

KEY SOLUTIONS

CE Solution

Client Server
Computing

Products

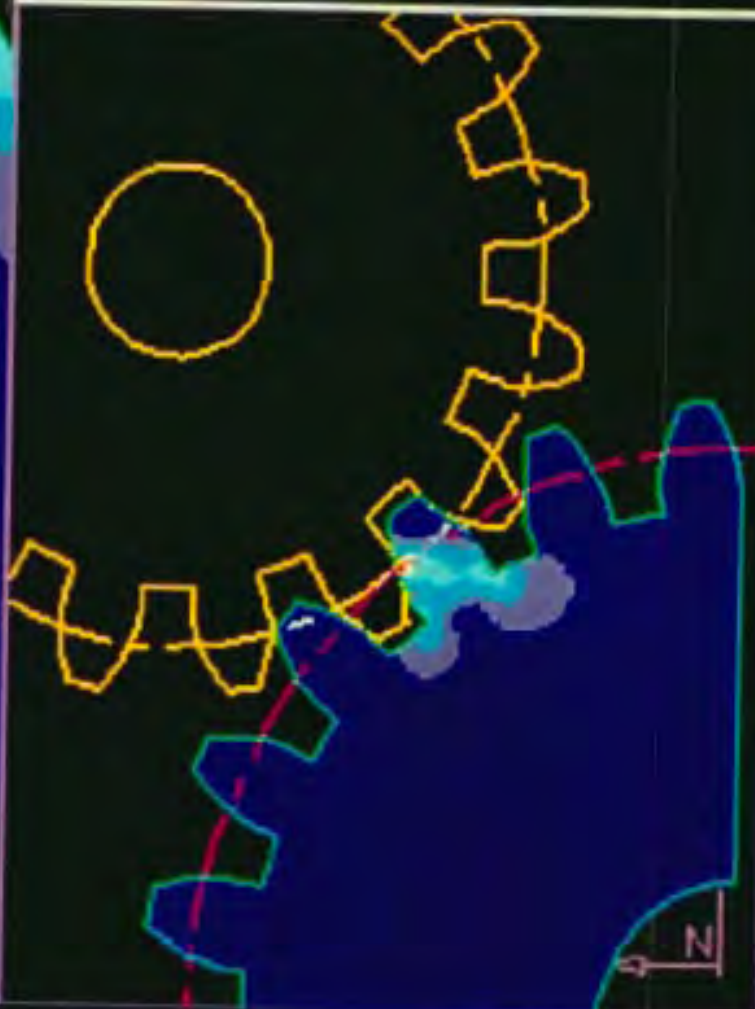
RASTER
PLOTTERS

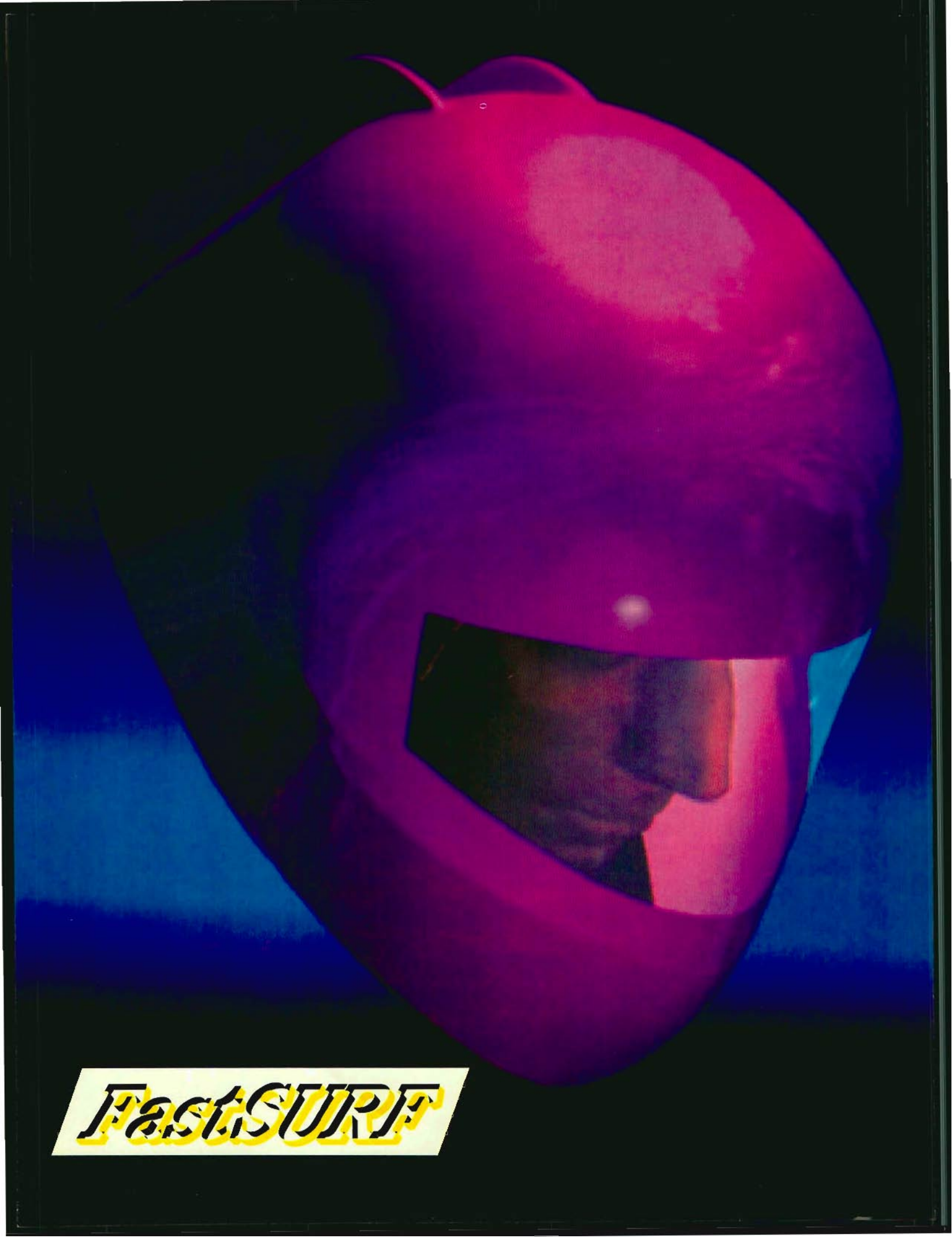
CADKEY at Work

Reinventing
THE WHEEL

BULK RATE
US POSTAGE PAID
PERMIT NO. 1784
HARTFORD, CT

02115332NMTR#1>
MARK MADURA
MADURA STUDIOS
332 NEWBURY ST.
2ND FLOOR
BOSTON MA 02115
USA





Fast SURF

CDE's Are Here!

1. *FastSURF.CDE demo disk.*

Two amazing and entertaining routines from the full working version of FastSURF.CDE are provided to give the user the feel of the real product.

Dynamic surface editing is provided to demonstrate the power of the CDE environment. Several surfaces are provided in a part file and the user can experiment with real time morphing of surface nodes.

After editing, the surface can be shaded.

2. *PLANES.CDE module.*

FastSURF has separated this important module from the rest of the FastSURF product in order to release it to the CADKEY user base as shareware.

Planes are a handy tool for building complex 3-D wire frame models.

3. *SHUNT-CDE.*

SHUNT-CDE provides the CADL programmer/user a way to load their CADL programs under the "APPLICATION" menu within CADKEY 5.0. It is simple to use and eliminates the need for CADL programmers to buy \$1,500 worth of software in order to turn their CADL programs into CDE's.

4. *FastSURF.CDE.*

If you can imagine it, then it can be done in the new CDE programming environment within CADKEY.

On August 1, FastSURF will release FastSURF.CDE. This product will contain all the features presently available in the CADL/DOS version of FastSURF. 2.5, plus exciting new features.

UNIX versions of FastSURF will be available by the end of August for SUN and SGI platforms.

Few developments will be as important to CAD/CAM technology for the rest of this millenium as the introduction of CDE and applications like FastSURF which take advantage of these new powers.

FastSURF

6 South Washington, Suite 14, Sonoma, CA 95370

PHONE (714) 282-8093

FAX: (714) 282-8094

BBS: (714) 282-7122

Easy Does It.

Introducing the Kurta XLP: . . .

Another Kurta Original

Draw on the best name for quality and reliability with Kurta's new XLP graphics tablet for IBM® PCs and compatibles.

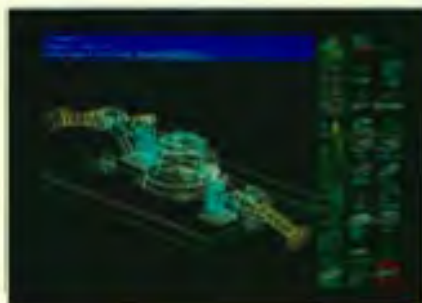
The easy-to-use, versatile XLP features Surfmagraphics® SurfmagSketch® compatibility and runs on virtually all software, from graphic arts to sophisticated CAD. The price is compatible too. . . just \$395 for the entire package, including:

- 12"x12" high-accuracy tablet
- 2-switch pen and programmable 4-button cursor
- An integrated mouse/ADI* driver with auto-toggle between mouse and ADI modes and a Windows® driver in absolute mode
- Test, Set-mode and Reset utilities
- Since the XLP draws its power from the serial port, no power supply is needed
- Unlimited free technical support
- Lifetime Warranty!

Get a total performance package, with the award-winning qualities you've come to expect in reliable Kurta products. . . from the value-leading XLP to the high-end, feature-rich IS/ONE® and large format XLC®. It's the easy way to better graphics for greater productivity.



Kurta works.®



1-800-44-KURTA

KURTA®

3007 East Chambers
Phoenix, Arizona 85040
(602) 276-5533

Kurta, Kurta logo and XLP are registered trademarks of Kurta Corp. Windows is a registered trademark of Microsoft Corp. ADI is a registered trademark of Autodesk Inc. IBM is a registered trademark of International Business Machines. Surfmagraphics SurfmagSketch is a registered trademark of Surfmagraphics Corp.

CONCURRENT ENGINEERING SOLUTIONS

- Building Blocks Of Concurrent Engineering*
- CADKEY ANALYSIS: A New Design Tool** by Dr. Anil Gupta 17
A technical comparison of FEA and BEM
- Teamwork: The Heart of Concurrent Engineering** by Calvin Miller 20
How to build and maintain a CE team
- BILL OF MATERIALS - Engineering's Other Job** by Steve Radford 25
Making your bill of materials work for you
- A Framework for Concurrent Engineering** by John Barry 28
"Client - server computing" with Sun

CADKEY AT WORK

- Reinventing the Wheel** by Claudia Martin 32
CADKEY helps win off-road races.
- From the Olympics to Hollywood and Beyond** 35
USPEP finds multiple uses for CADKEY / FastSURF

PRODUCT FOCUS

- Raster Plotting Technologies** by Scott Harlin 37
Inkjets, lasers and thermals - what, how, why
- Raster Plotters - A Closer Look** 40
Features and prices of 9 plotters
- Getting Your Act Together** by Ron Shea 46
*Maximize the CADKEY / CNC interface and
simplify CADKEY commands*
- ReVIEWPORT** 52
A brief look at hardware and software productivity tools

COLUMNS AND DEPARTMENTS

- Editorial 5
- CADKEY FORUM 7
- New Products 8
- KeyNotes 12
- CADKEY Corner 48
- CADL Toolbox 50
- Advertiser Index 56
- Solution Mart 58
- Endview 60

SUN'S SPARCSTATION™ LX
SEE PAGE 28



SOME OF OUR CONTRIBUTORS



Calvin Miller is the CAD/CAM Coordinator at Key Tronic Corporation, the largest independent manufacturer of computer keyboards. He has 10 years experience in the CAD/CAM industry. His roles include overseeing the CAD/CAM functions at Key Tronic as they relate to plastic design, mold design, printed circuit design and NC programming. Prior to Key Tronic, Calvin worked at Hughes Aircraft as CAD development engineer.

Dr. Anil Gupta has been involved since 1986 in the development and application of numerical methods for the solution of nonlinear partial differential equations in engineering and science. In Jan. 1991, he began developing analysis software based on the boundary element method which is marketed by Cadkey, Inc. He also teaches a course on advanced BEM at Worcester Polytechnic Institute.



Scott Harlin is vice president of Wilshire Newport, Inc., a full-service marketing company specializing in high tech in Burbank, California. He has a B.S. degree in Computer Engineering, a M.B.A. degree in Business, and has served as Chairman of NCGA's Marketing & Communications Committee. Mr. Harlin writes regularly for the CAD industry.

Steve Radford, former vice president of Materials/Operations at Key Tronic Corporation, is currently a partner in the Spokane, Washington-based Value Engineering Associates. He also serves as Business Manager and CEO of Key Solutions Magazine. His twenty-five year career in manufacturing began in 1967 at General Dynamics-Convair in San Diego, California.



John A. Barry is an author and editor. His latest book, *Technobabble* (MIT Press), examines the influence of computer terminology on language and society. He has been editor of DBMS, a monthly magazine for database-application developers, and managing editor of InfoWorld, a weekly newspaper for PC user and buyers. During five years at Sun Microsystems, John helped create and develop SunTech Journal, a quarterly publication for Sun users and developers.

On the Cover: Close-up of a gear tooth profile displaying a classic problem of stress analysis. A full view of this profile and the Von-Mises stress plot indicating high stress regions at the point of contact can be found in the article on CADKEY ANALYSIS. (Photo courtesy of Cadkey, Inc.)

KEY SOLUTIONS

Concurrent Engineering for the 90's

EDITORIAL

509-445-1799
Managing Editor
Claudia Martin

Technical Editor
Dr. Robert Martin

CONTRIBUTING COLUMNISTS

Ron Shea, Craig Storms
Al Torizzo

DESIGN

Art Director
Melissa Clark

PRODUCTION

509-928-5169
Production Manager
Gayle Simpson

ADMINISTRATION

509-928-5169
Business Manager/CEO
Steve Radford

ADVERTISING SALES

WESTERN REGION
Jimmie Bohn
Ph: 818-543-0206
Fz: 818-240-3231

EASTERN REGION

Jo Schmidt
Ph: 509-445-1748
Fz: 509-445-1146

EDITORIAL POLICY: Key Solutions is an independent publication without obligation to any software or hardware dealer, vendor or distributor, except as indicated. Articles noted as news or features are written without knowledgeable bias. Articles noted as editorial represent the opinion of the author. Technical articles represent the opinion of the author and are selected by virtue of their educational value.

SUBSCRIPTION CORRESPONDENCE: (orders, change of address, etc.) should be directed to Key Solutions, P.O. Box 11978, Spokane, WA 99211-1978. Allow six weeks for processing.

EDITORIAL CORRESPONDENCE should be directed to Managing Editor, Key Solutions, P.O. Box 11978, Spokane, WA 99211-1978. Key Solutions encourages readers to submit articles, letters, questions and technical tips.

Key Solutions, Copyright © 1992, ISSN 1064-2145 is published bi-monthly by Value Engineering Associates. Microsoft and Windows are registered trademarks of Microsoft Corporation. IBM is the registered trademark of the International Business Machines Corporation. CADKEY is the registered trademark of Cadkey, Inc.

KEY TALK

The political dust has settled, but the economic and technical wolves at our country's door are still lurking with fangs bared. We'll soon see if promised answers and solutions really materialize to chase them away. Frankly, I'm not holding my breath. First, I've observed that as a group politicians don't have a great track record and are incredibly s-l-o-o-o-w. Second, during the recent brouhaha, most seemed to overlook a very important and basic issue -- a foundation stone that profoundly affects our national well-being. The issue is the state of our public education system. Specifically, the vocational, technical and scientific areas of our education system are deficient and our young people, as well as the country, are the losers.

Public education was created around the turn of the century to prepare young people to contribute to the nation's success as an industrial power, but needs then were relatively simple. The ability to read and write, to understand standard units of measure and to calculate in four function mathematics comprised an adequate education. By the late 1930's most states had institutionalized their public school systems, putting the schools directly under the political arm of state governments which, as it turns out, was probably a mistake. Industry and technology developed rapidly but schools did not, because government does not change easily.

In today's high-tech world yesterday's standards are no longer adequate. Because schools have not kept pace, they are not providing the skilled and knowledgeable workers industry needs to compete with the rest of the world technologically. And so we have arrived at our current situation -- sending jobs offshore, letting other countries take away our leadership in R&D in many fields, shrinking profits, etc. etc.


Educators are not to blame. They have struggled valiantly for years with a multitude of difficulties: rising costs and slashed budgets dictate out of date or non-existent technical equipment; low salaries scare off top level scientific and technical instructors; increased demands at all levels continue to spread minimal resources thinner and thinner.

What to do? Wait for governmental solutions, or pitch in and create some solutions on our own? True, industry is already involved on a small scale with junior and senior high schools, providing instructors for special programs and some equipment. Companies like Cadkey, Inc. have programs for getting software products into student labs. Unfortunately, these admirable programs are just scratching the surface.

The need is vast and the territory so uncharted, knowing where to begin is a problem. Good intentions can be wasted if not focused. So one day Peter Smith (Vice President of Cadkey Inc.) and I came up with an idea. Key Solutions (magazine, readers and advertisers) should adopt one public school for a pilot project in vocational education -- a real showpiece of what schools and business can accomplish together without government help and/or interference. Y-E-S-S-S!

Key Solutions is planning this project right now and is requesting your support and contributions in the form of equipment, raw materials, technical assistance and/or software in exchange for tax credit for the donations. The goal is to make graduating seniors industrially employable. (Hey! It sure beats the prospect of a minimum wage job). The school selected will modify its curriculum to include CAD/CAM/CAE into its industrial arts program. The pilot could provide an example of how industry and public education can work together to provide a rich and relevant technical education for today's high school students.

If you're interested in participating in this project, please contact me for more information. There will be more details in the next issue. Whatever you think of Ross Perot, I learned something from the phenomena of his campaign. If enough people work concertedly together, they can make things happen. As a unified group of concerned technicians, engineers and industrialists we have the power and ability to initiate tremendous changes. The question is, do we care enough to roll up our sleeves and dig in?


 Robert Martin
 Technical Editor

ACCORD

Technology, Incorporated

P.O. Box 658 Len, MA 01218 FAX 413-243-2768
 "Performance Products for Professionals"

1-800-622-3373

PLOTTERS

ROLAND	
DDP 1100/1200/1300	\$790/995/1150
CAMM 1 Vinyl Cutter/Plotter "Best Price"	CALL
PNC 1100 34" Vinyl Cutter/Plotter	CALL
METFORMATE A-Size Plotter/Cutter	CALL
STRA Scanwin/Cutter	CALL
ENCAD	
SP1800 A/D 8 pin Super Quiet	\$2100
SP2000 A/E 8 pin	\$3070
Houston Instruments	
DMP 160 Series NEW & FAST	CALL
Hewlett Packard DESIGNJET	CALL
Calcomp DesignMate A-D, 8 Pin	\$1992
Inline	CALL
Mural 8000 A/D, 8 Pin	\$2195
Pacific Data ProTracer A-C Inkjet 5Mb	\$1647

DIGITIZERS

CALCOMP	
31120 12012, 4 or 16 Mb, Cabled	\$299
31140 14014, 16 Mb, Complete	\$1523
31480 14048, 16 Mb, Complete	\$1670
31600 14040, 16 Mb, Complete	\$1029
SUNMAGRAPHS	
SunmagGraph 8 12012, 4 Mb/Day	\$259
SunmagGraph 8 12012, 16 Mb	\$310
SunmagGraph 8 12018, 4 Mb/Day or 16 Mb	\$406
KURTA	
KLP 12012, 4 Mb/Day, SPECIAL PRICED	\$245
KLP 12018, 4 Mb/Day, SPECIAL PRICED	\$483
KLONE 12012, 4 Mb/Day or 12 Mb	\$345
KLONE 12012, 4 Mb/Day or 12 Mb	\$579
KLC 14036, 16 Mb	\$1379
KLC 14048, 16 Mb	\$1409
HITACHI	
Peris Plot 12012, 4/12/16 Mb	\$123

GRAPHICS CARDS

NUMBER NINE	
On Light Lanes 20/21	\$658/9752
On Low 20, 1280x1024, 16 Ch, 704000 CAD	\$2050
On Low 20, 1280x1024, 256 Ch, 704000 CAD	\$1750
On Low 20, True Color, 1280x1024, 40K Colors	\$1648
VERMONT MICROSYSTEMS	
Color 016 16	\$485
Color 016 Spectrum	\$1140
HERCULES	
Graphics Station Card 1Mb/1Mb	\$142/582
Graphic Station Card	CALL
Chrome, New Product, 8 Mb/16 Mb or 40Mb	From \$1387
METHULIS	
1214/1218 1280x1024 16/256 Colors	\$1100/1500
1214 Plus, VGA On Board	\$825
Proview 12 140, w/Retrospect 0LP	\$306
DIAMOND	
Speed Star 24 16 Mb/16 Colors to Windows	\$229
Speed, 140 1280x1024	\$289
VIDEO SEVEN	CALL
IMAGE PROCESSING SYSTEMS	
OverFlow 3104 w/SoftEngine 0LP	\$354
OverFlow 3204 w/SoftEngine 0LP	\$395

MONITORS

HITACHI	
CR2001M 19" SuperScan +	\$1870
HM4320-21AP Active 21" Flat Screen, 256K	\$2359
MITSUBISHI	
HL60454TS 19" VGA w/ 1280x1024	\$1867
HL601558M 20" DM, 60K VGA w/ 1280x1024	\$2388
TAXAN	
DT1000 20" VGA w/ 1280x1024, DM, 60K	\$1899
DT1150 21" Flat Screen 1400x1200, DM, 60K	\$2459
NANAO	
F550K 17" FlatScreen, 1280x1024	\$1199
T560K 17" FlatScreen, Trinitron, 1280x1024	\$1895
F560K 20" Trinitron, 1280x1024	\$2099
IDEX All Models, Great Pricing	CALL
SONY	
GM 1004 20" Trinitron	\$2499

New Products!!

Creative Labs Multi-MediaKit	CALL
URAG Scanners 1200/600 DPI	CALL

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

MASTER CARD & VISA Accepted

CIRCLE CARD NO. 203

SURFCAM™

Powerful CAM software for CADKEY users

SURFCAM's menu structure and view numbers are similar to CADKEY's for a clean and consistent interface.

SURFCAM includes bi-directional CADL support for seamless data translation between CADKEY and SURFCAM, including 2D & 3D geometry and NC toolpaths.

SURFCAM translates CADKEY's Bezier Surfaces from the Super Patch format into SURFCAM Bezier surfaces. (SURFCAM supports highest degree Bezier surfaces.)

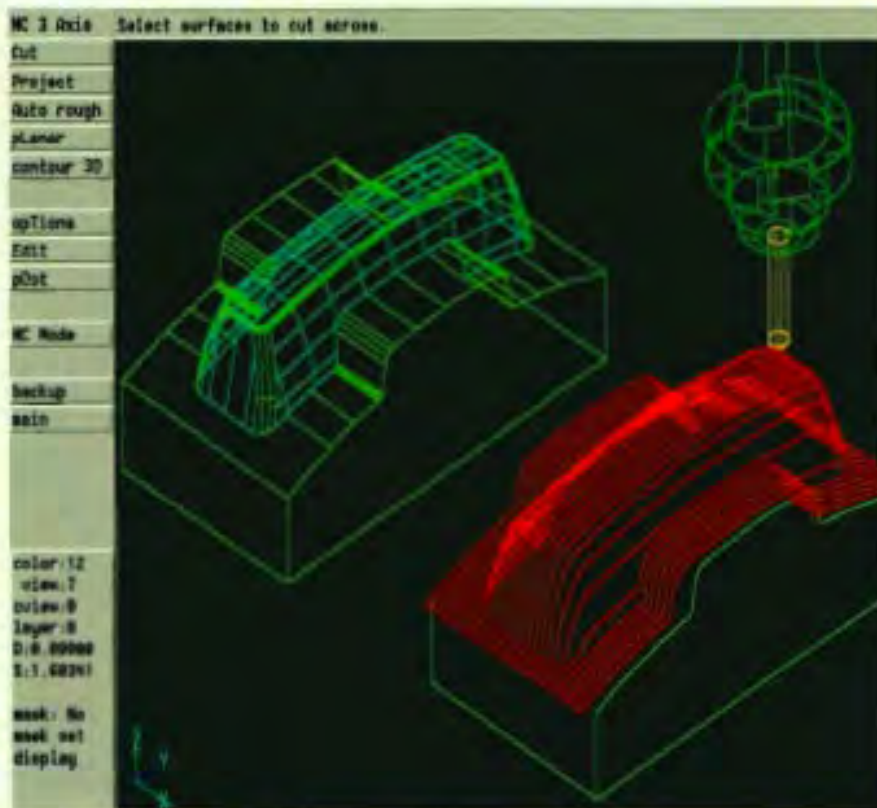
SURFCAM out-performs most high-end workstation systems in speed and features, yet has been judged the easiest-to-learn all-around CNC machining system.

