the design database without altering the drawing. "The expectation," contended Machover, "is that we are going to provide resources at the engineer's space that are over and above the conventional resources."

IBM representative Lou Mamo of the Entry Systems Division described the recently announced IBM PC Engineering/Scientific Series. The series is an assortment of software packages and plug-in cards that orient the IBM PC product line to engineering applications. Software packages provide the user with graphics development tools (modes for integrated text and graphics, graphic primitives, and primitive attributes), the Graphical Kernel System (to interface graphics utilities and application programs), a graphical file system (to store graphics information), and a graphics terminal emulator (to emulate the Tektronix 401X family and the Lear-Siegler ADM-3A terminals).

Plug-in cards include a data acquisition and control adapter for interfacing with analog laboratory and process control equipment, a general-purpose interface bus adapter, and a graphics display controller, which upgrades screen resolution to 640 x 480 pixels and gives the user the ability to use 256 colors simultaneously out of a total palette of 4096. IBM, said Mamo, intends to market these products through retail outlets in addition to its standard distribution channels.

Engineering economy to change. The speakers shared the sentiment that the micro-based engineering workstation represents nothing less than a transformation of the engineering sector of the economy. "The bulk of engineering endeavor in this country today," VMI's Richards held, "is carried on by small companies and not those that fit the mold of a GM or a Boeing." By providing the small company with affordable technology, said IBM's Mamo, we can keep the large companies from dominating the industry as well as making the United States competitive worldwide.

Mamo said he expected that by the 1990's 80 percent of all engineering workstations will be micro-based and that he wouldn't be surprised to see specialized retail stores ("CADlands") for engineering products. Complementing the emergence of the micro-based workstation is what Richards calls, "a new generation of professional who doesn't assume one needs a mainframe to get the job done.''

NCGA conference and expo nears

The National Computer Graphics Association's conference and exposition will be held at the Dallas Convention Center April 14 to 18, 1985. There will be more than 45 tutorials on subjects ranging from the management of CAD to developing applications using GKS. The tutorial program will last two and a half days, with half- and full-day courses.

There will be more than 70 technical sessions, including topics from facilities management and planning to an artists' forum. More than 200 companies will be exhibiting. NCGA maintains a special hotline for those who need registration information: 1-800-543-8000. Attendees will be sent maps and schedules for planning their itineraries, a description of all tutorials and technical sessions, and information about travel and hotel accommodations.
New member of IEEE CG&A Editorial Board is CAD/CAM systems developer

Lansing Hatfield, editor-in-chief of IEEE CG&A, is pleased to announce the approval of his appointment of Frank W. Bliss to the editorial board. Bliss has more than 16 years experience in CAD/CAM and computer graphics as a systems developer, user, and researcher. He is currently a project leader at Ford Motor Company on the research staff. He is in charge of the solid modeling project. This involves identifying needs and formulating research projects to meet them. He is also in charge of all the CAD/CAM systems at Ford Research. Previously Bliss was with the Computer Graphics Department at Ford, where he designed and implemented software. Before going to Ford, Bliss was software supervisor at Bendix Aerospace, where he conceived of and was responsible for the commercial interactive graphics product the Bendix System 100.

Bliss is an adjunct assistant professor at both the University of Michigan and Oakland University, where he has developed and taught courses in computer graphics. He is a member of the SIGGRAPH Course Committee and of the Society of Automotive Engineers Computer Applications Committee and has been a member of the Engineering Society of Detroit Computer Graphics Conference Committee. He has published several papers and is a member of ACM, IEEE, Tau Beta Pi, and Eta Kappa Nu. Bliss received his BSEE from Wayne State University, and his MS in systems engineering and a PhD in computer science from Case Western Reserve University.

West Virginia is the first to adopt CAD statewide

In the first instance of a statewide adoption of CAD for instruction, West Virginia officials announced the purchase of 495 AutoCAD programs to be used in 125 occupational and vocational centers throughout the state.

West Virginia's CAD project is designed to train students in CAD applications. "If our graduates are going to compete in today's job market, they're going to need computer-aided drafting and design skills," said Clarence Burdette, assistant superintendent of West Virginia's Schools for Vocational, Technical, and Adult Education. "As CAD becomes more and more prevalent in today's industry, the need for a skilled CAD work force will continue to grow," remarked Burdette.

The purchase, part of West Virginia's Microcomputer Educational Network program, was funded through a combination of Appalachian regional grant money and funding from the Job Training Partnership Act. These federal programs are designed to stimulate new job opportunities in geographic areas of high unemployment. State appropriations were also used in the purchase. Initially the AutoCAD-based systems will be placed in six area drafting centers, with up to ten stations at each site. Later, AutoCAD will be installed in such diverse classroom environments as automotive mechanics, wood shop, and even home economics. Autodesk Inc., makers of AutoCAD, will offer extensive teacher training and aid in curriculum development.

"We see the computer as a powerful drawing and design tool," said Burdette. "By learning drafting skills on a computer instead of drafting board, the student is exposed to the basic principles of CAD."

Comgraf 84 explores the future of computer graphics and the arts

"Over the past few years computer technology has altered the way we produce the printed image, but the impact has been primarily in post-creative areas. Now the technology is nearing a point where it can have a significant effect on the way a design office or advertising agency produces its creative work as well," said Richard Moore, vice chairman/chief creative director for Muir Cornelius Moore. He was speaking to more than 400 advertising and design professionals at Comgraf 84, a seminar, tutorial, and exhibit sponsored by Pratt Center for Computer Graphics in Design and Collier Graphic Services.