SURFCAM's NURBS features:

- a) One-step, gouge-free surface cutting of hundreds of trimmed surfaces.
- b) Contain cutter paths within boundary splines to allow gouge-free cutting to adjacent surfaces.
- c) Import IGES trimmed NURBS surfaces.

SURFCAM creates true surface models and optimized toolpaths with gouge avoidance for 2 axis through 5 axis CNC mills, lasers, waterjets, routers, digitizers, CMMs. Includes support for simultaneous 4 and 5 axis machining.

SURFCAM 32-bit DOS and 32-bit Windows versions require a 386/486 PC computer with 4 MB memory.



SURFCAM's Surfaces

Proven over 5 years.

- Easy! Learn to construct & cut surfaces the first day
- 3D surface design, modeling and machining
- Powerful 2 axis, 3 axis, 4 axis and 5 axis systems
- Workstation speed & power at PC prices
- Call 1-800-488-3615 for demo disks, \$15 VISA

Dealer Inquiries Welcome

SURFCAM INCORPORATED
421 Park Ave., San Fernando CA 91340
(818) 361-5606 Fax (818) 361-1919

SURFCAM™

Cadkey Forum

NEW PRESIDENT TALKS ABOUT CONCURRENT ENGINEERING, CADKEY AND KEY SOLUTIONS

by Malcolm Davies, President - Cadkey, Inc.

As the new president and CEO of Cadkey, I am excited about taking on a new venture and about the unique opportunity to tell you about it in *Key Solutions*. Continually beating the competition in competitive reviews, there is no doubt that CADKEY® is "best in class" software. CADKEY is the only PC-based CAD software honored as PC Magazine's Editor's Choice all three times: 1986, 1988 and 1990. Now Cadkey is poised for growth with a new class of quality engineering tools, support and training for the mechanical engineering marketplace.

This is not surprising. Historically, Cadkey always had the courage to adopt a different strategy than its competitors. Instead of simply developing a core graphics engine, and then depending totally on third-party developers to provide applications, Cadkey focused on producing complete solutions for manufacturing industries with integrated solids, surfaces and analysis built-on industry-leading 2D and 3D core systems. The flagship product, CADKEY, is designed by engineers for engineers, and it shows.

Cadkey is poised for growth...

I believe this approach to product development is appropriate today! In the global marketplace, the competitive advantage belongs not to the biggest or richest, but to the most productive. Customers want totally integrated solutions from a single vendor and still have the option to enhance function through third-party programs. Cadkey provides these opportunities, and is the most prominent supplier of PC-based desktop engineering tools.

Cadkey's approach to accelerating manufacturing productivity has been called desktop concurrent engineering. Using three core Cadkey pro-

grams, the design and manufacturing of products is accomplished with as little organizational waste as possible. A team tackles a project by setting many engineers to work at the same time on different aspects of a task -- or one engineer works alone on many different aspects of a task. CADKEY provides true 3D design, detailed drawing, and solid modeling capabilities at a fraction of the cost of other CAD systems. It is the foundation for other Cadkey tools which all share a single flexible database and easy-to-use interface.

I invite you to send
comments
both positive and negative...

As the engineers work, they can easily and quickly analyze and refine their product designs themselves using CADKEY®ANALYSIS. This tool lets them anticipate how factors such as thermal and load stress will affect their design choices. Having ready answers to "what if" questions early in the design stage can help engineers send high-quality designs more rapidly into manufacturing.

Manufacturing projects that took weeks can be wrapped up in hours when CADKEY and CADKEY ANALYSIS are integrated with CUTTING EDGE™. This CAM system for milling and lathe operations gives CAM operators full control over every tool path and every tool motion.

Like these three core capabilities, all of Cadkey's integrated software tools run on most DOS and UNIX® platforms. So, without buying extra hardware, your company can work and communicate with customers and vendors on any system because all are compatible with CADKEY.

Cadkey has the right products at the right time, understands the dynamics of the marketplace, and has the ability to rapidly adapt to chang-



Malcolm Davies

ing requirements. The CAD market was revolutionized in the 1980's with the advent of the PC. I believe we are poised for another revolution led by the high end capabilities and affordable prices of CADKEY.

Creating a dialogue between Cadkey and its users is extremely important. It will be my pleasure to use *Key Solutions* as a primary communications vehicle and a way to get to know you. I invite you to send comments, both positive and negative, as well as information and questions regarding CADKEY and your use of the products, to my attention at *Key Solutions*. Your input is valuable to insure the highest quality service and products are always available.

Send your comments to:
Malcolm Davies, President
Cadkey, Inc.
c/o Key Solutions
P.O. Box 11978
Spokane WA 99211-1978

Or, to the Cadkey section of the
CADDVEN Forum on
CompuServe.

NEW PRODUCTS

INPUT

Wide-Format Scanners

Océ Graphics USA, Inc. of Mountain View, Ca. has entered the market for 500 to 800 dots-per-inch (dpi) wide-format, monochrome scanners. The G6000 Series provides greater resolution, data input quality and user convenience than competitively featured or comparably priced scanners. The G6035, a 10,000 pixels per scan line 500 dpi scanner, is particularly suited for electronic data management systems (EDMS), archiving, raster overlay and paper-to-CAD conversion. The G6035 can scan an E-size drawing in 90 seconds into a 300 dpi RLC file. More than 35 file formats are supported, making the G6000 Series compatible with most popular GIS, CAD, EDMS and raster overlay packages. The G6000 Series scanners range in price from \$13,990 to \$19,990. Contact Océ Graphics at 800/545-5445; Fax 415/961-6252.

3D Input - Spaceball

CalComp Digitizer Products Group of Scottsdale, Az. has released Spaceball 2003, a unique 3D input device which allows simultaneous manipulation of the x, y, and z axes. It consists of a tennis ball-sized sphere fixed on a partially concave stand that senses hand pressure and motion. The Spaceball 2003 is a plug-and-play replacement for the dial box - the standard input device used by most 3D designers today. It lists at \$1,595.

Contact CalComp at 602/948-6540.

Programmable Keyboard

MaxiSwitch, Inc. of Tucson, Az. announced the release of the MaxiPro II, a fully programmable keyboard for PC compatible applications. MaxiPro II includes a microprocessor and internal memory that allows it to be

customized for use with any software. Keys can be relocated and macros up to 1,800 characters can be assigned to a single key. Multiple macro libraries can be stored on disk and down loaded as required using a pop-up utility. Contact MaxiSwitch at 602/294-5450; Fax 602/294-6890.

Flying Mouse

Handykey Corp. of Mt. Sinai, N.Y. offers a combination mouse and keyboard in a handheld unit called Twiddler. Characters are typed by combining some of the 12 finger and 6 thumb keys. The 4 oz. unit works with DOS and Windows and either the right or left hand. It lists for \$199.00 and has a three year warranty.

Contact Handykey Corp. at 516/474-4405; Fax 516/474-3760.



Handykey Corp.'s Twiddler

Raster/Vector Conversion Tool

Arbor Image of Ann Arbor, Michigan has announced the release of AfterImage 3.0 in December. This heads-up digitizing program was formerly known as Tracer but has been renamed due to trademark

confusions with other programs. The upgraded, renamed version will transparently overlay raster images and vector drawings on the same screen and provide raster as well as vector editing tools. AfterImage's new tools facilitate editing the raster image as well as digitizing the image into CAD. Entities produced with AfterImage are made of lines and area and may be exported to all CAD programs. AfterImage also has a seamless DDE interface to Arbor Images's automatic vectorization program, Draftsman for Windows. Contact Arbor Image at 313/741-8700 or Fax 313/741-8806.

Laser Measurement

Supraporte, Inc. of Carlsbad, California announces Laser I Probe, a major enhancement to the SYSTEM 6 line of portable, mobile measuring machines. This new non-contact probe can accurately measure moving or vibrating parts, or easily deformed materials, such as fabric. Previously non-contact probes were limited to small parts and were impractical for large surfaces. The laser technology is based on reflective light and has built-in surface reflectivity compensation. Potential applications for the Laser I include measuring power lines or other wires in place for deterioration, developing prostheses or measuring cell growth without disturbing the cells or their environment. The new Laser I measuring system is currently available as an option on the SYSTEM 6 portable measuring machine. The new probe is easily attached to the lightweight 6 axis arm.

Contact Supraporte Inc. at 619/431-7944 or Fax 619/431-7940.

Digitizer Performance in a Mouse Clone

ProHance Technologies, Inc. of Los Altos, California has announced

availability of four input devices for under \$90. The buttons of the 12-, 17, and 40 button models can be programmed to perform all the functions of a digitizer.

Contact ProHance Technologies at 415/967-5774 or Fax 415/967-5744.

OUTPUT

CAD, Windows and 3D Graphics Direct to Video

Hercules Computer Technology, Inc. of Berkeley, Ca. announced the SUPERSTATION XP series of modular graphics accelerators featuring scalable resolutions and color depths, and optional NTSC/PAL video encoding. Resolutions range from 640 x 480 to 1280 x 1024. Color depths include 4-, 8-, 15-, and 24-bits per pixel. With the video option, Windows, Autodesk, and TIGA applications can be recorded in real time. The board's flexibility gives users an option of selecting between maximum resolution for layout or analysis and maximum color depth for photo retouch or graphic design. Hercules' Windows drivers feature True Type/ATM font caching and BigMap[®] hardware pan control allowing instant access to a bitmap that is much larger than the visible display.

Contact Hercules at 510/540-6000 or 800/332-0600; Fax 510/540-6621.

VLD Displays Graphics 900 Feet from Host

STB Systems of Richardson, Tx. has announced the Video Line Driver (VLD), an add-in board which will allow the monitor to be placed over 900 feet (or 300 meters) from the host system and display high quality graphics

through standard 75 ohm coaxial cable. The VLD supports all IBM PC/XT/AT or compatible PCs, and VGA monitors accepting BNC inputs. This adapter is designed to work with any standard VGA or Super VGA adapter, as well as the new Windows accelerators. They amplify resolutions from 640 x 480 up to 1280 x 1024 in an unlimited number of colors and a variety of refresh rates. Resolution is limited only by the graphics adapter to which the VLD is connected. Suggested retail price for the VLD is \$369.

Contact STB Systems, Inc. at 214/234-8750.



CalComp's Print Bridge PostScript-Language Controller

PostScript-Language Controller

CalComp Computer Graphics Group of Anaheim, Ca. has introduced Print Bridge, a PostScript-language compatible controller for the company's large-format 68000 Series color electrostatic plotters and Model 67436 monochrome electrostatic plotter. This raster image processor, designed to produce large-format final output, is a stand alone unit measuring 14.5"W x 3"H x 16"D. Print Bridge includes drivers for Windows and Macintosh and is priced at \$9,995. Contact CalComp at 800/932-1212.

Mutoh Adds CalComp GL Support

Mutoh America, Inc. of Mt. Prospect, Ill. announces plotter output compatibility to CalComp's graphics language format. The CalComp graphics language is a binary-based format which allows significantly faster data transmission between host computer and output peripheral. This emulation provides a 40% increase in output transmission to Mutoh's F-920, an XP-500 Series of pencil/pen plotters. Contact Mutoh America at 708/952-8880; Fax 708/952-8808.

C-Size BubbleJet

JRL Systems of Austin, Texas now offers a low cost, laser quality C-size printer/plotter for CAD environments. The JR-670 HighRes BubbleJet prints and plots at 360 dpi, supports HP-GL, CalComp 906/907, and Epson LQ1050 input formats. The unit's dual-bin automatic sheet feeders accept A- through C size paper. The paper "parking" capability lets you alternate between cut sheet and tractor-fed paper. You can also manually feed paper in weights up to 33 lbs. Prices for the JR-670 begin at \$1,995. Contact JRL Systems, Inc. at

512/288-6750 or Fax 512/288-7676.

High Performance Pen/Pencil Plotters

Roland Digital Group of Irvine, Ca. is extending its line of large format plotters with the addition of two pen/pencil plotter lines: the new GSX drumfeed series, and the new DPX-2600/3600 flatbed models. Both support 8 pens/pencils. The GSX Series pencil plotting feature uses an automatic lead feeder that ensures continuous, high-quality plotting. Up to 10 leads can be fed into the pencil holder, which supports 0.2mm, 0.3mm, and

NEW PRODUCTS



Roland's GSX Pen/Pencil Plotter

0.5mm lead sizes. A 1 Mb data buffer may be expanded to 4 Mb. Features include auto-protocol, HP-GL and HP-GL/2 compatibility, pen and vector sorting, and a mirror function. Prices have been established at \$7995 for the GSX-3000 and \$8995 for the GSX-4000. New DPX models are priced at \$5995 for the DPX-2600 and \$6995 for the DPX-3600. The DPX-4600A is priced at \$11,995.

Contact Roland at 714/975-0560; Fax 714/975-0569.

HARDWARE

RapidCAD Prices Cut

Intel Corp. of Santa Clara, California announced a price cut on its RapidCAD Engineering coprocessor from \$499 to \$299. A specialized math coprocessor, RapidCAD is designed to boost the performance of technical applications like CAD, engineering, mathematics, science and statistics. Intel estimates that RapidCAD processes data up to 70% faster than a standard math coprocessor. RapidCAD is for 386DX CPU based systems.

Contact Intel Corp. at 800/538-3373.

PC Workstations Customized for CAD

Bay Engineering of Coos Bay, Or. is shipping a complete line of PC workstations custom-configured for the CAD market. The workstations are based on Intel 386 and 486 CPUs.

Each complete system is built "CAD-ready" and can be upgraded with a number of options such as tape drives, SCSI controllers, enhanced monitors and extra RAM. All systems come pre-loaded with DOS 5.0 and can support UNIX

and OS/2. Bay Engineering offers a 30-day, money-back guarantee, and one-year parts and labor warranty. On-site service provided nationwide by TRW.

Contact Bay Engineering at 800/258-6778.

CAM

DNC Direct from Standard CNC Controller

Solutionware Corporation of San Jose, Ca. has released their new Integrated CAD/CAM programming system for mills, lathes, and wire EDM. This update features a new DNC system which will allow the user to control everything from the CNC controller. Key features include lists of the NC files on hard-disk and automatic downloading to selected files on your control. The system is compatible with most standard CNC controllers with a CRT display; for example, Fanuc OM, Fanuc OT, Fanuc 6M, Fanuc 6T, Fanuc 10M, Fanuc 15, Yasnac MX1, Yasnac Tomato, etc. The only requirement is a switch-box for CNC controls that have RS232 with standard X-on/X-off. Software is free with the

purchase of Solutionware's Completely Integrated CAD/CAM CNC Programming system. Price: \$4995.

Contact Solutionware at 408/249-1529.

SOFTWARE

IGES Data Analysis

IGESView 3.0 is a graphics viewing program from IDA of Melrose Park, Ill. that lets users zoom, pan, crop, and rotate 2D and 3D graphics. Users can specify clipping planes in 3D to cut through an object and specify the angle or rotation of the x, y, or z axis. Other features include entity selection, engineering markup/redlining, a new window to summarize and modify the visibility and color of each IGES entity, and English and metric units of measure control. IGESView 3.0 supports most Unix and VMS workstations and is priced at \$1,995 for a single floating license. Contact IDA at 708/449-3430; Fax 708/344-2840.

Flexible Rendering Software

Lunar Graphics Inc., of Golden, CO has released REALIZE RENDERING TOOL. This 3-D solids rendering software program is a visualization and communications tool designed to run on any 8086 DOS computer. REALIZE RENDERING TOOL is the first rendering tool available under DOS that offers WYSIWYG (what you see is what you get) control over the rendering process. A rendered image can be produced at any time during wire frame viewing. REALIZE imports CADKEY SOLIDS and CADL files as well as DXF files. It can also import an ASCII polygon list file (e.g., generated by machine vision systems or medical imaging systems). It uses standard VGA or

Super VGA hardware providing resolutions up to 1024 x 768 by 256 colors using only 640K RAM. REALIZE can quickly render any size model, limited only by free disk space. Models in excess of 25,000 faces have been rendered in less than one minute. Other features include tools for rendering smooth (Phong), flat, and gradient surfaces with textures, unlimited point and constant lights, dynamic color image editing, a slide show presentation function, automatic view-to-view image generation, and Windows compatible output (PCX). REALIZE has a suggested retail price of \$695.

Contact Lunar Graphics Inc. at 303/526-2553 or Fax 303/526-7319.

MISCELLANEOUS

Engineering Handbook Updated

Desktop Engineering of Mahwah, New Jersey announced that version 4.0 of the DE/CAASE (Desktop Engineering/ Computer Aided Analytical Solutions for Engineers) computerized engineering handbook has been released. DE/CAASE can reduce the time required to solve structural/mechanical engineering problems by helping the user select the proper equation, prompting for required inputs, automatically solving equations and providing graphical illustrations. DE/CAASE incorporates solutions to over 5000 structural/mechanical engineering equations found in over 100 reference books. In addition to MS/DOS support, Version 4.0 will operate on a Unix platform in the X Window environment using the Motif Window Manager and will support Sun Sparcstations. Contact Desktop Engineering International Inc. at 201/818-9700 or Fax 201/818-9707.

You are cordially invited to attend the



"1993 Computer Aided Technology Open House"

January 14, 1993
Northbrook, Illinois

Topics:

New Software Technology Product Demonstrations
"Cutting Edge" Cadkey's Integrated Manufacturing
Cadkey's upcoming Product Developments
Cadkey and Alias - The Industrial Design Solution
Latest Hardware Output Technologies
New Unix workstations and Networking Cadkey
Rapid Prototyping
Door Prizes

Guest Speakers:

Ann MacKinnon
Cadkey Central US Representative
"Cadkey: The Next Generation"

Robert Bean P.E.
President of Boystate Technologies, Inc.
"New Product developments In DraftPak through Cadkey CDE's"

Kevin Coughlin P.E.
President of CAE Associates, Inc.
RASSA, ADINA & Cadkey Analysis State-of-the-Art Analysis software

Martin van der Roest
President of The van der Roest Group, Inc.
Solutions for Drawing & Document Management in a network environment

Katie Sullivan
Alias Channel Marketing Manager
ALIAS and Cadkey - The Industrial Design Solution

Agenda:

1:00-5:30pm
Informal vendor demonstrations
Hands-On Product Reviews
5:30-9:00pm
Refreshments will be served
Guest Speakers
User Group Meeting
(All CAD users welcome)

*For Free Registration contact
Robert Roberman at
(708) 498-9600
Fax this completed form to
(708) 498-9725

Sponsored by:
Computer Aided Technology, Inc.
3100 Dundee Rd. Suite 202
Northbrook, IL 60062

Please check the following product(s) of interest:

- | | | |
|-----------------------------------------------|-----------------------------------------------|-------------------------------------------------|
| <input type="checkbox"/> Cadkey | <input type="checkbox"/> DraftPak Die Design | <input type="checkbox"/> Alias CAID & Animation |
| <input type="checkbox"/> Cutting Edge | <input type="checkbox"/> DraftPak Mold Design | <input type="checkbox"/> Parametric Solutions |
| <input type="checkbox"/> Cadkey Analysis | <input type="checkbox"/> DraftPak B.O.M. | <input type="checkbox"/> Database Management |
| <input type="checkbox"/> Rasna Analysis | <input type="checkbox"/> Surface Modeling | <input type="checkbox"/> Cadkey View Stations |
| <input type="checkbox"/> Adina Analysis | <input type="checkbox"/> EMW CAD Furniture | <input type="checkbox"/> Reverse Engineering |
| <input type="checkbox"/> DraftPak Enhancement | <input type="checkbox"/> Rapid Prototyping | <input type="checkbox"/> Other _____ |

Name: _____ YES, I would like to attend!
Title: _____ No, I cannot attend, but please
keep me informed of other events.
Company: _____ Please send information on
items checked above
Address: _____
City: _____ St. _____ Zip: _____
Phone: _____ Fax: _____

CIRCLE CARD NO. 236

KEYNOTES

CADKEY in the News

New Cadkey President

Dr. Malcolm Davies, previously with Autodesk Inc., has joined Cadkey, Inc. as president and CEO. While at Autodesk he was vice president of marketing and sales from 1988 to 1992 and most recently senior vice president, Americas. During this period the company's sales grew from \$79 million to almost \$300 million. A registered architect, he has been active in computer-aided design since 1969 as a developer and user. He is a member of the board of directors of the National Computer Graphics Association.

New Cadkey

Vice President Appointed

Dr. George Krucik has been appointed senior vice president of Cadkey, Inc. Prior to joining Cadkey, Dr. Krucik was with Autodesk where he held several positions including managing director of Autodesk Australia, manager of international technical relations, and product development manager for AutoCAD Release 10. Dr. Krucik, a licensed physician, also has a bachelor of science degree in computer science from the University of Manitoba, Canada and has worked in the field of computer applications to medicine.

New Pricing, Bundles, Trade-Ups

Cadkey, Inc. has announced new CADKEY® bundles, lower prices and the most competitive trade-up offer in the CAD industry. This price restructuring is the first major announcement since Malcolm Davies, Cadkey's new president and CEO, joined the company in October. "One of the primary reasons I joined Cadkey was my immense respect for the quality CAD products it develops. As one of the "best kept secrets" in the industry, it's my intention to bring CADKEY the attention it deserves. One of the ways to do that is to make it available at an affordable price to virtually anyone who needs a technically superior CAD system."

(Continued on next page)

INDUSTRY

Government-Chip Producers Sign Agreement

Intel Corp., Ultratech Stepper, and Jamar Technology Co. recently signed a \$25 million research pact with the U.S. Department of Energy's Lawrence Livermore National Laboratory. The pact is designed to encourage U.S. companies to compete against Japanese firms working on the same advanced computer chip technology.

Representatives of the three electronic companies said the four-year pact will encourage the commercial development of "X-ray projection lithography" and could lead to computer chips that are 10 times faster and have 1,000 times more memory than any today.

"This technology potentially offers an approach for U.S. companies to 'leapfrog' their foreign competitors in producing computer chips," said Nat Cedilo, Livermore senior scientist. "It's highly experimental, visionary. There's a lot of risk involved."

The DOE's Office of Defense Programs will provide \$12.6 million; the three companies will provide a like amount.

Microprocessor Manufacturers Winning Computer Wars

Fierce price wars may be killing the profits of many personal computer manufacturers, but Bloomberg Business News reports that cut-rate prices triggered a big jump in PC sales and a windfall for companies such as Intel Corp., Motorola and others that make microprocessors supplied to PC makers who copy the IBM system.

Novell Security Cracked

Novell said that recently a Dutch research group at Leiden University discovered a method of breaking NetWare's security system. In response, Novell plans to offer free user enhancements to prevent further security breaches. Enhancements will be tested by Novell for several weeks before being made available to consumers.

PC LAN Market Soars

Personal computer local area network (PC-LAN) sales continue to grow by over 20 percent a year, with revenues projected to rise from \$6.4 billion in 1991 to \$7.7 billion in 1992. Operating systems are the fastest growing market segment, according to a study just released by Market Intelligence Sales.

Unprotected Data

Despite capable new technologies and repeated alarms, two-thirds of U.S. intensive business personal computer users are either unprotected by formal data safeguard policies or unaware of their existence, according to a study sponsored by 3M Corp. As a result, many firms could lose information because of natural disasters, computer viruses and hardware failure due to human error.

Data/Voice Networks Growing

Cost-saving private data/voice wide area networks are growing in popularity, especially among small- to mid-sized businesses. A new study by industry

analyst firm International Data Corp. identifies a strong and growing trend toward "piggybacking" free remote-site voice and fax calls on data or LAN private communication lines, increasing the value of the corporate network and reducing operating costs. The study says businesses are increasingly using low-cost private leased lines (analog and digital at 9.6K-55/64 Kbps) to carry not just data or LAN traffic, but also toll-free voice and fax. A new generation of multiplexing devices is used to compress voice and data so efficiently that data, voice, fax and LAN integration is now practical without using costly, high-capacity T1 lines.

Business Television on Desktop PCs

Scientific-Atlanta, Inc. has announced its DBTV desktop business television system that brings business television programming directly to desktop computers via satellite. The system's multimedia capabilities allows employees to view programming, ask questions of presenters and exchange written documents at their desks. They no longer have to go to a central viewing area to participate in video training.

SUN & WORKSTATIONS

New Plotters, Sun Workstations Compatible

JDL, the U.S. sales division of Japan Digital Laboratory Co., has announced a series of D- and E-size (A1A0) direct imaging, monochrome plotters that are fully compatible with Sun Microsystems's workstations. The standard set of software drivers and utilities enable users of Sun and Sun-compatible workstations to take full advantage of ExpressPlotter II's user interface, high-speed SCSI port, and plotting for CAD/CAE applications.

Dunkin' Donuts with a Sun

Sun Microsystems Computer Corp. said it has received an order valued at about \$8 million to install workstations at more than 800 Dunkin' Donuts franchise operations over the next four years. The companies said the SPARCstation IPC computers will be part of Dunkin' Donuts Shop Information System for retail, distribution and production of its products.

ON THE LIGHT SIDE

We Can Hope!

Most airline industry experts agree that service issues are increasingly important as the reason why passengers choose one airline instead of another. So on some flights a high-tech hand-held device is given to passengers on board a flight so they can rate the various aspects of airlines in general as well as the flight in particular. At the end of the flight, the device is returned to flight attendants and information is down loaded immediately into a retrieval system.

Interactive Betting on Way

Imagine using a credit card to bet on horse races moments before post time -- via home TV set. Or betting through a TV set in a bar. The technology is already there, says Dan Downs, vice president of NTN Communications of Carlsbad, Calif. The company is testing an interactive TV package that allows viewers to sell stocks, make plane reservations and play sports-related games.

CADKEY in the News

New CADKEY Bundle

The CADKEY 5 system has been bundled with CADKEY SOLIDS, CADKEY ANALYSIS, an IGES translator, CADKEY Light, and a full year of technical support and upgrades. The complete bundle is available for \$3,495 until February 1993. List prices for these systems total \$5,879.

Innovative Trade-Up Offer

Cadkey's new low cost trade-up offer for current users of other CAD packages (including AutoCAD®, Personal Designer, Anvil®, Microstation®, and others) lets these users upgrade to the current version of CADKEY 5 for only \$495 and receive one year of Cadkey telephone technical support for an additional \$200. This trade-up offer is for both the DOS and UNIX platforms.

CADKEY users can also take advantage of these promotions. The \$495 offer is extended to CADKEY users who do not have a maintenance agreement or use Version 4.0 or below.

CUTTING EDGE Adds Drafting

CUTTING EDGE, the new CAM system from Cadkey, Inc. now includes drafting capabilities provided by CADKEY Light. The new CUTTING EDGE package provides 3-axis machining as well as 2D/3D drafting features and a DXF translator. The price is \$3,495 through February 1993.

CADKEY 5/ UNIX

CADKEY 5 systems for UNIX have been reduced \$500 and are now priced at \$3,495, the same as the DOS version of the system. Versions are available for the Sun, Silicon Graphics and Digital Equipment platforms and include CADKEY 5, CADKEY SOLIDS, CADL, Computer-based training, and DXF and IGES translators.

New Version/Price for Light

The new version of CADKEY Light (V 5) is patterned after CADKEY 5 and has many of the same high end features. The new price of \$99 makes it the lowest cost and highest performing CAD system on the market.

**A highly placed engineer reveals his
technical assessment of the new
\$7,995, 59 MIPS, accelerated graphics,
eye-popping SPARCstation LX.**



©1992 Sun Microsystems, Inc. Sun, Sun Microsystems, the Sun logo, and PC-NIS are trademarks or registered trademarks of Sun Microsystems, Inc. All SPARC trademarks, including the SCD-Compliant logo, are trademarks or registered trademarks of SPARC International, Inc. SPARCStation is licensed exclusively to Sun Microsystems, Inc. Products bearing SPARC trademarks are based upon an architecture developed by Sun Microsystems, Inc. All other products or service marks mentioned herein are trademarks or registered trademarks of their respective owners.

"Can I keep it?"



To more than 650,000 people around the world a Sun™ workstation on their desk has become a way of life, a must.

Let us present the latest addiction, SPARCstation™ LX. A graphics workstation that will take you screaming through your applications. Whether you work with CAD, AEC, CASE, design automation or document processing, imaging and office automation, SPARCstation LX is for you.

You can look at the LX in two different ways.

Just put on your numbers hat and you'll see 50 MHz, 59 MIPS, 64-bit memory bus, 10Mb/sec I/O, and so forth.

Or just sit down, load your favorite application, and you might not want to leave your desk.

Because the 8-bit accelerated graphics will make you use the full extent of your software, like interactively manipulating 2-D and 3-D wire-frame models.



And the built-in ISDN lets you share documents that combine text, graphics, images, audio, and video with anyone, anywhere. All with an intuitive graphical user interface called OPEN LOOK®.

You can even create powerful workgroups of SPARCstation LXs and existing PCs with Sun's PC-NFS® technology.

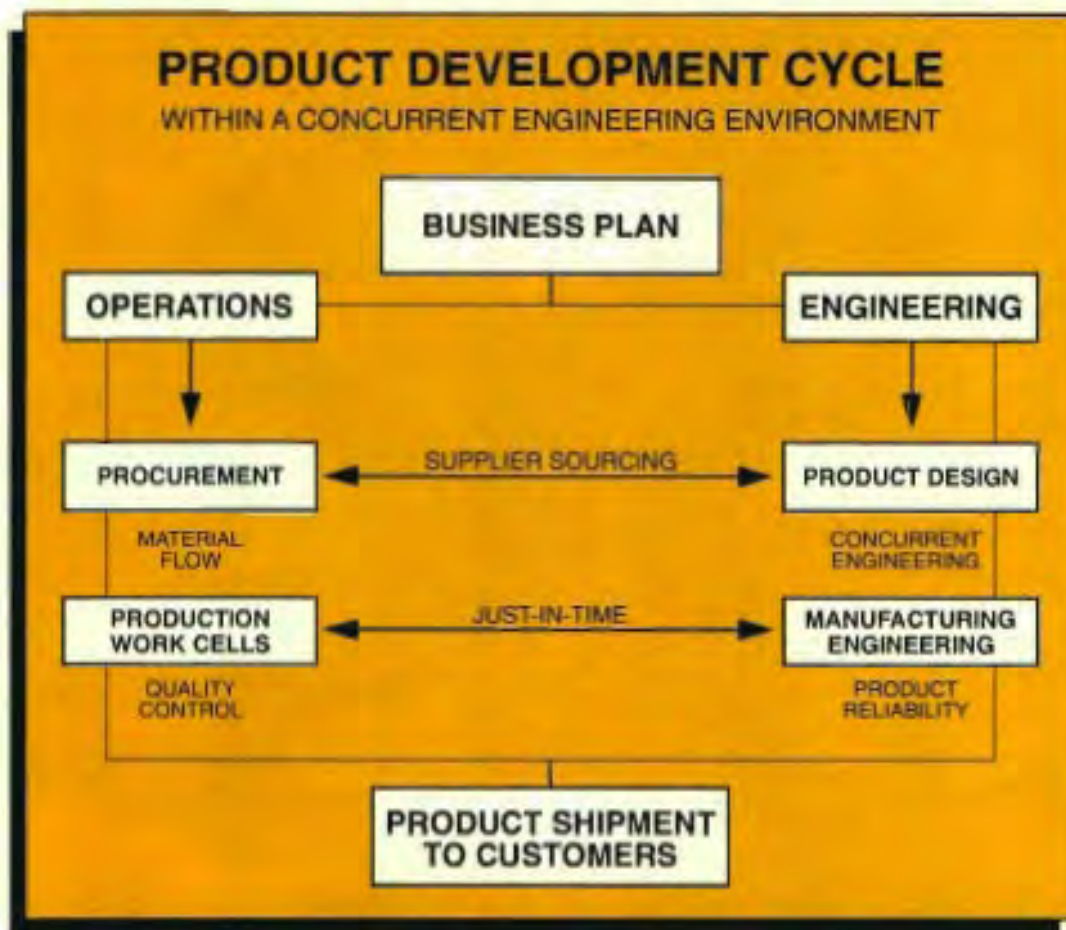
Any way you look at it, chances are this remarkable machine will end up staying on your desk.

Just call 1-800-426-5321, ext. 520 for more information or a demo. It's worth your time.



Sun Microsystems Computer Corporation
A Sun Microsystems, Inc. Business

Building Blocks of Concurrent Engineering



Just a glance at the product development cycle above, let alone real-life experience, would make most agree that concurrent engineering is a valuable concept and a valid goal. Although the theory is basically simple, putting a viable concurrent engineering plan into effect can be a major challenge. Multiple questions arise. What are some of the important components and factors? Where do you start? What problems might be encountered? What are some solutions?

The underlying question is, "Can we really do it at our company?" The answer is a resounding, YES. If you are already using CADKEY, you have a head start. To build on this foundation, all you need to do is select the best software and hardware support tools for the job, learn optimized techniques for managing people, data, and equipment, and engage in sound overall company-wide planning.

The following articles deal with a few of the issues involved in a concurrent engineering effort. Written by experts in the field, they will answer some questions and probably raise others. This is to be expected. After all, *concurrent engineering is a process -- not a destination.*

Hardware • *A Framework for Concurrent Engineering*

Engineering Tools • *CADKEY ANALYSIS - A New Design Tool*

Team Management • *Teamwork - The Heart of Concurrent Engineering*

Data Management • *Bill Of Materials - Engineering's Other Job*

CADKEY ANALYSIS: A NEW DESIGN TOOL

by Dr. Anil Gupta

BEM Versus FEA: Look Mom No Meshing!

Finite Element Analysis (FEA) has been the traditional method for mechanical part design and prototyping. In the hands of a well-trained operator the tool can produce accurate analysis results. However, FEA's success is dependent on several factors. First, accurate results are based on correctly breaking the desired part into finite elements through a process called meshing. Correct mesh building requires a high level of skill and knowledge. Depending on part complexity, the meshing step can be time consuming and improper meshing can cause costly errors in incorrectly analyzed parts.

While computers do all the mathematical analysis, FEA is still human-interaction intensive. Proper FEA results are dependent upon human skill and the reduction of human error is a top priority. The dependency on the human interaction time and skill factor in the part meshing process is the major reason so few parts are actually analyzed. For example, one study stated that within the automotive industry only 10% of all components are ever analyzed. Perhaps that is why you and I end up finding these under-designed parts ourselves. You know, the ones that cause the car to break down on our vacation trips when the car is loaded with the spouse, the children and the stuff, and we're 250 miles from home.

If that were not enough, files must go through many transfers for FEA. The majority of analysis products require that a part be first modeled in a CAD package separate from the analysis software. The file is then translated to a neutral language which is finally imported into the analysis product. The output from the analysis package is translated and transferred back to the specified CAD package to be viewed and/or modified in an easy to understand graphical environment.

This merry-go-round design cycle is repeated every time the part is modified and must be re-analyzed (a common occurrence in analysis). This translation process and file transfer adds further time and room for error into the design/analysis cycle.

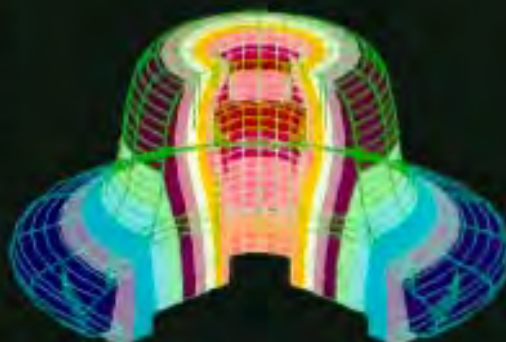
Enter CADKEY ANALYSIS. A model designed in CADKEY can be analyzed with no file transfer in an almost seamless fashion. Its most remarkable feature is the highly simplified and minimal procedure for meshing on the part of the operator. CADKEY has reduced the complexity of meshing and thus the associated time and human error levels all by an order of magnitude. They have accomplished this by using what is termed 'boundary elements' rather than 'finite elements'. With BEM the computer takes the boundary, segmented or tessellated, as described in a 2-D or 3-D model and begins the analysis. CADKEY's approach combines the analysis on the CADKEY CAD file without file translation and with the same user-interface that the designer used to create the original model. Time is reduced and human error is minimized in this design/analysis iteration.

Comparison Of Three Element Types For Analysis

H-elements

Traditional FEA code is based on H-version finite elements (H refers to the size of elements). The governing equation is derived from the integral formulation of the given differential equation. The integral equation embeds in it the evaluation of a volume integral. This integral is computed numerically by the sub-division of the volume into many small volumetric building elements called finite elements and evaluates the volumetric integral over all such elements.

The solution relies on the proper definition of the interior volume of the part. This is done through the use of meshing software (mesh generator) that is not integral with



TEMPERATURE PLOT

A thermal simulation involving both conduction and convection boundary conditions has been completed on this stainless steel collar model. (Photo courtesy Cadkey, Inc.)

the modeling software. The mesh generator adds both to the system cost (another product must be purchased) and the time factor of file transfer between the modeling and mesh software products being used.

The traditional FEA meshing software (mesh generator) divides a part into tiny square or triangular elements in 2-D models and cube shapes in 3-D. Even curved edges are broken down into multiple straight-sided edges or, at most, parabolic boundaries and not a true curved edge. All of these elements are finally linked together to form a complete volumetric representation of the model. This meshing and the linking process are both critical to the correct analysis of the part. Proper element types, precise mesh densities and linking schemes must be employed prior to the analysis being performed.

Unfortunately, the final mesh design is left totally up to the discretion of the designer. For that reason advanced engineering training is required to insure proper mesh design techniques are understood by the engineer. Once the concepts of FEA are understood, the software being used must be learned as well. Because of the complexity of using traditional FEA software, multiple manuals are required to cover the various meshing/element options and the learning process is time consuming. Finally, the software code itself is

very computer intensive.

While that value of analysis goes without question, the traditional FEA analysis process introduces a bottleneck to the overall design cycle. As mentioned earlier, the designer must first transfer or translate the model to another product. Secondly, the meshing, while automated to some degree, still relies on human skill and is prone to human error. If the analysis results are not favorable the part must be modified, often time intensively remeshed and analyzed again. Design cycle times can turn into an unmanageable several day delay with this continual translating/remeshing requirement.

P-elements

P-elements (Polynomial elements) are a variation on the more traditional H-version FEA. The mathematics behind this method follows that of H-version FEA, the difference being in the order of the polynomial used within a finite element. Here, the order of the polynomial is increased to get a more accurate solution. Current software employing P-elements perform the meshing in a semi-automatic method. The operator simply breaks the part up into several shapes by defining a rough mesh border. The software will prompt if the mesh has enough divisions to solve the analysis. While not automatic, the mesh

creation time is less than that required for the traditional H-version FEA meshing.

Reducing the time to create and define the mesh also reduces operator interaction time. The more important result of P-element based analysis is that the model requires far less finite elements for solving. The curved end of a mounting bracket would require only one P-element per defined quadrant, where in H-element models it could require 20 small elements to define the arc of the quadrant and 4-5 layers for the thickness of the part. P-element models generally require only 10% of the elements of an H-element FEA model.

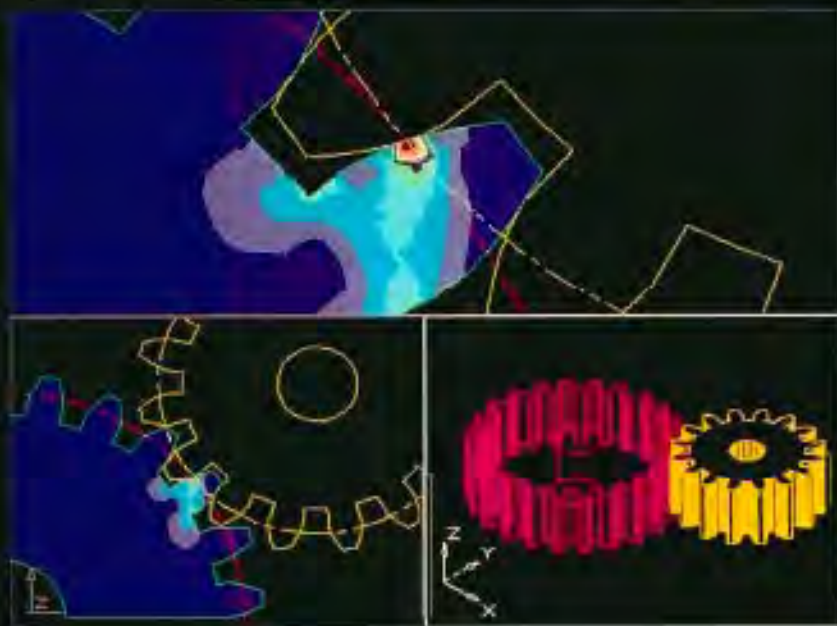
File transferring and translating are still an issue since the analysis products and the modeling products are generally from different vendors. While the P-method offers an alternative to the traditional H-method in terms of ease of use, it still has some inherent problems with solution accuracy and convergence. While these two methods do get the job done, in Biblical terms, "I show you a more excellent way."

B-elements

The B-elements (Boundary elements) based on BEM, on the other hand, are the exact opposite of nearly every category described for both the H- and P-element version FEA. The mathematical governing equation for BEM is completely different than the one used in FEA. The use of Gauss-Green (or Divergence) Theorem and Green's Function transforms the volume integral into an exactly equivalent surface integral on the surface or boundary.

The solution relies on the proper definition of the boundary surface rather than the volume of the part to be analyzed. While still not the same code as used for modeling, CADKEY ANALYSIS can directly read any CADKEY CAD model without translation. With 2-D or 3-D models the boundary is already given for the part. Since the BEM code does the volumetric analysis

A gear tooth profile displays a classic problem of stress analysis. The Von-Mises stress plot indicates high stress regions at the point of contact. Overlaying these results onto the original CADKEY model and using visualization capabilities eliminates guesswork about what your results represent. (Photo courtesy Cadkey, Inc.)



from the boundary description, no interior meshing is required. While the boundary must be broken into a simple mesh consisting of line segments for 2-D and polygonal elements for 3-D, it is much simpler than the volumetric meshing of FEA and is performed automatically by CADKEY. For this reason it is no longer essential for the operator to know the highly complex science of meshing. Proper element types, meshing and linking have all been eliminated. As a result, the multiple manuals required by traditional FEA products have been reduced to a single manual.

The result is a streamlining of the design cycle. The designer does not have to translate the model or perform sophisticated meshing as in FEA. Since the software does all the analysis, i.e., the work, less human expertise is required and less human error is interjected. If the analysis results are not favorable, the part can be modified and rerun with virtually no remeshing. The design cycle time is reduced to a manageable several minutes rather than an unmanageable several days.

Just to add to your confidence in this procedure, it has been around as long as FEA software has. It has been proven by many researchers that analysis based on BEM pro-

duces more accurate results, particularly in the critical areas such as stress concentration. The aircraft industry is so confident in the results from BEM that they have been using it for analyzing complex aircraft geometries since the mid-1970's. Furthermore, at present it is the most sought after research topic in the field of numerical simulation techniques.

While several products have been available commercially, they have limited modeling capabilities and cumbersome user-interfaces. Cadkey has overcome these last two areas by integrating CADKEY ANALYSIS into their existing 3-D modeling family. A similar easy-to-use interface is thus provided along with a smooth modeling, functionally prior to analysis.

Initial Modules

Three different types of analysis are currently supported from CADKEY ANALYSIS:

- 2-D and Axisymmetric Mechanical Elastic Stress/Strain
- 2-D and Axisymmetric Steady-State Heat Transfer
- 2-D and Axisymmetric Thermal elasticity

Conclusion

Since the analysis is part of the CADKEY family of products, it integrates directly with CADKEY Version 5, giving the operator direct access to all of the construction, display editing, printing, plotting capabilities, etc. of CADKEY. Mesh refinement, preprocessor and postprocessor are all included. Anyone familiar with CADKEY for designing can immediately begin to use CADKEY ANALYSIS since no prior knowledge of advanced mathematics is required. Hardware requirements are normally those of the existing CAD system with 8MB of RAM. Final output forms include contour plot, shaded contour plot and ASCII file.

What CADKEY did for design/drafting in the early 1980's, CADKEY ANALYSIS will do for concurrent engineering in the 1990's. Since BEM dramatically reduces the operator expertise level, designers can now do initial analysis on their own designs. This greatly reduces the requirement for "expert" FEA personnel to get involved. Compared to FEA, BEM simplifies file translating, reduces complex meshing and maximizes valuable design time while keeping the same level of analysis accuracy. CADKEY ANALYSIS truly offers "analysis for the masses."

TEAMWORK:

The Heart of Concurrent Engineering

Concurrent Engineering (CE) is a phrase that is beginning to get much attention in manufacturing environments today. Engineering managers may have different definitions of the phrase, but there are several common characteristics or ideas. These include: no pilot runs; get it right the first time; complete manufacturing plans; corporate scheduling rather than departmental scheduling; build prototypes in manufacturing not R&D model shops; high quality documentation to achieve fast ramp up (in production without needing to ask design engineering how this or that part is to work); and folding product engineering and design engineering under the same manager. All of these are elements of CE. Concurrent Engineering is based on successfully mastering the teamwork concept and innovatively using computer-aided engineering (CAE) systems.

Teamwork is the heart of CE. Traditional, serial-type, over-the-wall engineering must change to parallel engineering with quality, manufacturing engineers and suppliers involved at the conception of products. Successful companies find they reduce time to market by implementing quality and manufacturing requirements early on to avoid unnecessary changes later in the manufacturing cycle. A teamwork approach that involves all levels of management and employees also eliminates the problem of the "It's not my plan" syndrome.

This article is based on my experience at Key Tronic Corporation. It examines the issues of innovation in a CE environment and managing teamwork and CAE.

Building the Team

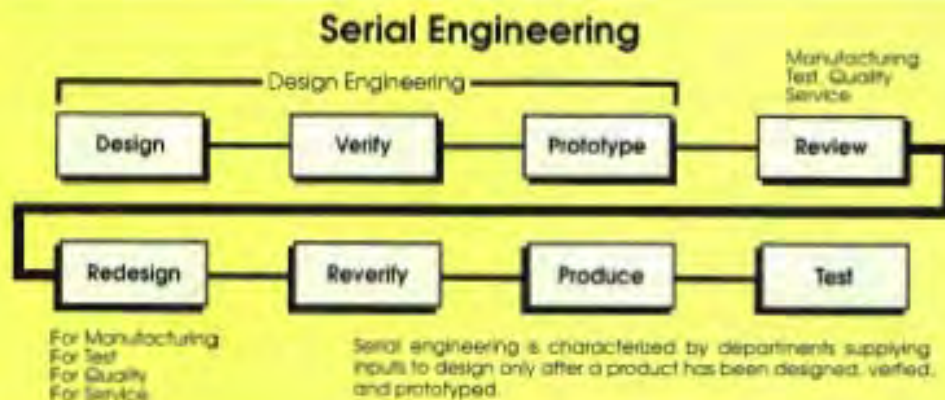
When managers implement CE, and achieve a united team effort among design engineering, manufacturing, quality, sales and marketing, they end up spending more time in the design phase than in the past. Management's largest responsibility is to get all the different functions within an organization to begin working together at the conceptual design phase. By spending the time up front, (this is the most difficult concept for management to grasp) we find that problems exponentially decrease in production and in the field. Companies must look at the whole picture; cost savings from CE will occur in departments further down in the product life cycle, not in engineering.