Both Moore and Nigel Holmes, executive art director of Time magazine, along with other seminar speakers, emphasized that they considered the computer another tool to help them achieve desired ends. Said Holmes, "My job at Time is to organize facts and figures and present them graphically and attractively in the magazine. One of the tools I use is the computer. I don't know a great deal about its inner workings, but I do know what I want it to do."

Carl Machover, president of Machover Associates, stressed the important changes taking place in the area of computer graphics. He said, "Significant changes have taken place over the past several years in the application of computer graphics to the production of images for video and multimedia. Not too many years ago computer graphics for video meant million-dollar systems, custom software, and very stylized output. Today, there are still multimillion-dollar systems, custom software, and stylized output, but there is much more! Useful systems based on reasonable computers, off-the-shelf software with user-friendly interfaces, and superb realism or outer-worldly fantasy are just a few of the resources and results available to today's graphic artist."

However, despite the ready acceptance of the computer as both a design and production tool and the incredible changes taking place in the field of computer graphics, all is not a bed of roses. "Communication vendors in the United States have not coordinated with each other," said George Stamps, president of GMS Consulting. "They have instead arranged 'incompatibility' to dominate the market." Stamps, who argued the need for standards, titled this incompatibility, the "dominant vendor theory."

George Alexander, associate editor of The Seybold Report, echoed similar sentiments when he said, "Digital techniques involving manipulation of images permit new types of creativity; but for
all their potential these techniques are not widely used, and their use is confined to the production process, not the design process.’’ He cited three key reasons: high costs, difficulty of use, and technology bottlenecks.

Another problem area, highlighted by consultant Frank Romano, is that we have not yet found the means to move data from one system (a PC, for instance) to another system (typesetting). In addition, he said, “We still do not have the capability to view art and type clearly on one screen. Computer systems are still expensive,’’ he continued.

“Prices have come down in text systems; they must do the same in pagination systems so everyone who needs one can afford one.”

Despite some problems, S. Thomas Dunn, president of Dunn Technology, who credits the small trade shops with a leadership role in the computer revolution, sees a bright future for the field of computer graphics in graphic arts. This future features specialized workstations; the movement of more data more efficiently within a system; and more acceptable on-screen color. Robert Anderson, new-product development manager for Chartpak, speaking during a panel on “PCs for Computer Graphics,’’ had this to say about the future: “Prices are coming down, better products geared to users are being developed, and better service addressing user concerns is being initiated.”

One of the more interesting aspects of computer graphics in the future is videotex, defined by Gary Holland, vice president for product development for Videolog Communication, as “a new communications media that combines computers, computer graphics, and traditional computer database techniques to deliver information and service interactively via communication channels, such as telephone and two-way cable television.”

Videotex, according to Holland and William Harlow, project manager of videotex for Sony Corporation, does not presently have a consumer application. “However, in the next two years everyone in this room will have used it,’’ said Harlow. “It still has a long way to go, but it is starting to happen now.”

IEEE seeks writers and reviewers of graphics definitions

The IEEE Computer Dictionary Working Group is calling for volunteers to write or review definitions of graphics-related terminology. Review criteria will be completeness of the set of terms selected and the correctness and clarity of definitions.

The entire computer dictionary should be ready for publication in its final hardcover form by mid-1987, but Jane Radatz, chair of the Computer Dictionary Working Group, tells us this dictionary will first be issued in softcover sections, with the first expected in mid-1985. These sections will be 35 to 50 pages each. The sections now planned will include:

- Hardware
- Software
- Mathematics of Computing (This will be the first increment published)
- Theory of Computation
- Computer Applications
- Methodologies: This will include:
  - Computer Graphics
  - Artificial Intelligence
  - Database Management
  - Modeling and Simulation
  - Sorting and Searching
  - Computer Networking
- Computing Environment, including

such subjects as Security and Privacy.

Besides becoming part of the IEEE Computer Dictionary, which will be a publication of the IEEE Computer Society, these definitions will also appear in the IEEE Standard Dictionary of Electrical and Electronics Terms, Frank Jay, editor-in-chief.

Any volunteers interested in writing definitions or reviewing them should contact Jane Radatz, chair, P610 IEEE Computer Dictionary Working Group, Logicom, 4010 Sorrento Valley Blvd., PO Box 85158, San Diego, CA 92138-5158; (619) 455-1330.

Errata

Upside down


Now

On page 44 of the January 1985 issue, in the article by P. R. Wilson et al., “Interfaces for Data Transfer Between Solid Modeling Systems,” the information in parentheses under the subhead “Experimental boundary file” should read: (which has now occurred). The sentence should therefore read: First, the IGES format at that time appeared as though it would become an ANSI standard (which has now occurred).

Address

The address of ACM was incorrectly given in “Background and Source Information About Computer Graphics” in the January 1985 issue. The correct address is:

ACM (Association for Computing Machinery)
11 West 42nd Street
New York, NY 10036
(212) 869-7440

The correct address for subscriptions to Transactions on Graphics, or TOG, is:

ACM
PO Box 12105
Church Street Station
New York, NY 10249

Addendum

to: “Back-to-Front Display of Voxel-Based Objects”

Gideon Frieder
University of Michigan
Dan Gordon
University of Cincinnati
R. Anthony Reynolds
University of Pennsylvania

The above article was published in IEEE CG&A, Vol. 5, No. 1, Jan. 1985, pp. 52-60. The research reported on in this article was carried out while Gideon Frieder and Dan Gordon visited the Medical Image Processing Group, or MIPG, Department of Radiology, University of Pennsylvania, July-August 1983. R. Anthony Reynolds’ work was carried out partly while he was with MIPG and partly while he was with the GRASP Laboratory, Moore School of Electrical Engineering, University of Pennsylvania. The authors were supported at MIPG by NIH grant HL28438.