Unfortunately, the organizational structure in most firms works against achieving interrela-

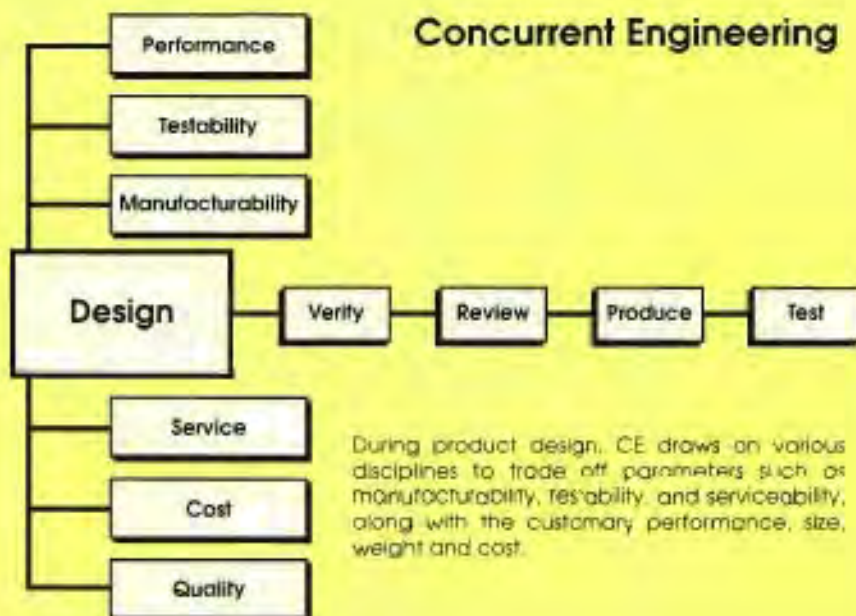
tionships between departments. Without a horizontal strategy, functional units may well act in ways that reduce rather than enhance their ability to work together. If you do not have a united team, it will be difficult to achieve CE let alone develop a successful CAE system.

Often in developing a CE environment you will find that the political barriers between the traditional departments are very difficult to change. Without the support of the departmental and general managers, your chances of success will be slim to none. You must have a general manager, or better yet, a CEO who is a key supporter and driver of the CE concept.

I believe in management by walking around (MBWA). As a CAD/CAM manager, I make it a point to go out and visit with my customers, the engineers. You wouldn't believe how much I learned the first time. Sometimes I found that I was focusing my efforts in the wrong areas. I have been able to learn a great deal about



Concurrent Engineering



by Calvin Miller

departmental barriers in the company. When I share these with management in our regular meetings, we discuss how to break down the barriers to establish better communications.

The most important aspect of MBWA is *listening*. Listening is an art that can be developed, and is clearly unrelated to having an outstanding personality. In fact, introverts who have the inherent ability to listen make the best wanderers, because listening is the heart of effective MBWA.

Coaching is the second integral part of MBWA. I find that when I wander around and talk with the engineers, I discover ways to coach or teach them how to use the CAE systems more effectively, or how to take advantage of the corporate network for better communications with team members in other areas.

A word of caution! If your people are not used to seeing you on a regular basis in their work areas, watch out! They will be terrified at first. You will need to make them feel as comfortable as possible. Once they know that you are there for support and not to check up on them, and you drop in occasionally, you will find that communications will begin to flow. This is where the listening comes in. If you listen not only to their words, but seek to understand their problems and find ways to solve them, you will become a trusted friend.

Encouraging Innovation

Innovation is a major factor in

successful CE projects. The more innovative companies become in adapting CAD/CAM/CAE systems to fit their needs, and in merging the different functional areas in their companies into a cohesive team, the more competitive they will become.

CE enables companies to develop a high level of innovation in their products and in the technology used to create those products. Using teamwork to develop products also brings technical people together to generate alternative ways to solve problems. Roger Von Oech in his book *Whack on the Side of the Head* (p. 19) said, "We don't need to be creative for most of what we do, but when there is a need to think something different, our own attitude can get in the way. I call these attitudes the mental locks. Mental locks can be opened in one of two ways. The first technique is to become aware of them, and then to temporarily forget them when you are trying to generate new ideas. If that doesn't work, maybe you need a whack on the side of the head. That should dislodge the presuppositions that hold the locks in place."

There are many tools that managers can use to aid the CE

team to innovatively solve problems. One method is to teach our people that there is more than one right answer. There are many ways to find the second right answer; by asking what if, playing the fool, reversing the problem, breaking the rules, etc. We need to ask questions that keep us on our toes in our jobs. Instead of seeking one answer, we need to ask questions that will lead to multiple answers.

Any one session will not make us more imaginative. However, if we practice consistently, we will find ourselves, our departments and our companies becoming more productive. Try having a brainstorming session with other functional areas within your company and find out how much you can learn. By doing so you will begin to break down the departmental barriers and begin working more as a team. Different brainstorming techniques can be used to solve problems. One that I have used and works well is the Nominal Group Technique (NGT). NGT is simple to use, works great for small to medium sized groups, and has four basic steps:

1. Silent Generation (10-15 minutes)

2. Round Robin listing of ideas
3. Clarification of ideas presented
4. Silent Voting and Ranking

The products and services obtained through technological innovation may also provide excellence in the workplace. The advances of CAE tools extend the capacity of the human mind to both remember and perform simple and difficult operations. Recently 3-D solids modeling has developed to a point where even the smallest of companies can benefit. Parametric design concepts, which tie different parameters of the design together, are revolutionizing the engineering field, when just yesterday they were special R&D tools that only large companies could afford to use.

Key Tronic Corporation

This brings us back to the central core, the team of people who need to be brought together in companies to make CE work effectively. CE requires teamwork, innovation and computer-aided technology to be an integrated process. This involves both management and employees with the ultimate goal of managing the invention, design, development, production, transfer, introduction, and the use of various forms of technology in the work environment.

We have spent a year planning a corporate information system to propel Key Tronic Corporation into the next century. The hardware for the network was important as far as connectivity was concerned; however, we felt that the network alone would not improve or enhance productivity in a significant way. To really benefit, we knew that implementing CE concepts and several software systems could greatly improve our chances of being a strong competitor in the next decade. The plan includes the following:

* Integrated CAD/CAM/CAE system

- * Engineering Document Control System
- * On-line drawing viewing system
- * Engineering Scheduling and Tracking System
- * MRP system

All of the above software systems, we felt, must be fully integrated to support the concurrent engineering process. From the onset our objectives were to develop an integrated system where engineers could access existing product bill of materials, drawings, processes and procedures.

By sharing CAD databases across a network, all engineers on the product development team can be kept up-to-date of any changes that affect their part of the design. Many of our products are custom designs. Therefore, products must be documented and classified so that continuation engineers can find information and make modifications easily.

Just recently we made a decision to lease 3-D solid workstations for a pilot project to develop a mold design for plastic parts. By using 3-D solid modeling we will be able to design products faster and with more accuracy than ever before. Technology today lends itself well to providing design associativity between the different functions of the CE team as well as parametric design.

We are also implementing a corporate wide scheduling and tracking system where each department is able to plan a job and send its schedule to the corporate product development scheduler. All schedules of product design then roll into one corporate schedule and a gantt chart report is provided to the management team on a regular basis. In the future we will be implementing a document control system for tracking products that are in the engineering design cycle.

We created project teams and moved them into central locations

away from their functional departments. It really makes a difference how much faster issues come to the table if the teams are physically located close enough and are informal enough to interrupt anyone on the team at any time with a question. The teams generally meet on a regular basis to discuss any issues that may arise.

One area that we found to be very critical is training and documentation. Using CAE tools and integrating the databases in an information system required some standards to be set. It takes extra effort to keep processes and procedures to a minimum. Whenever a new system or process is implemented, we send all associates through training and provide them with documentation.

We presently have a team assigned to develop a new product and they have been given a goal to cut the development cycle in half, from product conception to production. I believe that we are making great strides. The CE team has also been given the responsibility to cut the number of design changes, once the product reaches production, by at least 50 percent.

We are working on the critical path items which are identified by our corporate scheduling system and CAE data flow. We have a team of managers, engineers and CAE support personnel assigned to work on the flow of work and flow of information to identify ways to work in parallel and to cut out any unnecessary functions. Several items have been identified. These include moving personnel, acquiring new software tools, and providing more support.

CE is not something that can be planned and implemented immediately, but involves long term planning and cultural change that will continually be refined. TEAMWORK has been the heart and soul of the Key Tronic effort. TEAMWORK will be central to any company considering Concurrent Engineering implementation.

YOU CAN'T BUY BETTER CAD SOFTWARE ANYWHERE. NOW, YOU CAN'T BUY IT AT A BETTER PRICE.

1 CADKEY® 5
Sale Price: \$3,495 (List Price: \$6,175. Save \$2,680!)
CADKEY® 5, CADKEY SOLIDS™, CADKEY ANALYSIS™, IGES and DXF™ Translators, CADKEY Light™ and one year of technical support/upgrades. Educational pricing available.

2 TRADE-UP OFFER
Sale Price: \$495 (List Price: \$5,085. Save \$4,590!)
Incredible, but true! If you own a comparably priced CAD system, an earlier CADKEY version, or don't have a CADKEY maintenance agreement, we will upgrade you to a fully featured CADKEY 5.*

3 CADKEY 5®/UNIX™
Sale Price: \$3,495 (List Price: \$5,390. Save \$1,895!)
Full-featured versions available for Sun, Silicon Graphics and Digital Equipment platforms.

4 CADKEY LIGHT™ 5
Sale Price: \$99 (List Price: \$395. Save \$296!)
The lowest cost, highest performing CAD system on the market. Completely compatible with CADKEY 5.

5 CUTTING EDGE™
Sale Price: \$3,495 (List Price: \$5,390. Save \$1,895!)
Cadkey's new 3-axis CAM system includes 2-D/3-D design capabilities, IGES and DXF Translators. Seamlessly integrate design/analysis/machining data.

6 DATACAD®
Sale Price: \$1995 (List Price: \$4,185. Save \$2,190!)
The A/E/C program developed specifically for architects and designers. Includes DataCAD, Velocity (Photorealistic renderer), DCAL (programming language), one year's maintenance. Home use, additional seat, trade-up specials available.

7 HOME USE OPTION
Sale Price: \$495 (List Price: \$3,495. Save \$3,000!)
Corporate CADKEY users can have CADKEY at home for just a \$495 licensing and registration fee.

 **Cadkey, Inc.**

Cadkey, Inc., 4 Griffin Road North □ Windsor, CT 06095-1511
(203) 298-8888 □ (800) 394-2231 □ FAX: (203) 298-6401 or 298-6480

CADKEY SPECIAL OFFER ORDER FORM

To order, call or visit your Authorized Cadkey Dealer. Or contact Cadkey by phone, FAX or mail.

Please enter my order for the following:

- CADKEY® DOS 5.....\$3,495
- Competitive Trade-up.....\$ 495
- CADKEY 5®/UNIX.....\$3,495
- CADKEY LIGHT™ (Version 5).....\$ 99
- CUTTING EDGE™.....\$3,495
- DataCAD®.....\$1,995
- Home Use License.....\$ 495

Shipping and sales tax will be added. To order call 1-800-394-2231 or FAX your order to (203) 298-6401 or (203) 298-6480. Prices valid through February 28, 1993. Offer good only in the U.S. and Canada.

Name _____ Title _____
Company Name: _____
Address: _____ City _____ State/ZIP _____
Phone _____ FAX _____
Present CAD system owned _____
Current CADKEY version owned _____
Payment: Check Money Order MasterCard VISA P.O. # _____
Card number _____ Expiration date _____
Signature _____

CADKEY, CADKEY SOLIDS, CADKEY SURFACES, CADKEY ANALYSIS, CUTTING EDGE, CADKEY Light, DataCAD and DataCAD are trademarks of Cadkey, Inc. UNIX is a trademark of UNIX Systems Laboratories. TRF is a trademark of Autodesk, Inc. *CADKEY ANALYSIS available in UNIX version only. One year of technical support available for \$200 additional.



The only thing we can't offer you is a raise...

Our complete line of tooling components is so extensive, we can save you a great deal of time in the ordering process. Used in conjunction with our extensive CAD/CAM tooling component library, you will save countless hours — and the enormous expense — of building a standard library from scratch.

Compatible with dozens of ready-to-use software formats, the Tool

Designer's Assistant® is the largest such library available, allowing you to access thousands of standard components in just minutes.

The time you'll save turns into money when the boss notices that you are doing more designing and being more productive, instead of spending hours trying to locate the tooling you need. Who knows, maybe we *will* get you that raise.

Carr Lane...we make your life easier.



MANUFACTURING CO.

4200 Carr Lane Ct., P.O. Box 191970

St. Louis, Missouri 63119-2196

Phone: 314-647-6200, FAX: 314-647-5736

Bill of Materials

ENGINEERING'S OTHER JOB

I've been a vice president of operations and a materials manager in manufacturing companies for over 25 years and I've seen it all, from rip roaring success to full blown catastrophe. One of the things I've learned (often the hard way) is how important the bill of material (BOM) database can be to a company's efficiency and profits.

While many people immediately think of the "glamorous" side of engineering (inventing and designing products with hot CAD/CAM tools), engineering has another equally important but not so glamorous job, especially in a concurrent engineering environment. This job is creating, monitoring and maintaining the Bill of Materials.

Engineering generates data for the original BOM as they specify the parts and material required by the design. At this point they cannot kiss the BOM goodbye and send it on its way.

As the design and BOM advance through the various stages, changes are likely to occur. For example, design modifications may be made for functionality or manufacturability; purchasing may request a part substitution for better price or availability; or production may find a subassembly that won't go together as designed and/or require a new or different part. Engineering, however, still has the primary responsibility for making sure the BOM is up to date. This is a heavy responsibility indeed because the quality of the BOM affects every company department.

The BOM's central role was reinforced at an APICS conference I attended several years ago. A conference leader presented an article that began, "Who is impacted by an incorrect BOM? It might be simpler to ask who is not: the cafeteria

staff and security guards — that's about it."

Although this may sound obvious, it's too true. Numerous company activities and departments must use the data on the BOM. Activities include product design, order entry, master production scheduling, materials planning, pick lists, production scheduling, product costings and routings. Then, just think about the organizations these activities impact: design engineering, manufacturing engineering, marketing, finance, materials management and manufacturing. All depend on data from the BOM.

Tied directly to the bottom line, the accuracy, completeness and ongoing checks are all BOM issues that need to be aggressively pursued in a concurrent engineering company to avoid the disasters lurking around every corner.

Accuracy Issues

In conventional Material Resources Planning (MRP) systems, a *minimum* of 98% accuracy is required. This sounds simple, until you apply the "laugh test." Do you get laughs and snickers from assemblers and production supervisors when you walk on the production floor and ask if the BOM reflects the parts and materials actually being used on the line? Unfortunately, in 25 years of working for and with manufacturing companies, I found that BOMs often failed the laugh test. Let's look at why this is so and explore some solutions.

BOM accuracy is based on part numbers, unit of measure and quantity per parent item. These three areas cause varying degrees of problems.

by Steve Radford

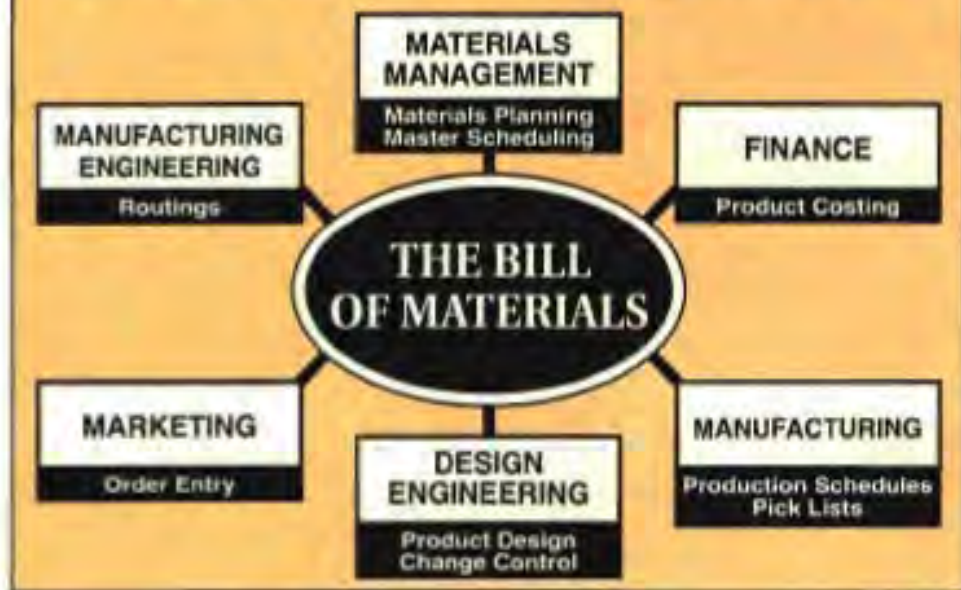
"Unit of measure" is usually each. When the unit of measure is not each (feet or pounds for instance), mistakes are caught and corrected quickly by the Material Planning function. Generally, unit of measure meets the 98% accuracy requirement and causes the least amount of problems.

"Quantity per" area is the second most accurate. The problems I've encountered in this area usually involve products that require printed circuit boards, particularly PCB's with many components. Some components (typically resistors, capacitors, integrated circuits, etc.) have large quantities per that can be in error, particularly when numerous engineering changes have been incorporated. However, any product requiring large quantities per on items such as hardware are susceptible to inaccuracies. The results of such inaccuracies are combined and explained with a later section.

By far, "part number" discrepancies create the most problems in achieving 98% BOM accuracy and are the most prevalent. There are three primary questions to ask about part numbers. Are they correct? Are they missing? Are they not needed? Part number inaccuracies can cause ugly problems — especially on your hottest "home run" project; you know, the latest and greatest new product which is going to increase your revenues by 50%; the product that is being advertised internationally and is about to be released next month. Maybe!

The reason for this has a common sense base. Mature products in production for several years have stable designs and BOM problems have been corrected by the Change Control Board and/or the school of hard knocks. New products, on the other hand, are in a state of uncontrolled frenzy. In the rush to meet the marketing window, corners are cut. Changes affecting materials, part dimensions, product assembly and testing, and part substitutions are implemented with "the paperwork

WHO AND WHAT'S AFFECTED



catching up later." I've seen some interesting consequences when it doesn't catch up, or errors of omission occur but I'll cover that later.

Completeness and Structure

BOM accuracy is affected by two additional factors - completeness and structure. Completeness means inclusion of everything required for fabrication and assembly from all the hardware and raw material to shipping and documentation packages. Part numbers missing from BOMs don't tend to be printed circuit boards but rather pen nuts and washers; but any missing item can result in down time, confusion and unexpected expense.

BOM structure considerations reside in two major areas. The first has to do with products that have options and features. The BOM must be consistent with 1) how customers are ordering and 2) how forecasting and subsequent planning are accomplished. Most companies do a good job with the first consideration because a call or two from your best customers about a wrong or incomplete part usually solves the problem.

The second involves the relationship between the BOM structure and the Bills of Operations or routings. Does the BOM reflect how the product is put together? Are assemblies and phantoms structured to maximize material flow and insure the right parts get to the right work centers

when they are needed? Errors in this area typically won't shut you down, but can decrease manufacturing efficiency enough to inflate your Cost-of-Goods-Sold.

How Inaccuracies Come Back to Haunt You

I alluded earlier to the consequences of inaccurate BOMs. The following scenarios depict problems that can result from an imprecise BOM. All can cost mega-bucks and to a greater or lesser degree cut into profits and time schedules.

1. Trips to the Local Hardware Store - This occurs shortly after the production line has shut down due to missing parts; perhaps they didn't get enough or didn't get the parts at all. Normally, because the situation is caused by missing or wrong part numbers on the BOM, the parts aren't on order, so expediting isn't an option. Trips can be made by corporate officers or anyone who isn't worried about submitting an expense report for gas. In some companies this happens so often that designated employees make the trips. By the way, even without considering the time factor, the parts will cost a lot more at the local hardware store.

2. Oops! We Have the Wrong Product Cost - This happens when Cost Accounting runs a costed BOM with errors. Here's one horror story I know about. With the

BOM and a report from purchasing on better sourcing and other cost reductions firmly in hand, the company made a decision to lower the price of an existing product. The price cut was announced publicly with the usual amount of hoopla. Less than a month later, it was discovered that the Power Supply Assembly was missing from the BOM. This, I must add, represented a not insignificant amount of money. When the oversight was corrected, the company found they would make virtually no profit on this product. I assure you, this was not their intent.

3. What's that Big Pile of Parts Over There? - The flip side of trips to the hardware store is the 20-year supply of widgets (the buyer got a great quantity price) that will be obsolete in one year or not needed at all. Excess inventory decreases cash flow and generally causes other nasty things to happen.

Many company inventories are littered with materials/ parts/ assemblies which fit this description. They are no longer used but weren't deleted from the BOM until they arrived at the back dock and storage became a problem. Product options can also contribute to excess inventory. A good example (or bad, as the case may be) was a printed circuit board which was incorrectly stated on a BOM. In this particular case, the PCB appeared in the structure as a 1-per for every unit. In reality, it was an option forecasted to be ordered for only 30% of the products produced.

4. You Want It When? - Sales or the Customer Service Rep promised delivery by a date and now is told the product will be four weeks late. Why? The BOM monster strikes again. The AMP connector on your CPU printed circuit board had the wrong part number. Now weeks later when the mistake is discovered, the one really needed is on worldwide allocation. This is not only embarrassing for the rep, but deadly on customer relations.

There are many, many more consequences (none good) caused by BOM inaccuracies. Contrary to the absurdity of some of the situations described, most are not really funny. They can cost a company its reputation, employee dissatisfaction, and wasted dollars and time, but most can be avoided. Let me explain how.

The Audit

Two people working as a team, spending no more than two to three days per month, auditing the BOM at each project step, can cure your ills. One person from Cost Accounting and one from Quality Assurance would be wise choices because they can function as independent auditors measuring "what" the accuracy is, not "why" the percentage is what it is. Their findings can then be relayed to the appropriate department responsible for database maintenance.

The Audit Procedure consists of eight steps:

1. Run a current copy of the indented BOM.
2. Conduct an initial informal field survey. Ask the person/persons actually putting the product together on the factory floor if inaccuracies exist. Chances are he or she tried to report an error a while back; it didn't get corrected and he or she gave up trying.
3. Check the next kit being released. Rather than interrupting production,

go to your staging area and check the kits, part number by part number, for the right part and the right quantity compared to your computer copy. Note inaccuracies. If your company is a Just In Time (JIT) manufacturer, this actual physical audit will be done on the factory floor. **THIS STEP IS A MUST!**

4. Check Finished Goods Inventory. Get authorization to disassemble a completed product. Check each part as in Step 3. You will ensure that what is being shipped to customers is as documented.

5. Check for Manual Requisitions and Returns to Stock. Unplanned issues and returns, if not caused by scrap, can indicate parts that are missing or not needed. Again, note inaccuracies.

6. Run a current copy of the Bill of Operations for the product. Go to production and observe if the work centers are building the assemblies as structured on the BOM. Note any occurrence of differences.

7. Have the Cost Accounting member of the team perform an audit of standard cost, part by part. Although you are not

actually measuring BOM accuracy in this step, a check for reasonable costing against a costed BOM is a prudent idea and will prevent serious decision making errors down the road.

8. Present the findings to proper organizations for research and correction.

Conclusion

The last step in the audit process will require considerable effort from engineering. As they have the ultimate responsibility for change control management and BOM database maintenance, research and correction of errors will require dedicated time for resolution. The quality of information in the audit findings and timeliness of presentation will help engineering quickly react and head-off potential stumbling blocks. Virtually everyone in the company has a vested interest in the success of the documentation group. Make this a highly visible program with top management support and reap the benefits.

PLOTTERS • PLOTTERS • PLOTTERS • PLOTTERS

BUY • SELL • TRADE • SUPPLIES • REPAIR DEPOT

3 Tier Pricing On Parts • No Expedite Fee, Drop Ship To Any Location
7 Days, 24 Hour Emergency Service • 5-10 Day Turnaround • Leasing Available

DMP-160 Series A-to D size and A-to E-size plotters



- Up to 4 times faster than competitive models
- Includes HP-GL/2 plot language to create highly compact plot files
- 512K standard memory, expandable to 4 MB—equivalent to 16 MB on competitive models
- Immediately harnesses the plotter's power in AutoCAD® with real and protected mode ADI® with drivers
- Affordable SCAN-CAD™ turns the plotter into a wide format scanner (Optional)

Kurta XLP™



- 12"x12" or 12"x18" high-accuracy tablet
- 2-switch pen and programmable 4-button cursor
- An integrated mouse/ADI™ driver with auto-toggle between mouse and ADI modes and a Windows® drive in absolute mode
- Test, Set-mode and Reset utilities
- Unlimited free technical support
- Lifetime Warranty!

DrawingMaster Plus



Awarded Master Dealer Of The Year
Largest Nationwide Hardware Dealer

- 400 x 400 dpi
- 24" and 36"
- "Archive" quality plots ideal for diazo or photo reproduction.
- Connects up to 4 PCs, workstations or mainframes
- No toner, ribbons, pens or chemicals.
- Automatic Media Cutter
- Embedded RISC-based rasterizer for "screaming hot" throughput.
- 1 year warranty



Call TMS (714) 582-5007

LEASE PLANS & RATES • TRADE-IN'S AND TECHNICAL SUPPORT

Woman Owned Small Business • 26061 Merit Circle, Suite 105, Laguna Hills, California 92653 • Fax (714) 582-0793



A Framework For CONCURRENT ENGINEERING

by John A. Barry

Client-Server Solutions

Two major issues face today's CAD/CAM professionals: selecting the best, most affordable equipment for the job and making concurrent engineering a reality. Both involve making the most cost-effective and efficient use of human and computing resources.

But concurrent engineering requires far more than hardware -- even high-level systems such as the new Sun SPARCclassic, SPARCstation LX, or SPARCcenter 2000, says Dal Canto. It also demands the ability to creatively use software solutions to improve teamwork between engineers and between engineering and other groups in a company. "It's no longer a game of just speed and graphics. It's a networking, database management, multimedia, and application-development game too.

"While the terms 'concurrent engineering' and 'client-server computing' may not be technically synonymous, 'client-server computing' (i.e., various forms of networking) is the basic technology and the framework which allows us to achieve concurrent engineering," says Dal Canto. "Otherwise, it's almost impossible. Centralized computing or personal computing just do not support efficient collaborative work, particularly across different departments and different geographies."

In fact, a promising new technology, Integrated Services Digital Network (ISDN), promises to be an important solution for expediting global collaborative work. ISDN is already fully in place in Germany, Japan, and France. This digital network was only available in the United States on a local basis as this article went to press. By the time you read this, the Bell companies nationwide should be on the ISDN standard, making interstate ISDN networks available. What this means, says Dal Canto, is that CAD/CAM enterprises will be able

*... client-server technology
makes concurrent
engineering possible*

to communicate globally over ISDN. In anticipation of fast, efficient global communications, SMCC has built ISDN capability into the motherboard of their desktop systems from the LX to SPARCstation 10.

Many other features integral to SMCC systems, says Dal Canto, facilitate the collaborative work that is the hallmark of concurrent engineering. One example is the ShowMe® product, often referred to as a "shared white board." ShowMe allows engineers to work together, independent of their location, and see each other's work on the screen." This means an engineer in

Mario Dal Canto, the director of Sun Microsystems Computer Corporation's (SMCC) technical and industrial markets development group, specializes in design automation - EDA, MCAD, AEC. His goal is to leverage SMCC's strengths in engineering and research into the manufacturing arena. He took time recently to talk to Key Solutions about concurrent engineering and how SMCC's new products provide solutions for CAD/CAM companies.

Japan and an engineer in California can work together in real time to develop a product.

Dal Canto adds that MCAD (mechanical CAD) professionals also need flexible, scalable systems. For example, all SMCC systems, from the low-cost SPARCclassic to established products (e.g., SPARCstation 10 multiprocessor desktop workstation and the SPARCserver 600MP Series) are based on a single, scalable architecture, SPARC, and the Solaris distributed operating environment. Dal Canto points out that with the addition of several new systems, the SMCC product line now can handle all functions of a manufacturing enterprise.

Dal Canto described briefly how SMCC's new and existing systems could fit into a large manufacturing enterprise. In a large company, the engineering and research departments would use high-end models of the multiprocessor SPARCstation 10 family for analysis and simulation and lower-end models as well

as the LX for standard design and engineering work.

These systems would be connected to a network and managed by a SPARCcenter 2000 or perhaps a couple of multiprocessor SPARCservers functioning as data management, file management and compute servers. Then the engineering, research and development departments would be linked by a company wide network backbone to the manufacturing department, where a SPARCcenter 2000 would run the MRP system. A range of smaller servers, from the SPARCserver 10 to the SPARCserver 690MP, would manage different factories, communications with suppliers, and the shop floor.

The new SPARCclassics and LXs could come into the picture by controlling different production units, locally and remotely. The SPARCclassics would also handle administrative management. The suppliers could use SPARCstations and SPARCservers to hook into the SPARCcenter 2000 to coordinate delivery of parts for just-in-time delivery of products.

All these endeavors could be extended globally. With ISDN, even a small company will be able to "plug their computers into phone jacks and have, on demand, a full-blown client-server network available within their own company." The phone company will manage it, and it will cost only as much as the enterprise uses it.

Dal Canto moved from the theoretical to the specific. A SMCC-Cadkey combination is in place at Wrangler, one of the largest makers of jeans in the world. Using SMCC workstations and Cadkey software, Wrangler has one of the most cost-effective operations in the industry, according to Dal Canto. Before installing this solution, Wrangler relied on a slow, inflexible

minicomputer based system for designing and building custom jeans-making machinery.

Because this machinery is so specialized, fast network interaction between designers and field plant managers was essential but it wasn't happening. Now designers and shop-floor employees can

ISDN promises to be an important solution for expediting global collaborative work.

quickly handle change requests from the plants. The SMCC-Cadkey system has reduced the time needed to store a design file and bring it back on screen from half an hour to four seconds. A part can be redesigned, rebuilt, and installed in the field in fewer than five days. The entire operation, says Dal Canto, from design to shop floor to manufacturing, is efficient and integrated.

Sun is deeply involved in other aspects of the "client-server" operation as it affects CAD/CAM. In May 1992, Sun, Cadkey, and Fanuc (the leading supplier of machine-tool controllers) announced

that Fanuc would use Cadkey Version 5 in its Fanuc CAD DIE systems. CAD DIE is a high-level, integrated CAD/CAM system developed especially for multi-axis machining used in the automotive, aerospace, and general manufacturing markets worldwide. The system runs exclusively on SMCC SPARCstations.

"Fanuc is the number one maker of machine controllers in the world," Dal Canto notes. "The Cadkey software allows Fanuc customers to run the entire shop floor, machine by machine, over the network. These customers can review product designs while the machine is operating, modify them on site, and have them checked with the main database to ensure that the changes can be made. This is a very interesting and important use of client-server technology in CAD/CAM."

Equipment for the Job

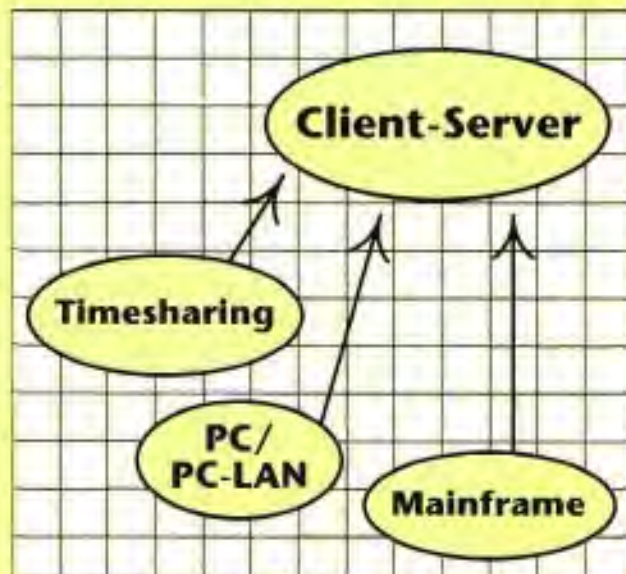
When it comes to desktop CAD systems, Dal Canto says, any lingering myths about PCs being less expensive than UNIX workstations have been shattered by SMCC's new color SPARCclassic desktop system. "It's cheaper than

Do You Need Distributed Client-Server Computing?

Enterprise-Wide

Type of Information Access

Dedicated



Low Priority

Mission-Critical

Time Urgency

a 486 if you consider the configuration, memory, networking and all the features it provides. It's two to three times as fast (60-MIPS performance levels); comes standard with color, so no implications for upgrading; and is more convenient and easier to use than a PC, especially on a network in a workgroup environment." To even approach the capabilities of a SPARCclassic, he notes, a 50MHz 486 machine would require so many add-ons that the final price would be about double that of the SMCC computer, which lists for \$3,995 in quantities of 12.

In contrast to a DOS machine on a LAN, the multimedia- and network-ready SPARCclassic is a "full client-server machine. These are real clients of real networks of real servers."

The SPARCclassic is a more cost-effective machine for concurrent engineering than a PC because it's based on a 1990's architecture, Dal Canto says. The system, operating system, and CPU designs can grow along with users' needs for 10 to 15 years. This was the case with the PC architecture in the 1980's. But that architecture has now reached saturation. PCs have a 1980 CPU design and a 1970's system design. The problem is, Dal Canto observes, "that DOS is a *disk* operating system, no matter how many windows or doors you put on it." The SPARCclassic runs the Solaris distributed computing environment, Sun's version of the UNIX operating system.

The SPARCclassic is one of two new desktop computers from SMCC. The other is the SPARCstation LX. The \$7,995 LX

New Sun Products at a Glance



The SPARCstation™ LX is the industry's least expensive graphics workstation, shown here running CADKEY software. The new system features the GXplus accelerator, CD-quality audio and built-in ISDN (Integrated Services Digital Network).

SPARCclassic. This color RISC desktop system is based on the 30-MHz microSPARC microprocessor designed by Texas Instruments, a highly integrated "workstation on a chip" that runs at 26.4 SPECint 91 and 71.0 SPECfp 92. The microSPARC processor incorporates integer, floating-point, memory-management, and cache functions. A 15-inch color monitor comes standard, with additional color and grayscale options available. Priced at \$3,995, the SPARCclassic is the world's least expensive color RISC system.

SPARCstation LX. Also based on microSPARC technology, the \$7,995 LX comes standard with the GXplus accelerator, which delivers accelerated 8-bit 2-D/3-D wireframe graphics on a standard 16-inch color monitor, with several options available. It includes 16-bit CD-quality audio and built-in ISDN.

Each system offers standard interfaces, including Ethernet, SCSI, serial and parallel, and SBus. Each comes with 16 megabytes of memory, expandable to 96 megabytes. The SPARCclassic and the LX are the first systems to come bundled with the newly introduced Solaris 2.1 distributed computing environment.

SPARCcenter 2000. This multiprocessor enterprise-class server is based on the supercubic SPARC version 8 architecture. One of its many innovations is an advanced multiprocessing bus technology. The bus uses a single system board, which can be replicated 10 times to configure a larger, more-powerful system. A two-processor entry-level system can be upgraded with up to 20 processors by the addition of boards and SuperSPARC processor modules to the original package. In its maximum configuration, the SPARCcenter 2000 delivers more than 500 megabytes per second of dedicated I/O throughput. It is the highest-performance UNIX server available, providing 2.19 billion instructions per second and 269 MFLOPS with 20 processors. All leading relational databases will be available for the system, as are major system-management and emulation products.

brings low-cost accelerated graphics to the graphics-intensive field of MCAD. Dal Canto says that the LX delivers the best 2D and low-end 3D performance for the price. This desktop computer is based on the Sun GX graphics-acceleration

technology and can be upgraded to GS or GT class. Additionally, current and forthcoming accelerators from third parties will increase graphics performance even further.

"What this means to MCAD customers is that they can buy

Cadkey software and run it on a SPARCstation LX. Then when they decide they need to move up to more graphics power, all they have to do is buy an accelerator, and the software will take advantage of it." The software will run faster and do 3D and solids modeling according to the capabilities of the accelerator. Customers will not have to modify or upgrade the software, or buy a new version. Dal Canto says that the LX will enable MCAD users to perform the same sophisticated operations that they would on high-end CAD systems at considerably lower costs.

"Besides accelerated graphics, the LX brings other features such as a gigabyte of disk to MCAD applications." And for the first time, he notes, it brings to the table of every engineer in the world, even when they are working at home, the ability to have communications on a global network through ISDN. ISDN is a major advantage for concurrent engineering. The LX also has built-in multimedia capabilities.

At the high end of the spectrum, SMCC offers the enterprise-class SPARCcenter 2000. SMCC's highest-performance, highest-capacity server should help fulfill Dal Canto's goal of "leveraging SMCC's strengths in engineering and research across the enterprise, into manufacturing." The mainframe power of this system makes it well suited for compute-intensive tasks such as computational fluid dynamics and structural or mechanical analysis.

Because SMCC's two new desktop computers are so powerful and easy for MCAD customers to use, the amount of information they can generate will grow, meaning that computing needs will grow across the enterprise. "That's where the SPARCcenter 2000 comes in," says Dal Canto. "It is probably the best computer server available for the price, as well as the leading database machine on the market today," making it an excellent platform for engineering databases.

This server will help take SMCC onto the factory floor, says Dal

Canto, because it is powerful enough to handle tasks that have traditionally been done by mainframes—MRP and massive database management, for example.

Looking Ahead

SMCC plans to help CAD software vendors move their customers to client-server, says Dal Canto. Users of products from Cadkey, Autodesk, Computervision, SDRC, Unigraphics, PTC and CADAM will be able to run their applications on the LX platform—or on the SPARCclassic if graphics acceleration is not a requirement.

Very few technical applications still run on minicomputers, says Dal Canto, and as he noted, SMCC's new desktop machines give MCAD customers little incentive to continue to purchase PCs. "I think SMCC's new systems—indeed, all of our systems—give CAD/CAM customers the best product line for their needs."



**Get Even
Productivity with
ACTools Utilities
\$195.00
Productivity
Enhancements for
CADKEY®
30 DAY MONEY BACK
GUARANTEE
Supplement CADKEY® with
the tools CADKEY® forgot...**



Quality CAD, Inc.
1-800-523-4223
One Call Does it All

Quality Design Services
A-E size detailed drawings on paper
Or on disk
FAST Turnaround, LOW Prices!
Call us for pricing on YOUR Design!

**Train Your Entire Staff with Dr. Leonard Nasman's
Videos from Microcomputer Education Systems,
Inc. for the cost of Sending ONE Person to training!**

CADKEY Videos - 8 Tapes & Study Guide	\$450.00
CADKEY Light Videos - 5 tapes & Study Guide	\$350.00
Many CADKEY V 4 & 5 Hints	\$350.00
DataCAD Videos - 10 tapes & Study Guide	\$650.00

All prices are in U.S. Funds
Prices do not include shipping & handling or applicable sales tax. Pricing subject to change without notice.

Reinventing the Wheel

There are only 100 wheel companies worldwide. The Ultra Wheel Company in Garden Grove, California is one of the newest. It is also one of the largest in the United States.

Started only six years ago in 1986, Ultra Wheel now produces over 750,000 wheels a year. The number of employees has grown from 1 to 350-400. Recognized as a leader in style and quality for one- and two-piece chrome and aluminum wheels, they are also one of the most knowledgeable manufacturers in the business. You can get good when wheels are your only business.

After-market products comprise 90% of Ultra Wheel's sales. With at least 100 different current models in production, they have wheels for virtually every domestic or foreign car on the market today. They also produce specialty wheels for race cars. OEM sales constitute the remaining 10%.

Here's an example of the type of product made by Ultra Wheel. Victor Moreno, chief product engineer, explained that manufacturers often try to save money by using the same wheel design for many vehicles — whether they're just right or not. For example, the factory-installed wheels on several new GM 4x4 truck models stick out beyond the wheel well at least two inches. Since this is not acceptable to many truck owners, Ultra Wheel has designed an attractive replacement that fits within the wheel



Ultra Wheel's chief product engineer, Victor Moreno.

well. They expect sales to be excellent.

Speaking of sales, Moreno shared the fact that Ultra Wheel has not felt the recent recession at all. "Probably people won't go out and buy a new car in tight times, but they will spend a little to fix up their old one. Wheels can really dress up a car relatively inexpensively. Sales have been great," he said.

Knowledge, experience and skill are the backbone of Ultra Wheel's accomplishments. Company founder Jim Smith is an accomplished off-road racer with a wall full of trophies. He was also a co-owner of American Racing which he sold before he started Ultra Wheel. Work and play blend for Smith. He not only raced in this year's High Desert Racing Association USA Cup in Nevada, but Ultra Wheel sponsored a vehicle and built most of the off-road racing wheels that were used by all the vehicles.

Racing technology has also affected the engineering of the products. Ultra Wheel is the only domestic manufacturer that uses steel inserts in the bolt holes for safe and secure attachment in all their wheels — not just racing models.

Moreno uses CADKEY to design all the wheels, molds and tools needed in the manufacturing process. At 27 he is making quite a name for himself. He worked as a draftsman for six years before joining Ultra Wheel in 1991. At his previous company he not only learned CADKEY, but many sophisticated engineering and design concepts.

When he came to Ultra Wheel, all design and engineering drawings were created manually. He selected the system (a 486/33 and a Mitsubishi Diamond Scan monitor) and CADKEY. Recently he added an XP-500 Mutch pencil/pen plotter which he says has reduced his

with CADKEY

plotting time by 30 to 40 percent.

Real engineers are born, not made. Now, as an engineering design department of one, Moreno performs all phases of product design -- all without a formal engineering education. After he finishes the drawing, it is passed on to the CAM engineer who translates it to CNC and other manufacturing operations. Ultra Wheel's manufacturing is vertically integrated. They have a tool shop, a foundry with five large furnaces, a CNC machine shop, and a chrome and paint line.



From product design to final product.



Moreno uses CADKEY to design all wheels, molds and tools.

CADKEY use is developing at Ultra Wheel. Until now they have only used CADKEY's 2D capabilities. Moreno says he's been so busy because of the volume of business, he hasn't had time to think, let alone sit down and learn 3D. As soon as an assistant is hired for him, he's hoping to attend a CADKEY training session on 3D and modeling and have time to work with the areas of the program he has yet to use. At that time, he can help direct the company push to integrate CAM more closely with CAD.

3D DIGITIZER

Direct 3D Input to AutoCAD® and CADKEY®



*Introducing a new evolution in product design,
reverse engineering, and coordinate measuring
machines...*

The Metrecom by FARO Technologies Inc.

The Metrecom's articulated arm measures points and orientations of objects in complete 3D for direct serial port input to AutoCAD, CADKEY and other leading software packages. Custom interfaces are available. Simply connect the Metrecom to your system like another mouse!

Digitize single points or polylines. Measure very large objects with our unique "leap frog" technique. The Metrecom is portable, durable, and gives you convenient, affordable precision in an instant! Call today and discover this amazing device for yourself.

Model 100 U.S.A.

FARO
METRECOM®

FARO Technologies Inc.
Industrial Division
125 Technology Park
Lake Mary, Florida 32746

(800) 736-6063

(407) 333-9911

Thunder The Dragon



US PEP (United States Performance Engineering Program) didn't even know what a surface modeler was four years ago. Now they have successfully used CADKEY and FastSURF (a third party surface modeler) for several varied and exciting projects. US PEP is a not-for-profit corporation based in Carlsbad, California that applies technology toward the improvement of the human condition.

Their first project (and most famous) was the development of a safety helmet for U.S. amateur skiers. Then, working with Bell Sports and using CADKEY and FastSURF, US PEP helped develop the Bell Vortex™ which scored two bronze medals at the '92 summer games for both the US and French cycling teams.

With the Olympics over, what's next? Currently they are developing a new animated character, Thunder the Dragon, for an upcoming TV series, "Tales of a Planet." The series will feature environmental and ecological themes.

CADKEY and FastSURF were used, along with other tools, to model Thunder who was first drawn by Walt Disney Miller, grandson of Walt. The original drawings were then used to create a sculpted model for digitizing. US PEP then used CADKEY's CAD Inspector and Brown and Sharpe's Micro VAL to digitize Thunder's head. They then worked with Quicksilver CAM to laser digitize the rest of Thunder using Laser Design's laser scanner. Next, using CADKEY/FastSURF, Thunder

From the Olympics to Hollywood and Beyond

was modeled in preparation for animation using a combination of Alias Studio and Power Animator from Alias Research.

With Olympic medals under their belt and Thunder almost a reality, Stephen Gubelmann, co-founder, says that US PEP is now applying FastSURF technology to other arenas.

For instance, they recently installed a computer center on the Hopi Indian reservation powered exclusively by solar energy and wind. The center is located on mesas near the ancient city of Old Oriabi, approximately 50 miles southeast of the Grand Canyon.

The systems are being used in support of the Hopi's much larger New Village project. The Hopi's are a remote culture, have a strong sense of community and want to preserve their traditions. However,

even atop the mesas they cannot escape the influence of the '90s. Instead of fighting this influence, they are using technology to preserve their ancient ways. The computer center is one way of making their community as independent as possible, while taking advantage of current technology.

The computer center is busy from dawn to dusk. There the Hopi design their community center, homes, wind powered water systems, and support their arts and crafts. For example, CADKEY and FastSURF help model jewelry in support of silver smithing.

Stephen Gubelman says there's more to come. US PEP continues to look for worthy projects in which they can creatively use their innovative CADKEY and FastSURF skills.

Digitizer Performance for under \$90

CADKEY users - Four revolutionary devices from ProHance Technologies, Inc. can improve your productivity up to 2 hours a day or more for a fraction of the cost, size, and bulk of a digitizer.



PowerMouse™ and PowerTrack™ have user-programmable buttons that allow you - with one button press - to backup, pick windows, return to the main menu, execute immediate mode and other commands, and take shortcuts through the hierarchical CADKEY menu structure. Macros do the work instantly, and without error. The buttons are grouped on a single keypad for convenient and easy access. Because the "button bar" is on the pointer, you gain unprecedented speed and ease of use.

Commands can be picked without moving the cursor off your drawing, clicking through layers of menus, or going back to the keyboard. In addition, cursor motion can be included within commands, making every command a simple "drag-and-drop" type operation.

- 12-, 17-, and 40-button models
- Up to 6 functions per button (using shift keys) for expansion from up to 72, 102 or 240 total functions
- Not just a CAD product. Adds one-click control to virtually all your DOS, Windows and Gem programs. Windows TOP 100 award winner.
- IBM-compatible, serial COM port, DOS 2.1 or greater, 15K RAM
- Only \$89.95 to \$129.95! Optional CADKEY PowerPak \$39.95.

ProHance Technologies, Inc.

1558 Siesta Drive, Los Altos, CA 94024 (415) 967-5774

CIRCLE CARD NO. 206

GX-3000A

Only \$1,995

The ultimate plotter that does your work for only \$1,995.



Satisfaction or money back!

2 year warranty!

Easy usage and maintenance!

Total accessories included!

GX-3000A is the perfect A-D size, flat bed plotter for engineering, architectural, CAD/CAM and other duties. Flat bed plotter offers the better accuracy and view of progress that is lacking in freestanding plotters. The angle of our stand is adjustable according to your space availability. The many features of GX-3000A include auto 8 pen selection, auto pen return, pen speed, pen pressure/height controls. Our total package comes with the stand, user's guide, power adapter, AC power cord, RS-232 cable, 8 fibertip pens, 10 plotter papers, dust cover, metal strips and magnet at no extra cost. We offer a quality plotter at a bargain price. For more information and brochure, call us today.



G.C.C. Galtech Computer Corp.

3475 Investment Blvd., Suite 2, Hayward, CA 94545 Phone: 510/732-0911 Fax: 510/732-0912

RASTER PLOTTING TECHNOLOGIES Pros & Cons

by Scott Harlin

INKJETS

Available since the mid-1980's for CAD applications, inkjet technology has really grown over the past year with the introduction of cost-effective, large format devices for both color and monochrome output. The technology is based on spraying ink onto the media through narrow jet nozzles. The narrower the inkjet nozzle, the higher the resolution. Color output is accomplished by mixing primary ink color cartridges through each spray nozzle.

STRENGTHS

Plotting Speed

Documentation on inkjet plotters suggests that inkjets can produce a "typical" E-size, monochrome drawing in about 3 to 6 minutes

depending on the media used. Add about 5 minutes to convert the vector CAD data into raster data and another 1 to 4 minutes (media

dependent) for the plot to dry. Therefore, an initial plot takes somewhere between 10 to 15 minutes, making it faster than vector devices for larger, complex drawings. For smaller, simpler drawings vector plotters could actually be faster, especially the pencil/pen plotters, since they operate at the device's maximum speed. Inkjets are not the fastest raster technology.

Some inkjet plotters also include a draft mode, which reduces the output quality from 300 x 300 dpi to 300 x 150 dpi but increases the speed by about 50%. Draft mode is not available on film media.

Replot Speed

Inkjet plotters produce multiple plots quickly. Since the drawing data has already been rasterized and stored within the plotter's memory buffer, replot speed is faster than initial plot speed. The time it takes to replot a typical E-size monochrome drawing is about 3 to 6 minutes depending on the media and resolution used. This capability is an outstanding time saver compared to vector technology.

Reproduction

Once the inkjet output has dried, reproduction on blueprint or dry toner machines is excellent.

Unit Cost

Several years ago, the unit cost for a large format inkjet plotter exceeded \$60,000 and was targeted mostly to the pre-press and graphics

art industries. Over the past year, the cost for these devices has been greatly reduced to compete with large format vector plotters. At a street price of approximately \$7,500 for E-size monochrome and \$10,000 for E-size color, large format inkjet plotters have become affordable.

Versatility

Media Compatibility

Though special media available from the manufacturers produces the very best results, commercially available bond, vellum, and translucent is acceptable for use by inkjet plotters. The devices also accept both roll or sheet media.

Adjustable Line Widths

To provide line differentiation and shading, some inkjets feature adjustable line widths. This concept is similar to different size tips for ink or leads for pencils.

Cut and Stack

Some inkjet plotters cut and stack drawings automatically without user involvement.

WEAKNESSES

Output Quality

The definition of inkjet lines can never match the precision of vector plotting technology which calculates and draws accurate vector endpoint data. At 300 dpi resolution, inkjet plotters have a difficult time with small character, arcs and circles, creating a jaggedness that may be troubling to some. Since the ink is wet when it hits the

media, some lines may not be crisp and for filled areas, ink puddles may occur. With 600 dpi resolution devices a reality, the output quality is expected to increase.

User Intervention

Inkjet plotters require more user intervention than most other raster technologies. Since "time is money," there is an associated cost for an individual's time to monitor these plotters. Items that require monitoring and/or user intervention include:

Ink Cartridges

May run out of ink in the middle of a plot since no detection of ink levels currently exists for black ink. Some color cartridges are translucent, allowing monitoring of ink.

The cartridges may clog and fail, requiring replacement.

Inkjet Nozzles

The tiny piezoelectric nozzles can clog, leaving white stripes across the medium.

Media Handling

To ensure that the media dries properly and does not smear, special handling is required.

Multiple Copies

Some inkjets do not support spooling functions and can only accept one file at a time. As a result, manual selection of replot is required.

Cost Per Plot

On standard media, the cost per plot for large format inkjet plotters

is approximately equivalent to pen plotters. Hewlett-Packard estimates the DesignJet can produce up to 200 E-size plots per each set of two ink cartridges. ENCAD plotters use four cartridges at a time, but produce 400 plots. A sheet of E-size inkjet polyester film lists for \$10, but bond and vellum are averagely priced.

Environmental Considerations

If an inkjet plot gets wet, even after it's dried for some period, the plot can smear. This can limit the plotter's ability to work at sites where moisture is a consideration. In dusty or temperature extreme conditions, inkjet output may be affected as well.

THERMALS

Similar in concept to fax machines, direct thermal imaging plotters use thermal heads to burn an image into thermosensitive paper or film. Embedding the image into the media's coating through nibs, and using more durable, heavier media has eliminated the risk of smearing. Usually only monochrome applications are used, but recent technology has allowed for colored media that supports one color output other than black.

STRENGTHS

Plotting Speed

Some thermal plotters claim faster speeds than inkjets. One reason may be that thermals have a consistent plotting speed regardless of the media. A second may be that some thermal heads produce output faster than inkjet sprays. In addition, the output does not require time to dry. The time it takes to rasterize data is comparable between the two technologies.

Some thermal plotters also have a draft mode, which reduces the quality of the output (usually from 400 x 400 dpi to 400 x 200 dpi) but increases the output speed by about 50%. In fact, one recent thermal plotter introduction can actually provide check plots, in draft mode, at the faster output speed using 400 x 400 dpi resolution.

Replot Speed

Identical to inkjets, thermal plotters produce multiple plots quickly. Most are equipped with a replot function that allows for 99 copies of a drawing from one data transmission. And since no drying time is required, the output is produced one after the other without any delay.

User Intervention

One of the biggest attributes of the thermal plotter is that they do not require toners, ribbons, chemicals, ink, or lead, and are generally maintenance-free with very few moving parts that require servicing.

Cost Per Plot

Special thermal coated media is required for these devices whether report grade, premium, vellum or film is used. For report grade media, the cost per plot is about \$1.00 and very cost-effective.

Versatility

Printer Emulation

Some of the small format thermal devices can emulate a commonly used graphics printer. This allows the plotter to double as a printer for word processing, spreadsheet, or other applications.

Adjustable Line Widths

Most thermal plotters feature adjustable line widths.

Gray Scales

Some thermal plotters even provide gray scales for adding

contrast and visual realism.

Auto-Scaling

Some of the small format thermal devices feature auto-scaling which reduces a C-, D-, or E-size drawing into a B-size output format.

Nesting

Some E-size thermal plotters are capable of arranging and outputting multiple smaller format drawings into one E-size plot: a good feature, especially for evaluating different views of one design.

Unit Cost

Two years ago, typical D- and E-size thermal plotters ranged in price from \$10,000 to \$20,000, respectively. With the competitive threat and affordability of large format inkjet plotters, the cost of thermal units has decreased. It is not unusual to obtain a street price of under \$6,000 for a 200 dpi D-size thermal and under \$9,000 for an E-size. Typical price for a 400 dpi, E-size direct thermal imaging plotter is about \$10,000.

WEAKNESSES

Output Quality

Similar to inkjet technology, the line definition of thermals can never match the precision of vector plotters. Whether the device's resolution is 200 x 200 dpi, 400 x 200 dpi, or 400 x 400 dpi, line quality is still questionable and

small characters, arcs and circles are difficult to produce without jaggies. The 400 x 400 dpi units are certainly better than the lower resolution devices.

Reproduction

Thermal output does not respond well to high temperature environments like diazo blueprinting machines. Not only is the reproduction dark and difficult to read, but the high temperature of the machine may blur or obliterate

the original, though the technology is improving. Dry toner reproduction machines seem to work pretty well with thermal output.

Color Output

At present, direct thermal imaging devices provide one color with monochrome output. The thermosensitive color media comes in black, red, green, yellow, orange, and blue. However, color is limited and will probably drive the cost of the unit or consumables higher

when multi-colored technology becomes available.

Environmental Considerations

Thermal plots must be kept away from high temperature environments including direct exposure to the sun which will yellow some output. Hot items are not friendly to thermal output including diazo blueprint machines, hot windshields, coffee mugs, and so on.

LASERS

Laser plotting is a fairly recent technology which combines laser printing with electrostatic plotting. An electrically charged photoreceptor plate discharges to the non-image areas when exposed to a laser beam. Areas not exposed to the laser beam are applied with dry toner and become the image area. Only monochrome output is supported at this time, though some small format units can combine laser plotting with color copying. Smaller format devices that support PostScript could double as a laser printer for graphics and desktop publishing applications.

STRENGTHS

Plotting Speed

Of the three types of raster devices outlined in this article, laser plotters provide the fastest plotting speeds, whether large or small format. Once the vector data has been converted into raster, laser plotters are capable of producing output in seconds as opposed to minutes, making them ideally suited for check plot requirements.

Replot Speed

Laser plotters also offer the fastest replot capabilities by producing multiple copies in seconds. In situations where revisions need to be accessed quickly, either for the design team or the client, laser plotters can meet this requirement. And since no drying time of the media is required, the output can be produced continuously.

Reproduction

Laser plotters provide exceptional reproduction on blueprint or dry toner machines.

Cost Per Plot

Laser plotters require a special dry toner and utilize commercially available bond, transparencies and mylar. The cost per plot for larger format devices is comparable to thermals, ranging somewhere between \$.50 and under \$1.00, making them cost-effective in this category.

Versatility

Compatibility

Printers first, most A- to C-size lasers have Postscript and/or LaserJet capabilities with built-in fonts.

Media Compatibility

Laser plotters use commercially available bond, vellum, and film media.

WEAKNESSES

Output Quality

Like all raster output, the line definition of laser plotters can never match the precision of vector plotters. Whether the device's resolution is 300 or 400 dpi, line quality is still questionable and small characters, arcs and circles are difficult to produce without jaggies. With the future availability of 600 dpi units, output quality will certainly be greatly improved.

Unit Cost

Unfortunately, unit cost for large format laser plotters ranges from \$30,000 to \$50,000, making them unreasonably priced versus inkjets and thermals. The smaller format units range in size from A to C and in price from \$3,500 to \$8,500. The cost will probably need to decrease even further to justify them as a dedicated check plotter.

Color Output

Monochrome output limits their use as a production plotter.

Environmental Considerations

Though laser plotters have fewer environmental considerations than inkjets or thermals, they are not really suited for shop floor operations or dusty environments which will affect the device and eventually the output. In addition, the toner itself is considered to be a hazardous material which may affect some project requirements and country codes.

User Intervention

The larger format units require more user intervention than the smaller devices, which are usually self-running. However, regular maintenance of the toner, heads, and photoreceptor is required.

SUMMARY

The demand for raster output devices has increased dramatically as technology and affordability have improved. Although currently the output quality of raster plotters is acceptable, this is one element of the technology that requires improvement. When compared to vector devices, the output quality cannot be matched in terms of line definition and crispness, especially with small characters, arcs and circles. Until this changes, many raster devices will be limited in their ability to be completely versatile, just as vector devices are limited in their ability to produce fast output of complex drawings.

RASTER PLOTTERS

A Closer Look

Raster output devices have always been valued for small-format check plots in support of final large-format output—often to a pen plotter. However, the new crop of large- and small-format rasters is so strong they are increasingly purchased as primary plotters. Competitive pricing, speed, output quality, and many high-powered productivity features have made these products very attractive. As a group, they are faster, easier to use, and cost no more than

high-end pen plotters with comparable features.

If you're thinking of retiring the "old pen plotter," adding a small raster for check plots, or changing to a large format raster device, what do you need to know? This review looks at nine devices ranging from A- through C-size desktop printer/plotters that can perform a variety of office printing functions, to D/E-size dedicated plotting machines that don't fit on a desk or tabletop. They include: two E-size

inkjets, two C-size bubble jets, three E-size direct thermal plotters, and two B-size lasers. All have excellent features and perform remarkably in the right situation. In general, a direct correlation exists between features/performance and price; but your needs and budget are also major factors. Price/performance is the real issue. If a \$2000 device does the job for you, go for it. If you need the features of a \$10,000 (or more) machine and have the budget, don't settle for less.

COMPARATIVE SHOPPING

PLOTTER	TYPE	MAX. OUTPUT	MEDIA TYPE	DESKTOP PLOTTERS			SPECIAL FEATURES	PRICE
				COLORS	LANGUAGES/EMULATIONS			
BGL LaserLeader 9115	Laser	B-size	cut-sheet 3-trays	black	HPGL, HPGL/2, LND3+, CalComp, Veratec, Post- Script, custom EXCL & more	52Mb hard drive, 1.2 floppy drive, many network interfaces	\$6595- \$7395	
DataProducts LZR 1555/1560	Laser	B-size	cut-sheet 3-trays	black	HPGL, HPGL/2, Postscript, (1555 LaserJet III), PCL5	Fully independent ports, to 16Mb	\$3395- \$3795	
Pacific Data Products ProTracer	Bubblejet	C-size	roll, tractor, or sheet feed	black	Epson LQ-1050, IBM ProPrinter, HP-GL and Postscript add-on cards	Postscript card, simultaneous serial and parallel input	\$2249- \$2895	
Summagraphics Hi JetPro Series	Bubblejet	C-size or long plot	roll, tractor or sheet feed	black	HPGL, HPGL/2, DMPL, IBM ProPrinter	Faxing capability, Windows/RTL drivers	\$1995- \$2995	
LARGE-FORMAT PLOTTERS								
CalComp DrawingMaster Plus	Thermal	E-size	roll, special thermal	black/red or monochrome	CalComp 960/907, HPGL, CCRF	4 multiplexed ports, auto. media cutter, plot collection basket, 25Mb hard disk, 400-x 200-dp	\$11,495- \$12,995	
ENCAD NOVAJET 840	Inkjet	E-size	roll or sheets	16 simul- taneous	HPGL, HPGL/2, RTL, Postscript	Translucent cartridges, cut & stack, line widths	\$9995	
Hewlett Packard DesignJet 500	Inkjet	E-size	roll or sheets	black	HPGL, HPGL/2, RTL	Enhanced 600 dpi, JET direct network cards, cut & stack	\$8495- \$9995	
JDL ExpressPlotter II	Thermal	E-size	roll-special thermal	monochrome	HPGL, HPGL/2, JDL FastPlot	User ID/date/time stamping, cut & stack, optl. 52Mb hard disk	\$8995- \$11,995	
Roland LTX 420	Thermal	E-size	roll-special thermal	monochrome: black, red, blue, orange	HPGL, RD-GLII	Direct raster input cap- abilities, easy media loading	\$8995	



LASER - DataProducts LZR 1555/1560



The LZR 1555 laser printer operates in two modes that work well with CADKEY. As a 7475A plotter mode, it accepts drawings in HPGL format and produces true 400 dpi output; as an HP LaserJet printer (HP PCL5) it produces 300 dpi.

The LZR line includes single-, double-, and triple-input tray models which can accommodate trays for letter, legal and/or ledger size (11" x 17" or B-size) paper. At \$3595 for a two tray model (one 8 1/2" x 11" and one 11" x 17"), this is the lowest priced B-size laser on the market. The LZR 1560 Postscript model, also priced at

\$3595, can emulate an HP LaserJet, but does not have 7475A capabilities.

We found both LZR models fast, flexible and easy to use. The resolution of drawings was extremely good; the control panels offered much flexibility; they also printed everything -- from spreadsheets and letters to Pagemaker and other graphic files.

The LZR 1555 features 13 scalable and 14 bitmap fonts and accepts HP and other third party font cartridges. It is highly functional in an office and/or CAD environment. The LZR 1555 is rated for 30,000 pages per month and it has the smallest footprint of any B-size laser today.

The price and features of the LZR printers make them the price/performance leader in the 11" x 17" laser market.

LASER - BGL LaserLeader 9115

Loaded with features and options, BGL's LaserLeader printers do everything B-size lasers should and more. They have more of everything including emulations, networking capabilities, and duty cycles of up to 100,000 pages per month. They were, in fact, designed to be corporate, networking workhorses. They operate well in mixed environments -- Apollo, DEC, IBM, Macintosh, PC or Sun -- and with multiple dissimilar Ethernet ports, are a network manager's dream come true.

The HSGC-3 (High Speed Graphics Controller) has an Auto-Emulation/Interface Switching and Simultaneous Sensing (A.E.I.S.S.) feature which allows data to be received from up to four dissimilar interfaces and automatically



switches to the appropriate emulation. Emulations include the most popular printer/plotter emulations such as Pipeline/PDL (Postscript), HPGL (7475, 7550, 7580, 7585), HPGL/2, LaserJet Series II, LaserJet 2000, LN03 Plus, Tektronix 4010/4014, Versatec V-80, CalComp 960/

907, Bar Codes and QMS Magnum Code.

All BGL lasers come with a 1.2MB floppy drive and a 50 MB hard disk that acts as a spooler, leaving the host to work on other things. All this power costs more (about \$6,500) but is worth every penny if you need it.

C - SIZE INKJETS

BUBBLE JET - *Summagraphics HI JetPro Series*

The HI JetPro is an office jack-of-all-trades. It plots HP-GL/2, HP-GL and DM/PL formats at 360dpi, and emulates an IBM ProPrinter XL124 for standard office printing such as correspondence, reports, spreadsheets and long project management charts. The V100 and V50 models of this C-size bubble jet are essentially identical in plotting capabilities for CADKEY. The V100 can output scanned images, automatically identifying the raster file format. The V100 also has built-in fax and modem capabilities, outputting fax/modem (PCX) files to A- to C-size plain paper. The V50 goes for \$1,995, the V100 for \$2,995.

The 360 dpi resolution produced much better than readable plots of D- or E-size drawings. When we got

"muddy" areas (where there were many complex wide lines) we were able to easily adjust this by resetting line widths. An AutoScale feature let us plot on standard sized (A, B, C) paper without reconfiguring the software.

The HI JetPro plotters are good for producing A- to C-size check plots and the V100 could be invaluable if you



need to print raster files, scanned images, and/or want to use the fax and modem functions.



BUBBLE JET - *Pacific Data Products ProTracer*

As a "roll-your-own" type C-size inkjet, the ProTracer is highly upgradable. It comes off the line with only resident Epson LG-1050 and IBM ProPrinter XL24E emulations, and 512K of memory for \$1,495. However, it's equipped with two upgrade and one memory expansion slots. To use it to plot CADKEY drawings, you must order it with at least the HP-GL upgrade which includes an HP-GL emulation card and a 5MB memory upgrade board, still a bargain at \$2,249. A Postscript card and 8MB memory upgrade are also available.

We looked at the ProTracer with both the HP-GL and Postscript options. We were a little worried when it arrived in separate boxes (unit, cards, sheet feeders), but in fact, it was extremely easy to put together. You

really do just plug the cartridges (and the memory card) into the easily accessible slots and install the software.

The documentation was refreshingly good (clear, professional, organized, lots of pictures) and actually included accurate step-by-step instructions for configuring CADKEY. One convenience we discovered using both the HP-GL and Postscript is that we could change from CADKEY to Windows applications and switch quickly to Postscript via the control panel. In HP-GL mode, output was fast, the 360dpi resolution was good and it printed right to the edge of the paper.

For CADKEY plotting and all around office printing, the ProTracer is the solution of choice.



D/E - SIZE INKJETS



INKJET - ENCAD NOVAJET 840



Until recently, to get multiple colors and good resolution in a large format drawing you needed a pen plotter (slow and awkward), an electrostatic (much faster, but wildly expensive) or a thermal (faster than a pen plotter but requiring special thermal paper.) Now there's another choice - the NOVAJET 840 from ENCAD.

ENCAD based the NOVAJET on the monochrome inkjet technology that has been around for a while, adapted it for color and added some high-end features for good measure. You can plot 16 different vector colors at one time out of 256 possible colors. The

new cartridges hold twice as much ink as standard cartridges and can produce up to 400 E/ A0 plots. The cartridges are translucent which lets you visually track the ink levels -- a nice convenience. Fifteen pen widths (narrower and wider than pen plotters) can be selected through NOVAJET's 32-character LED display. The standard 4 megabyte buffer can be expanded to 14 MB.

For standard vector output the NOVAJET emulates HP-GL and HP-GL/2, but NOVAJET's raster output features expand your options. The HP RTL emulation supports Postscript (via Freedom of the Press software) and a variety of scanning applications such as CAD Overlay @ ESP.

If you require fast A/E color output, the NOVAJET is an excellent choice with a satisfying variety of high-end features.

INKJET - Hewlett Packard DesignJet 600

The DesignJet 600 is the latest version of the HP DesignJet released last year. Its enhancements include better print quality, broader connectivity, greater functionality and a lower price.

This D- or E-size plotter's three selectable resolutions are enhanced (addressable 600 dpi), final (300) and draft (addressable 300 dpi). We found the 600 dpi resolution excellent and the others very good. The DesignJet features algorithms for enhanced mode that produce especially smooth circles, fine lines, clean low-angle lines and readable 4-point type. The 300 dpi final mode is twice as fast as enhanced mode, but produces the same print quality as the final mode of the HP DesignJet plotter. We even tried printing on the cheapest transbond roll media we could buy. The plots were still gorgeous. For the many engi-

neering applications that don't require color plots, the monochrome black output is all that's necessary.

Much trial and error is involved in plotting. The DesignJet 600 let us save time and paper. HPGL/2 and other internal features made plotting very quick and if we saw that the drawing was not to our liking (i.e., line widths, placement, etc.), the plotter stopped instantly with the cancel feature and we could tell the plotter to cut off just a few inches instead of wasting a whole sheet.

Hewlett-Packard continues to set industry standards with the DesignJet 600. It's a solid, quality machine, that has the speed and resolution, and high end features engineers and designers require for D- or E-size final output.

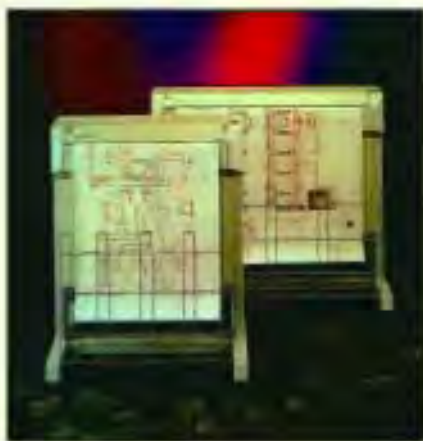


THERMALS

THERMAL - CalComp DrawingMaster Plus

While most thermals produce only monochrome drawings, the CalComp DrawingMaster Plus can plot in black and red and has other unique power features. One is CalComp's proprietary Quikplot. Quikplot nearly doubles the plotting speed for check plots, but keeps a high degree of image quality by decreasing the resolution only in the media travel axis. CalComp also has included a RISC-based processor that provides high-speed vector-to-raster conversion.

We found the output quality very good. CalComp's paper is extremely white, which provides higher contrast (a trick to remember for any plotting or printing application) but complex fine images were very clear. Normal resolution is 200 dots per inch (dpi), but for those who need higher resolution, CalComp's new DrawingMaster



Professional Series yields 406 dpi.

Other standard features include a 25 MB hard drive, indicators that warn you when the media supply is low or empty, a four-switch control panel, a terminal port, a program-

mable automatic media cutter, and CalComp Device Control Language, which lets you control plotter parameters from the computer.

Convenience features include an optional take-up reel for unattended plotting and a standard automatic programmable media cutter. We like the ease of being able to load the media from the front. It required less handling. The DrawingMaster Plus also has optional IBM 2780/3780 and 3285 emulations, CalComp 980 Local Area Network or Ethernet interfaces and an operator communications terminal.

For crowded work spaces, this plotter also comes in a wall mounted version. It's an excellent plotter for fast throughput and unattended plotting. Price is now \$11,495 for the D-size model, \$12,995 for the E-size.

THERMAL - Roland LTX 420

Roland's LTX plotter line offers several choices for thermal plotting ranging from the E-size 420 to the B-size LTX-120. We looked at the LTX 420 and found it fast, reliable and quiet. Its maximum resolution of 200 dpi was less than some of the other thermals, but these numbers weren't very noticeable on the final output. The images were very good with lines as fine as 0.125mm.

Standard features include built-in vector-to-raster conversion, automatic serial/parallel detection (configures plotter for appropriate language) and replot capability. Although it has a plot collection basket, it doesn't have an automatic cutter - a mild inconvenience.

At \$1795 the B-size LTX 120 is a table top model which would be ideal for check plots. It has most of the features of the larger versions, including replot functions, high speed

vector/raster conversion, and adjustable line widths.

The LTX-120 has additional capabilities. For example, it automatically reduces C, D, or E size drawings to fit B size paper. It can also be more than a plotter. Its auto-detect IBM Graphics Printer mode lets it be used for word processing and other general applications. It also accepts DXY and RD-GL1 commands.



THERMALS

THERMAL - JDL Express Plotter II

The JDL ExpressPlotter II has several unique and useful features. It's also very fast. Detailed E-size monochrome plots can be produced in one to two minutes.

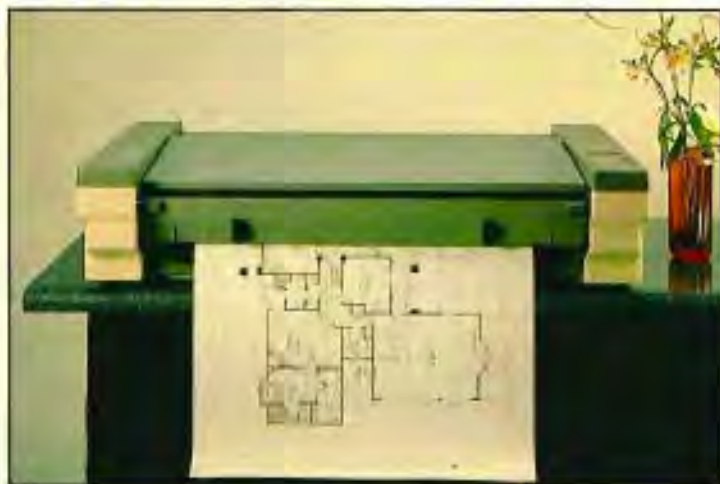
The "horse-power" is provided by two microprocessors, a dedicated vector-to-raster converter (VRC), 4 MB of RAM, a 52 MB hard drive and fast interfaces. The SCSI interface, for example, can transfer a one megabyte file to the plotter in less than five seconds.

In addition to HPGL and HPGL/2 support, JDL's proprietary JDLPlot™ is a very efficient vector format that significantly reduces data transfer times.

The ExpressPlotter II's "Total Plot Management System" would be especially useful in networked environments where many users share a single output device. The plotter labels each plot with a user-defined name, date and time, and

then automatically cuts each plot exactly to size, neatly stacking up to 70 plots of various sizes on the automated stacking bar. This sure solves the problem of whose drawing it is and we like stacked drawings instead of the rolled drawings some other plotters provide.

The ExpressPlotter II is a good choice for a large number of users on a network, large daily volume throughput, and situations where the plotter must produce vector, raster and hybrid vector/raster files. The price is definitely right considering the richness of the feature set.



FOR MORE INFORMATION, CONTACT:

3GL Technology Corp.
LaserLeader 9115
451 Constitution Ave.
Camarillo CA 93012
805/987-7305
Fax: 805/987-7346

CalComp
DrawingMaster Plus
2411 West La Palma Ave.
Anaheim CA 92801-2689
800/932-1212
714/821-2000
Fax: 714/821-2709

DataProducts
LZR 1560
6219 DeSoto Ave.
Woodland Hills CA 91367
800/283-7227
818/887-8000
Fax: 818/887-4789

ENCAD
NOVAJET 840
7710 Kenamar Court
San Diego CA 92121
800/356-2808
619/578-4070
Fax: 619/578-4613

Hewlett Packard
DesignJet 600
3400 Hanover Street
Palo Alto CA 94304
800/752-0900
Fax: 800/333-1917

JDL
ExpressPlotter II
4700 Calle Quetzal
Camarillo CA 93012
805/388-8709
805/389-6958
Fax: 805/388-8708

Pacific Data Products
ProTracer
9125 Rehco Road
San Diego CA 92121
619/552-0880
Fax: 609/552-0889

Roland Digital
LTX 420
1981 McGaw Avenue
Irvine CA 92714
714/975-0560
Fax: 714/975-0569

Summagraphics
Hi JetPro Series
8500 Cameron Rd.
Austin TX 78753
800/444-3425
Fax: 512/835-0900

GETTING YOUR ACT TOGETHER

by Ron Shea

My daddy always said, "Use the right tool for the job." I know this because every time my Mom asked him to do a project he would say, "I can't unless I have the correct tool to creatis fran the muffler bearings with." Dad did not like to work on cars! Fortunately, with CADKEY it's a cinch to have the correct tools. Not only can the engineer design an item and send it to Computer Numerical Control machines directly; with ACTools' Utilities from Allan CAD TOOLS, he has access to a series of commands executed from within CADKEY that not only help him perform many needed functions but also often make the CAM connection smoother.

Here's a good example. We all know that CADKEY shines with such features as MIRROR, but there are potential problems for manu-facturing. When you mirror, the result is two lines along the same plane. This often could be more productive, from the manufacturing perspective, if it were one continuous line. The CNC programmer must either go in and correct the geometry or create additional code to cut the geometry. This is not efficient. ACTools' UTILITIES comes to the rescue.

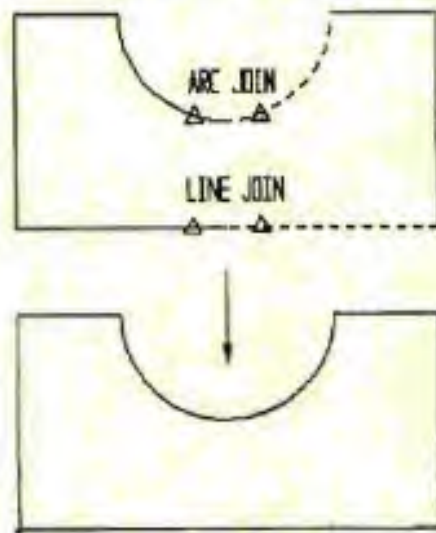


Figure 1



Use the "Join" command and the two entities are replaced by one. (Fig.1) If you wish to retrieve the old geometry, the Control U function "Recall Last" will bring the old geometry back. Now the CNC programmer no longer has to create the additional code for the program nor does he have to create imaginative alternate names for the engineer, because they both have their ACT together.

We'll talk more about specific functions later, but first let's look at two CADKEY screens. The typical before and after picture:



Before

After

Notice that with ACTools' Utilities the menu is categorized by functionality. View, Dimension, Attribute and Text functions are clustered within the Status Window to help the user identify them more easily. This helps reduce user eye strain as well as speed up the selection process.

ACTools Functions

Now more about the functions ACTools' UTILITIES provides to make the designer's job easier. Look at the various figures. You see that these commands are quite useful for preparing data to go to the CNC program as well as reducing the frustration designers currently experience using long work-arounds.

ALONGAX (Fig.2) allows the user to create arcs and circles along a line or arc axis. The most common uses are to create swept cylindrical profiles such as those identifying the surface of revolution for a vase or wine glass and to create tubular profiles with an arc axis such as rings or tires.



Figure 2

KINK (Fig. 3) will dynamically "kink" a line. This gives you the ability to dynamically move the vertex. The movement can be snapped orthogonally in a horizontal or vertical direction.

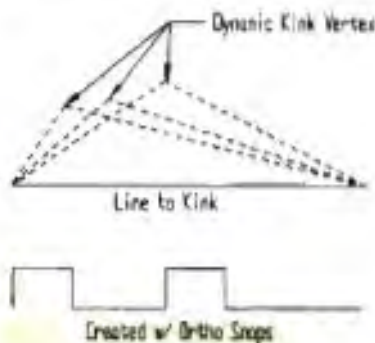


Figure 3

OFFSET (Fig. 4) creates a parallel offset of a chain selected profile. The profile can be specified with Thru Pt, At Dist or w/Draft.

with a draft angle and depth. The offset profile is always projected to the current construction plane.

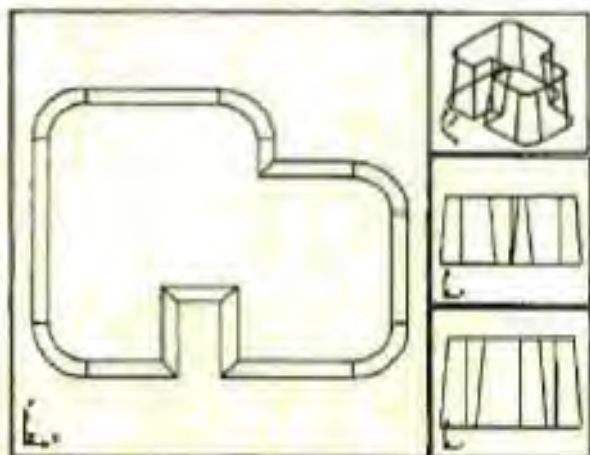


Figure 4

PARARC (Fig. 5) and **PARLINE** (Fig. 6) allows the operator to create parallel arcs and lines, similar to offset, but does single arc or line offsets as opposed to a chain of entities.

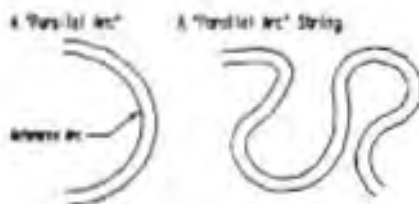


Figure 5

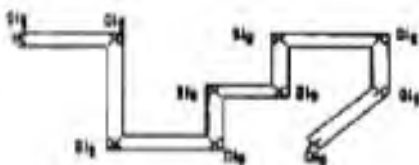


Figure 6

PTRIM (Fig. 7) or position trim is a much needed function. We can now trim or extend to a point location as opposed to trimming or extending to existing geometry. **TANANG** (Fig. 8) creates a line of a specified angle, tangent to a selected arc or circle.

TUBES (Fig. 9) is a utility the hydraulic engineers would "kill" for. It creates a 3D tubular shell along the centerline of existing geometry.

Create a centerline with a line string, then fillet the vertices along the string with the desired bend radius. The tube is formed using the center line trajectory.

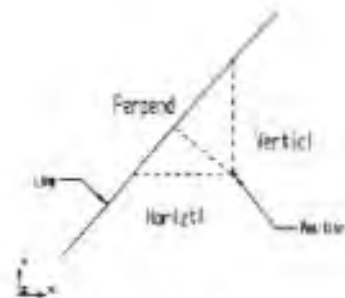


Figure 7

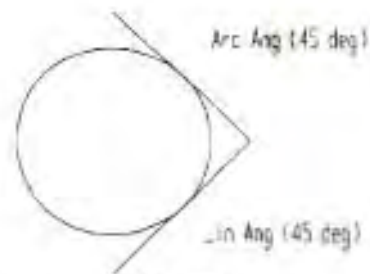


Figure 8

How's that for putting in brake lines, airplane hydraulics or irrigation systems. This makes design a snap for hydraulics. I have heard many descriptions of this utility, but I think my friend, Don Barton of Chehalis Pump and Electric, summed it up best with the description of "Butt Kickin'".



Figure 9

ACTools' UTILITIES has many more functions than the samples described here. They include SPIRALS, EXPLODE polygons, polylines, or x-hatching, the ability to save four views of a design, and do a slide SHOW of each level containing entities. In fact, there are over 40. The students of New Market Vocational Skills Center said it best. "COOL!"

ACTools' UTILITIES is a productivity must for the CADKEY user. Jon Allan has done his homework, creating a nice package that is easy to work with.

For more information on ACTools' UTILITIES, contact Quality CAD, Inc. at 1-800-523-4223.

CADKEY CORNER

by Al Torizzo



Tips for Getting Organized

Daily survival and staying sane requires more than super CADKEY skills. It's often the little things, like staying organized that can drive you nuts. Here are a few organizational tips I've discovered and use on a daily basis.

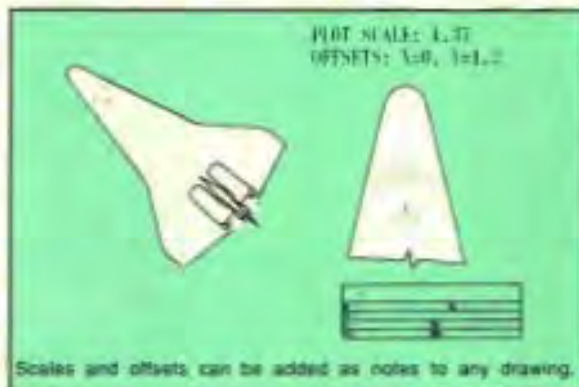
Notes / Memos

My drawings often receive notes or memos just for my personal use but not intended to be part of the finished drawing. They are done in the HIWHITE color. Why HIWHITE? It's simple. CADKEY uses this color to identify selected entities during various operations. Therefore, it isn't useful for other entities and certainly stands out. Prior to plotting, I can delete my HIWHITE information, but even better, use PLOT/PRINT, ALL DSP, EX TYPES, COLOR. In addition, using LEVELS lets me turn these memos off as needed.

Memos and notes can be put anywhere, but you can also have a boxed area in a specific location for notes which are not to be part of the final drawing. These notes resemble the posted memo stickers we find stuck to our chair, phones, and monitors when we get back from lunch.

I've also known users to develop a standard drawing log and keep it on a specific level. Drawing standards throughout a shop should

also include colors and line widths for your line types and/or certain entities. Pick your colors; it can be rather subjective. For me yellow is for centerlines, light blue for construction lines, and light green for dimensions and texts. If the drawing size is not apparent or if plot scales and offsets must be known, then use such a system as standard office practice for noting these items on the drawing.



Fill Ins

For ease when adding fill in data to a drawing, such as the date or drawing number, begin with an "X" as a place holder in a template. Thus, you might see DATE: X. The X must originally be set up as a separate text entity from whatever precedes it. Make it in the preset color and text attributes you will be using. Then use EDIT TXT and select that X to fill in the new information. The color, attributes and location will always be correct.

Planning Ahead

Do give yourself a break by closing work sessions in the view you wish to begin with next time. This includes windowing in. Version 5 users can also choose to end work in either MODE or LAYOUT modes and be assured that when they begin again, that mode will be active.

Finding and Naming Drawings

A common problem is naming drawings so they are grouped logically and easy to find in a long list of drawings. Good old DOS/MSDOS only lets us have eight letters, like eight tiny reindeer, with which to identify and organize our drawings from our many lists of drawing names, so we need to get really creative.

You can use DOS commands and tools, or file management utility software can be helpful. With either approach, a certain category of drawings could begin with a specific letter, say "N". Then to see a list of those drawings just use an N?.*.

Organizing drawings into subdirectories also works. It does have the detractor of having to type in the path for CADKEY to locate the subdirectories other than PRT. Or CADKEY config. can be reset to allow for opening in a different subdirectory on start up, if desired.

Printing lists of drawings can

also be very helpful. On this list you will also get drawing dates (when last worked on), drawing time and drawing size (in bytes) when you work from DOS/MSDOS or better yet, from a file management utility. PRINT SCREEN works well in CADKEY using the CONTROL, SYSCMD option and the suitable DOS/MSDOS commands. If you are unfamiliar with these commands, either be humble and ask your local shop guru, try your DOS/MSDOS manual, or go to the nearest book store and get a good "HOW TO" manual for your version of DOS. There are only a few commands you will need to learn and mastery is quite simple. For the exotic, I know of one user, Brian Gross, who now runs CADKEY under WINDOWS. It's a noteworthy achievement in hardware/software configuration.

Have a suggestion for organizing your CADKEY work? I'd sure like to hear from you!

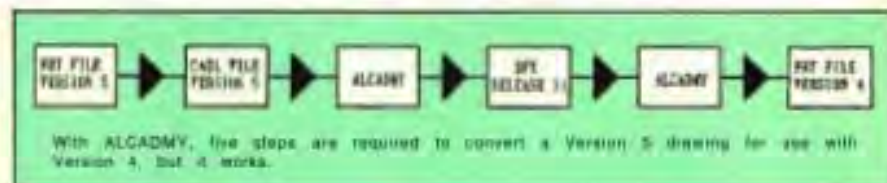
Converting Part Files to Lower Releases - REDUX

Whoa! did this topic in the last issue generate reader response when some who tried it encountered difficulties. I suggested turning a part file into a CADL file to take the

I also learned another trick about complete file transferability from Spence Quilling of METRA who put me onto the ALCADMY file which comes with CADKEY. It was originally designed to prep CADKEY files for AutoCAD and visa versa. Using ALCADMY, DXF the drawing to AutoCAD 11, then back to CADKEY requesting a lower version. No need to have AutoCAD.

Another reader response came from Tom Appolloni of CADAMA Design Group. He tells me his latest version of ALCADMY (5.13) is available on CADKEY's electronic bulletin board. ALCADMY is included in CADKEY's packages but will not be the very latest and greatest. Look for a printable text file, ALCADMY.DOC on your CADKEY utility diskette. It does do a 100 percent data conversion. There are 5 long steps to the process, but it works! Anticipate a complete conversion system (any version to any version) in very early spring 1993. You can also write to Tom at 1025 Melinda Lane, Monument, Colorado 80132.

In closing, it's becoming a very bright world for us CADKEYers. With the addition of Malcolm



drawing into a lower version. One problem is that you can lose details and text in the conversion because CADKEY 5 sees this data as entity specific. Jon Allen of ACTools has a suggestion that guarantees that at least most of the entities will convert downward. Simply use a text editor to strip the top line of the part file "int TXTINFO(0), DIMINFO(0), ENTATT(0)". Watch out for splines which should have no more than 74 segments for this method. (Version 5 supports 200 segments.)

Davies as new Cadkey CEO (formerly a very successful vice president at Autodesk), the recent release of CUTTING EDGE, bundles of terrific third party software, and the emergence of more powerful computers, I look forward to each new day with eager anticipation.

Till next time!

AMERICAD

HELPING YOU DESIGN THE FUTURE

(800) 835-0355

AMERICAD WOULD LIKE TO THANK YOU FOR YOUR CONTINUED PATRONAGE THROUGHOUT THE YEAR. BEST WISHES TO YOU AND YOURS THIS HOLIDAY SEASON!

DIGITIZERS

CALCOMP 3320 (4 OR 16 Bit)	209
HITACHI PUMA PLUS (4 or 16 Bit)	215
KURTA XLP	239
SUMMAKETCH II PLUS (4 or 16 Bit)	285

MONITORS

HITACHINSA CM2085M (19")	1389
IDEX 5217 17"	949
MACMULTI 17"	1199
MITSUBISHI F5680SATK 16"	949
MITSUBISHI TF5670SETEK 17"	1129
MITSUBISHI ML4955ATEL 19"	1799
NANAD 9070 16"	820
NANAD F590 17"	1129
TASAKI MV915 PLUS 17"	1119

GRAPHIC CARDS

NUMBER NINE LEVEL 25	995
NUMBER NINE LEVEL 39 GDI TC	1649
ARTIST X3000	1079
RTN 53 ADVANTAGE	379
NOE 2000	1049
VMO COMBA ELITE	899
HELIO TC 1280	599
DIAMOND STEALTH	239
DIAMOND SPEEDSTAR 245	179

PLOTTERS

HOLISTON INSTRUMENTS DMP10 WAMP	1495
HOLISTON INSTRUMENTS DMP10	2499
HOUSTON INSTRUMENTS DMP162	3249
HEWLETT PACKARD COMBA DESIGNER	CALL
HEWLETT PACKARD DRAFTER DILEX	CALL
ROLAND SKETCHMATE	329
ROLAND DRY 1200	1099
CALCOMP PAGESETER	CALL
CALCOMP ROLLFRED	CALL
CALCOMP DRAWINGMASTER	CALL

SYSTEMS

COMPAQ, EVEREX, AND MICRONICS... CALL US FOR CUSTOM CONFIGURATIONS TO MEET YOUR HARDWARE AND SOFTWARE REQUIREMENTS!

WE CARRY THE FULL PRODUCT LINE OF ALL ADVERTISED!

(404) 751-9955
11940 Alpharetta Highway, Suite 121
Alpharetta, GA 30201

Prices reflect a 10% cash discount.
Leasing available thru Monetta.
Visa, MasterCard and AMEX accepted.
Purchase orders accepted from qualified organizations.
All product names are Trademarks and Registered Trademarks of their respective companies.
Prices subject to change without notice.

DataIn.cdp is a program used to input position data from a text file. Many users need to take measurements or data from an external program and efficiently bring the data into CADKEY. Rather than sit and laboriously key in the data (which many people do!), DataIn.cdp can be used to directly read the positions and add points or lines directly to the database. Modifications of the program can be used to create splines, polylines, or other useful geometry.

This program enters to a specific data file format. For each line of the text file, the program reads eight characters that are not useful (in this case, the word POSITION) and 3 floating point values. Each set of values indicates a 3D position, and a menu choice directs the program control to construct the appropriate CADKEY entities.

The exact format of text-based data files may vary considerably, but the variations can often be taken into account by simply inspecting the format specifiers (see comments in the code) and adjusting the input format. Changes such as different numbers of characters on each line, the exact order of the data, or how data is separated (by words, blank spaces, commas, new lines), can be dealt with by changing the input format.

This program assumes the following text file form.

```
POSITION 0.5002 1.2340 1.7809
POSITION 0.6752 2.2340 1.9341
POSITION 1.7677 1.3407 2.7119
POSITION 0.2352 1.2908 3.7229
POSITION 0.5012 1.6541 3.7125
```

Interaction is simple. The program starts with a prompt for the input file name. Once the file name is entered, menu options allow the user to select the CADKEY entity type: POINTS or LINES. The program opens the appropriate file from the CADL directory and reads data until the end of the file is reached, constructing geometry as needed.

To compile this code, place the file DataIn.cdp in a directory with the CADKEY ccomp files (ccomp.exe, ccomp1.exe, ccomp.txt) and type: CCOMP DATAIN

```
local x1, y1, x2, y2, z1, z2, datatype, $file
$file = "data.txt"

:exit
/* get the file name and set path plus name to the current cadl directory */
getdb "Enter the filename for data input (%s)", $file, $file
open $file, "r" @CDLPATH, $file

/* open the file */
set devin, $file
f (@devin == 1)
|
| prompt "ERROR: Unable to open file in CADL directory «Enter»"
| goto :exit
|

:menu
getmenu "Choose Data Construction Option", 1
"POINTS" "LINES", ..... 1
switch (@key)
|
| case -3
|   goto :end
| case -2
|   goto :start
| case 1
|   datatype=1
|   break
| case 2
|   datatype=2
|   break
| default
|   goto :menu
|

/* input the first line of data, 6 characters, 3 floating point values */
input "%6s %f %f %f %f\n", x1, y1, z1

/* enter loop: continue reading and creating geometry */
while (@read > 0)
|
| x2 = x1
| y2 = y1
| z2 = z1
| /* read next line of data */
| input "%6s %f %f %f %f\n", x1, y1, z1
| f (@datatype==1)
|   point x1, y1, z1
| else
|   line x1, y1, z1, x2, y2, z2, 0
|
| close devin
:and
```

The text of this code is available on Cadkey's In house Bulletin Board (203/647-8523) and on Compuserve.

This creates the file DATAIN.CDX, a binary executable CADL file. Place this file in the current CADL directory (CDL is the default) and execute the program by choosing FILES, CADL, BINEXEC and entering the name of this file. For faster access, this command sequence can be stored as a macro and bound to a key or added to the CADKEY menu structure.

This CADL ToolBox provided by Craig Storms and Ken Fortier

**CADL Plug: Look for the revised
DISCOVERING CADL
Coming soon!**

THE PERFECT TOOL FOR CONCURRENT ENGINEERING

When you need to design for maximum manufacturing productivity, put the Tool Designer's Assistant® to work for you. We offer the largest, most-complete CAD library of standard tooling components available. Use with Cadkey® or a variety of other software formats, on virtually any workstation, microcomputer, or mainframe system. Installing our library helps you save the expense and countless hours of building your own standard library from scratch.



TOOL DESIGNER'S ASSISTANT®



CHUCK JAWS



TOGGLE CLAMPS



HANDLES, KNOBS



ALIGNMENT PINS



MODULAR FIXTURING

The Tool Designer's Assistant® . . . the perfect tool to allow a smooth interchange between design and manufacturing. Send for more information on our limited-time \$95 special.



POWER WORKHOLDING
DEVICES



MANUFACTURING CO.

4200 Carr Lane Ct., P.O. Box 191970

St. Louis, Missouri 63119-0190

© Phone: 314-647-6200, FAX: 314-647-6736

Tool Designer's Assistant - Component Library for CADKEY

Although fixture design is one of the newer applications for CAD, tool designers can often benefit more than anyone from CAD/CAM. Since part size and shape are key factors in deciding how to locate and clamp, one obvious advantage in using a CAD system for tool design is that workpiece geometry is often already stored on the system as an output of the product-design process.

An even greater advantage is the ability to use and reuse a standard library of tooling components. Now, in addition to your own in-house standards, Carr Lane is offering its new 3D drawing library of standard jig-and-fixture components. Carr Lane is, in fact, the first company to offer true 3D tooling libraries for micro based CAD/CAM systems. CADKEY and other CAD systems are directly supported.

Called *Tool Designer's Assistant*, the tooling component library is an extensive data base of engineering layout drawings. The 2D version

contains more than 8800 detailed view drawings and the 3D version has over 3300 wireframe models. Both versions allow more than 5400 different tooling components to be assembled in a matter of seconds. Components include workpiece geometry, fixture bases, supports, locators, clamps, and fixture accessories.

In the 2D version, components are drawn in two, three, or four commonly used orthographic views, usually top and front profile. This minimizes the amount of computer storage required, yet gives enough information to construct any other view easily.

In the 3D version, components are constructed as true 3D geometric wireframe models. Any required orthographic views can be taken instantly from the 3-dimensional model. Parts are oriented as you would most commonly use them in fixturing. Standard origin points are established, but can be changed to

suit your standards.

All the library drawings are accurate and fully detailed. They were individually drawn based on manufacturing prints, not optically read from template drawings. Each has been checked and rechecked for accuracy.

The drawings are stored at full scale, but can be reduced or changed at will. They can also support CADKEY's auto dimensioning and bill of materials features. Clear documentation with pictures, sizes and CAD/CAM library part numbers are available for personal and multi-user CAD systems.

Carr Lane's sure you'll like it. They ship the complete tooling component library with a mini-library which you can use and test for 30 days. If you decide not to keep the package, you return it (with full library unopened) and you get all your money back.

For more information contact Carr Lane, 314/647-6200 or Fax 314/647-5736.



SNAKE OIL? NO!

CAD-Synergy!

ONLY
\$50

Also Included:
Move Line Endpoints
Smooth Integration Into Cadkey Menus
Medium And Bold Helvetica Fonts
Change Circle Diameters To Match A Selected Circle
Have Entity Attributes Match A Selected Entity
Set New Default Paths From Within Cadkey
Set System Attributes to Match A Selected Entity
Spell Check All Drawing Text - New In Version 3



HANSEN DESIGN CO.
6107 105TH AVE N.E. • KIRKLAND, WA 98033
PH OR FAX 206 643-8528

CIRCLE CARD NO. 228

Kurta Features Cordless Pointers / Tablet Controls

by Claudia Martin

Kurta's new XGT Serial Graphics Digitizing Tablet has several unique, high end features. They include optional cordless pointing devices (based on second generation technology), an on-tablet control panel, tablet/screen scaling, and multiple emulations.

Emulations - I use PageMaker, QuattroPro, and WordPerfect as much or more than I use CADKEY, so a real plus for me was the ability to switch back and forth easily between the Kurta and Microsoft serial mouse emulations. We used to need a digitizer and a mouse complete with cords (usually tangled) both hooked up at once. Life is much simpler now; one click and the XGT is ready to go. The cordless devices, by the way, save their batteries by turning off when not used for 20 minutes.

The XGT has a menu strip that runs across the top edge of the tablet with 34 buttons. Besides letting you change emulations easily, this "command" center lets you control how the pointing devices work and change tablet and screen scaling. Sixteen are user definable and can be used for macro recordings. The modifiable defaults for emulation switching buttons are Kurta XGT Pressure format, Kurta IS/ONE, Wacom, Summagraphics and Microsoft Mouse. We configured button 3 specifically for CADKEY and button 2 for Windows.

Scaling - The XGT lets you adjust (from the on-tablet control panel) the size and location of the tablet's active area and the screen window to which the tablet area is mapped. Uses? You can change the active area to limit how far you physically have to reach to move the screen cursor, if all you're doing is screen-picks, and a small active area allows you to move quickly from one side of the screen to the other. You could also change the relationship of the tablet's active area to the screen when concentrating on a specific area of the screen, such as tracing into an application window.



To trace an object and have it appear the same size on the screen,



You can scale the tablet and/or screen from the tablet logo menu strip

you can define the active area and screen window area to the same size.

For heavy-duty CAD users, XGT is technically very strong. It has excellent accuracy and high resolution. Buttons on the 16-button cursor can be programmed inside CADKEY to perform any function via the "button" panel in CADKEY device configuration.

The XGT also has a pen with adjustable pressure. The cordless pen and special drawing surface simulate the feel of working with pen on paper. They were designed for graphic arts and drawing applications that recognize pressure data.

The XGT tablet works very well with CADKEY (we used it with the CADJET template from HLB). It also works with any system that has an RS232 serial interface including Sun Microsystems work stations. The XGT Serial Digitizing Tablet is priced at \$600. The cordless pressure pen is \$200; the cordless pen \$100; the 4-button corded and cordless cursors \$100; and the corded 16-button cursor \$200.

Contact Kurta at 602/276-5533 or 800/44KURTA.

A WYSIWYG RENDERING TOOL?



REALIZE rendering tool is the first rendering tool available under DOS offering true What You See Is What You Get control over the rendering process.

Sounds too easy, but it's true. And REALIZE has "virtual reality" viewing to allow realistic walk throughs.



All on Standard VGA

Other Features:

- Resolutions up to 1024x768-256 colors
- FAST!
- Renders any model size
- Icon driven user interface with on-line help
- Dynamic wire frame display
- Phong, flat, and gradient shading with textures
- Dynamic color image editing
- Imports all 2-1/2 and 3-D DXF entities
- Windows compatible PCX output
- Runs on any 80 x 86 DOS machine with Standard or Super VGA



\$695

VGA, Mouse, & Controller required

lunar graphics, inc.

23845 Curran Dr., Golden, CO 80401
(303) 526-2553

© 1992 Lunar Graphics, Inc. All rights reserved. This is a registered trademark of Lunar Graphics, Inc. All other trademarks are the property of their respective owners.

that when the part is folded into shape the holes and notches end up in the right place.

Software Tools

It's not as simple as it sounds because calculations must be made for material thicknesses, tolerances, and bend radii. Several good software packages are available that can do this work for you. ProFold Pattern Development, API_Shapes and DVC Shapes are excellent examples of products designed to work with CADKEY.

ProFold Pattern Development from Applied Production, Inc. does exactly what the name implies. It folds, unfolds, and adds material thickness to CAD drawings of sheet metal parts. The latest version includes a feature for 2D unfolding, in addition to existing 3D unfolding capabilities. Other new features provide special handling for offset bends, edge bends, and common edge lines. ProFold output can be readily utilized by most CNC programming software products.

API_Shapes, also from Applied Production, simplifies the creation of punching shapes and patterns in a sheet metal design. Ten standard shapes used in sheet metal parts are available. In addition to creating shapes on 3D parts, API_Shapes permits them to be placed into the commonly used punching patterns, greatly reducing drafting time.

API_Shapes comes with ProFold or can be purchased separately.

DVC Shapes from DVC Planners can speed up construction of sheet metal wire models. It draws parametric and rotatable shapes and has a thickness generator. It does holes, rectangles, squares, trapezoids, keyholes, keyways, D, double-D, obrounds and user-definable shapes. The

program's sheet metal modeling options also allow you to do box or pan folding.

ProFold, API_Shapes and DVC Shapes link with CADKEY and CUTTING EDGE via CADL. For more information, contact Applied Production, Inc. at 513/831-8600 or Fax 513/831-1236; DVC Planners at 909/926-1219.

Flat Bed Plotters

A flat bed plotter can be another useful tool for sheet metal work. It lets you experiment without tying up CNC machine time or finalizing a CNC program. For example, if you plot a flat pattern on hardboard, you can build a mock-up or a model before actually working in sheet metal. Or you can make a real-live prototype by plotting directly on sheet metal and manually cutting

and folding. Don't forget that the plotter must be able to plot the flat pattern at full-size. Piecing sheet metal doesn't work well.

Affordable D- and E- size flat beds are not readily available. Since many companies prefer a standing roll-bed plotter for most work, a flat bed for sheet metal work may be an additional piece of equipment. Cost, therefore, becomes a consideration.

One of the most affordable D-size flat beds around is the GX-3000A from Galtech Computer Corp. For \$1,995 you get eight pens, a clear LED control panel, adjustable pen pressure (useful when plotting on thick media), and most of the standard features a plotter should have. Galtech can be contacted at 510/732-0911.

pSERVER™ Diskette Based Interactive Plot Server

Don't Tie Up Your PC For Plotting!

pSERVER drives your plotter from plot files on diskette, so you keep full use of your PC while plotting. Use it stand alone - or connected between your PC and plotter for optional direct plotting too. The LCD front panel displays disk directory for file selection, plot status and pen change requests.

pSERVER keeps you in control of both your PC and plotter. Works with HI, HP, Calcomp and other CAD supported plotters.



- Offline Plotting
- Plotter Sharing
- Interactive File Selection
- Multiple File Diskettes



1420 NW Gilman Blvd. Suite 2163 Issaquah, WA 98027
(206) 392-6541

ADVERTISER INDEX

CATEGORY CODES:

A ADD-ONS/ACCELERATOR BOARDS
 C COMPUTERS
 CN CONSULTANTS
 E EDUCATION/PUBLICATIONS
 G GRAPHICS BOARDS

I INPUT DEVICES
 M MONITORS
 N NETWORKS
 O OFFICE SUPPLIES/FURNITURE
 P PRINTERS/PLOTTERS

Q SALES/SERVICES
 SC SCANNERS
 S SERVICE BUREAUS
 SW SOFTWARE
 SA SOFTWARE: AEC/CIVIL/STRUCTURAL
 SM SOFTWARE: ME/CAM/CIM

PG.#	COMPANY	CATEGORY	RS#
59	ACCESS TECHNOLOGIES,INC.	P,Q,S,SC,SW	219
5	ACCORD TECHNOLOGY,INC.	C,G,I,M,N,P	203
49	AMERICAD	A,C,G,I,M,N,P,Q,SA,SM,SW	211
58	ARBOR IMAGE CORP.	SW	220
23, BC	CADKEY	C,E,Q,S,SW	202
54	CADPRO CHICAGO,INC.	SW	224
IBC	CALCOMP	I	240
24, 51	CARR LANE MANUFACTURING CO.	SM	234
11	COMPUTER AIDED TECHNOLOGY,INC.	Q,SM	236
58	DIGITAL RESOURCES,INC.	I,P	223
59	DVC PLANNERS	SM	232
34	FARO TECHNOLOGIES,INC.	I	208
55	FAR MOUNTAIN CORP.	P	238
IFC, 1	FASTSURF	SM	207
36	GALTECH COMPUTER CORP.	P	212
52	HANSEN DESIGN CO.	SM	228
57	HLB TECHNOLOGY,INC.	I,SW	205
2	KURTA	I	239
53	LUNAR GRAPHICS,INC.	SW,SA,SM	235
59	MECHTECH SOLUTIONS,INC.	CN,S,SM	221
59	POOLED DESIGN QUORUM	SW,SM,Q	229
35	PROHANCE TECHNOLOGIES,INC.	I, SW	206
31	QUALITY CAD	I	209
59	SOFTWARE VENTURES,INC.	SW	226
14, 15	SUN MICROSYSTEMS	C	204
6	SURFWARE, INC.	I	233
58	TECHNICAL & SCIENTIFIC APPLICATION,INC.	A,C,M,P,Q	227
27	TMS PLOTTER SPECIALIST	P	215
58	VALUE ENGINEERING ASSOC.	E,CN	230

Coming Next Issue

- Commercial audio speakers: a concurrent engineering project from concept to product with CUTTING EDGE, innovative communications, etc.
- New developments in workstations and platforms: 486 local bus, UNIX, etc.
- Windows in a CADKEY world! Working with, in or around?
- Details on new IGES 5.1
- Tutorial: Using CADKEY and CUTTING EDGE

DESIGNER'S TOOLKIT

Designer's Toolkit was created to fulfill the need of productivity tools for CADKEY users. With the Toolkit, you have the capability to use parametric symbol libraries, detailed dimensioning and text editing.

Call today for your FREE copy of Designers TOOLKIT!

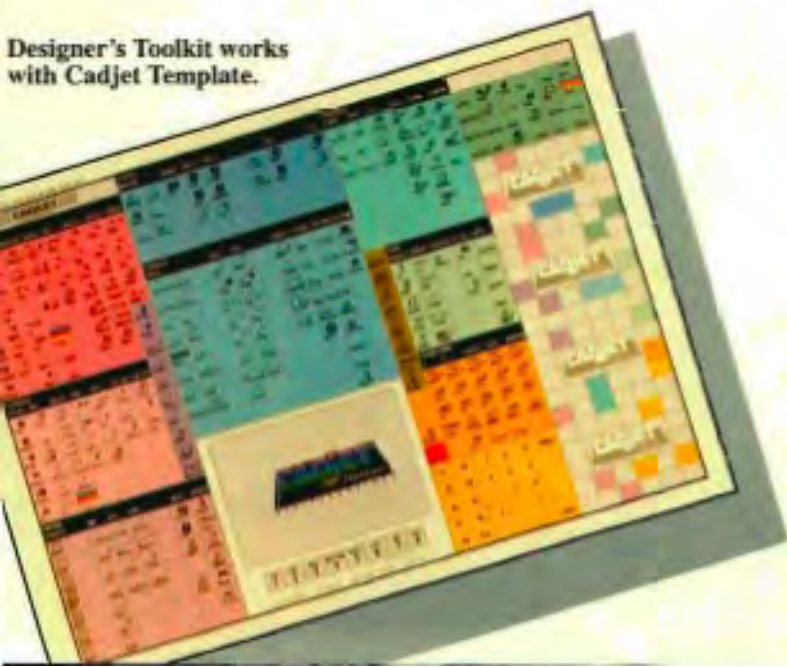
Upgraded Features

- GEOMETRIC TOLERANCING
- DRAFTING SYMBOLS
- WELDING SYMBOLS
- 2D NUTS, BOLTS & WASHERS
- 3D NUTS, BOLTS, WASHERS & HOLES
- AUTODRAFT
- QUIKVIEW
- BEAMS & CHANNELS
- PLOTTER FONT W/ FONT MANAGER

New Features

- SET ATTRIBUTES
Sets level, color, line width, line type, etc. in one command.
- CHANGE ATTRIBUTES
Changes level, color, line width, line type, etc. in one command.
- DYNAMIC TEXT
Lets you see text on-screen as you type it!
- SEARCH & REPLACE
Search and replace text automatically. CDE Interface.
- CIRCLE TEXT
Draws any CADKEY text on an arc or in a circle.

Designer's Toolkit works
with Cadjet Template.



**GET A FREE COPY OF THE BEST
DRAFTING PACKAGE YOU'VE EVER
USED! CALL TODAY**

Limited Time Offer. No Dealer Orders Please.
Offer Good In Cont. U.S. & Canada Only

HLB TECHNOLOGY

For more information about Designer's Toolkit or any
HLB Technology product, please contact:
HLB Technology, Inc., P.O. Box 527, Blue Ridge, VA 24064
Tel: (703) 977-6520 Fax: (703) 977-6531

AUTHORIZED PLOTTER LIQUIDATIONS

ELECTROSTATIC - LASER - THERMAL
INKJET - PENCIL - PEN

Licensed
to
Export



SCANNERS
ALSO

GUARANTEED

New

Used

• CALL FOR STOCK •

SAVE - 30% - 50% - 70% - & MORE



Buy **digital resources inc.** Sell
P.O. Box 23851, Portland, Oregon 97223
503-246-0072 • Fax 503-425-0880

CIRCLE CARD NO. 221

CONVERT YOUR DRAWINGS To CAD

Draftsman

Raster-To-Vector
Conversion That Works!

- Compatible with all CAD programs
- Produces lines, arcs and circles
- Handles PCX and RLC files
- Converts accurately
- Cost effective
- Productive

Arbor Image Corporation

230 Collingwood, Suite 250
Ann Arbor, MI 48103
Fax: (313) 741-8806
Phone: (313) 741-8700

CIRCLE CARD NO. 220

Value Engineering Associates have the key to cost reduction!

- Value Analysis
- Product / Tool Design for Manufacturing
- Inventory Reduction Programs
- Material Resources Planning
- Procurement Analysis
- Domestic and International Sourcing

Find out how VEA can help
your company save money.

VEA

(509) 445-1799

or

(509) 928-5169

CIRCLE CARD NO. 230

SOLUTION MART

A smart
choice for
effective,
economical
advertising!

For more information call

Jo Schmidt

(509) 445-1748

HP remarketed PLOTTERS

CALL for remarketed
HP 9000 CAD stations
1-800-422-4872

- 2400/E
- 7596A
- 7595A
- 7576A
- 7575A
- 7570A
- 7550A
- 7475A
- 7470A
- 7440A



TECHNICAL & SCIENTIFIC APPLICATIONS, INC.
2240 West Sun Harbor Parkway North
Houston, Texas 77060
Tel: 713-622-1559

CIRCLE CARD NO. 227

MICRO-MECH™ Mechanism Design On Your PC

- Modeling
- Analysis
- Documents
- CAD Interface



Improve quality of mechanism designs with analysis on your PC. Kinematic, force, dynamic and tolerance analysis with animation can show the best direction for your design. Bi-directional interface to CADKEY ensures use of geometry plus assembly information.

FREE Demo Diskette
Circle Reader Service No.

MechTech
Solutions, Inc.

831 Harriet Ave.
Shoreview, MN 55126
612-483-0848
FAX: 612-483-0478

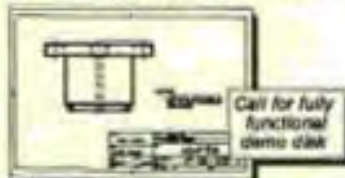
CIRCLE CARD NO. 221

Why start here?

Detailing is nearly as much fun as having a root canal... nearly. You have too many things to do already, and better things to do with your time. Wouldn't you rather just...



LET GEORGE DO IT!



Call for fully functional demo disk

- Creates 2D drawing from 3D wireframe models autoscales and plots views on user's own format
- Fast!
- Removes unnecessary entities
- Removes redundant entities
- Adds horizon and center lines
- Trims overlapping entities
- Generates Bill of Material
- Generates spreadsheet version of parts list
- Example formats included to get you started
- Handles large files
- Now includes FREE sectioning software
- Built-in text editor
- Built-in drawing note system
- For CADKEY versions 2.0 to 5.02+

NEW LOW PRICE! **\$295.00**

POOLED DESIGN QUORUM
2608 DEAN DRIVE
WILMINGTON, DE 19808
PHONE/FAX (302) 888-1718

CIRCLE CARD NO. 229

Fast Conversion! Paper To CAD.

ACCESS
VECTORIZATION SOFTWARE



- A Thru J Size Document Scanning.

- Over 30 Industry Standard File Formats Supported.

- GTX 5000 (Expert Series) Autovectorization Processing.

- CADD Perfect 2D & 3D Drafting.

- 24 Hr. Bulletin Board Service (BBS)

BBS 414-797-8984

414-797-9189

Brookfield, Wisconsin

CIRCLE CARD NO. 218

Now rescuing paper drawings from exile.

Now there's a way to get paper drawings into CADKEY- fast. OverLay and Draftsman allow CADD operators to view, trace or automatically convert existing paper drawings into CADKEY part files.

Plan your rescue today.
Call Software Ventures, Inc.
Tel. (616) 381-4527 FAX (616) 381-2965

Software Ventures, Inc. 10000 Old Orchard Road, Grand Rapids, MI 49508

CIRCLE CARD NO. 226

DVC SHAPES

DVC SHAPES will save you time drawing Obrounds, Circles, Rectangles, Squares, Trapezoids, Single Dee, Double Dee, Bolt Hole Patterns, Key Holes, Keyways, and user definable shapes. The rectangle, square, and trapezoid shapes can be drawn with or without radius corners. All shapes can be drawn at any size or angle. An origin can be selected at any time on your wire model and these shapes can be located by using X,Y coordinates or incrementally from any last drawn shape. Reference points can be placed at the center of any shape.

DVC PLANNERS, 33815 Andy Way
Winchester, Ca. 92596
(909) 926-1219

CIRCLE CARD NO. 232

End View

School's Out for the Summer -- **NOT** -- CADKEY is There!

Please understand -- this is not a terrible "techie" treatise, but a nineties version of "How I spent my summer vacation." For vocational teachers across the nation, summer is time to bone up on new innovations in technology, and I had the privilege of rubbing elbows with them.

First I went to the AVA - Arizona Vocational Association Conference in Tucson. CADKEY was there -- represented by Southwest Educational Systems' first class booth. Teachers viewed demos during breaks between presentations about Outcome Based Education, Control Theory, Reality Therapy and Quality Schools. "Oohs" and "Aahs" could be heard from teachers gathered at the CADKEY booth at the latest, greatest, biggest and bestest of CADKEY technology. (Good thing they weren't English teachers!)

What, you may ask, do Outcome Based Education, Control Theory, Reality Therapy, and other educational buzz words have to do with CADKEY? A lot, because of the nature of CADKEY. For example, in Outcome Based Education, you tell the students what they will be able to do after the lesson is complete. A CADKEY example: upon completing the lesson the student will be able to create lines using the Cartesian coordinate system in order to form a box within one minute.

Control Theory means students take responsibility for their education. The student, therefore, is not a discipline problem, due to the realization that education IS IMPORTANT. I personally wish they had used this system when I was in school. I grew up in the "Fanny Whacker" educational system. Coercion, manipulation, intimidation, begging, pleading or holding a gun to the students' head to get them to learn is not required in a school where Control Theory is truly in practice. Of course these days, it is the students holding the gun. At least, the teacher can be assured that by effectively delivering the CADKEY instruction, the student may have designed the gun themselves. And this may be the catalyst to inspire the student to take Principles of Technology or Manufacturing Technology to complete the project.

After the AVA conference, I was off to Phoenix with Dwayne Polson, the Cadkey Educational Representative for Arizona and New Mexico, and owner of Phoenix based Southwest Educational Systems. Dwayne had invited me to see a technological heaven, the Phoenix Preparatory Academy! And CADKEY is there!

Phoenix Prep is located where Phoenix Union High School used to be. Phoenix Union High School, for you trivia buffs,

was attended by such greats as Wayne Newton and My Mom. Hi, Mom! The principal, John Flores, gave us the grand tour of this approximately 25 million dollar facility. The Academy is filled with computer equipment - three-hundred plus computers to be exact, including a 20-workstation CADKEY lab. The Academy for 7th and 8th graders provides Junior High students with the opportunity to get into education and not into gangs. Phoenix Preparatory Academy is just starting its first year, but Quality School concepts are being implemented. Given some time, I think this school will rank with such greats as New Market Vocational Skills Center in Washington and Woodland in California!

This school would not be a reality if it were not for the Phoenix Alliance of Businesses. Over 400 businesses united with support for the new facility. The concept of business involvement in education is not new. For instance, New Market Vocational Skills Center, located in Tumwater, Washington, has employed instructors from industry for years. I strongly urge those of you in the Phoenix area to go down town and BUY something. Show your support for these businesses' involvement.

After being overwhelmed by the technological/educational innovations CADKEY is a part of in Arizona, I popped on the plane to attend the Washington Vocational Association (WVA) Conference in Seattle. And CADKEY is there! Again, teachers gathered at the CADKEY booth to "Ooh" and "Aah."

While Arizona was just starting, it seemed like Washington was implementing. Northwest Technical Products based in Gig Harbor, Washington is the Educational Representative for Washington, Oregon, Idaho, Montana, Alaska and British Columbia. President, Vic Gallenne, insists on service and support as the key to establishing CADKEY in the educational system. In both Arizona and Washington, the Educational Representatives did Cadkey, Inc. proud.

CADKEY is in use at many schools across the country: schools you remember because of sports such as Stanford, Purdue, Duke and Arizona State University (ASU); schools you remember because of prestige such as Harvard, MIT, Princeton and Cornell; and schools you may not have heard of such as Walla College, Memorial University of Newfoundland, Iona College and Bufile College. From the University level to Junior High, CADKEY is THERE!

So as I fade into the sunset of my summer journey, I want to leave you with this one thought. GET INVOLVED IN EDUCATION! CADKEY IS!

by Ron Shea

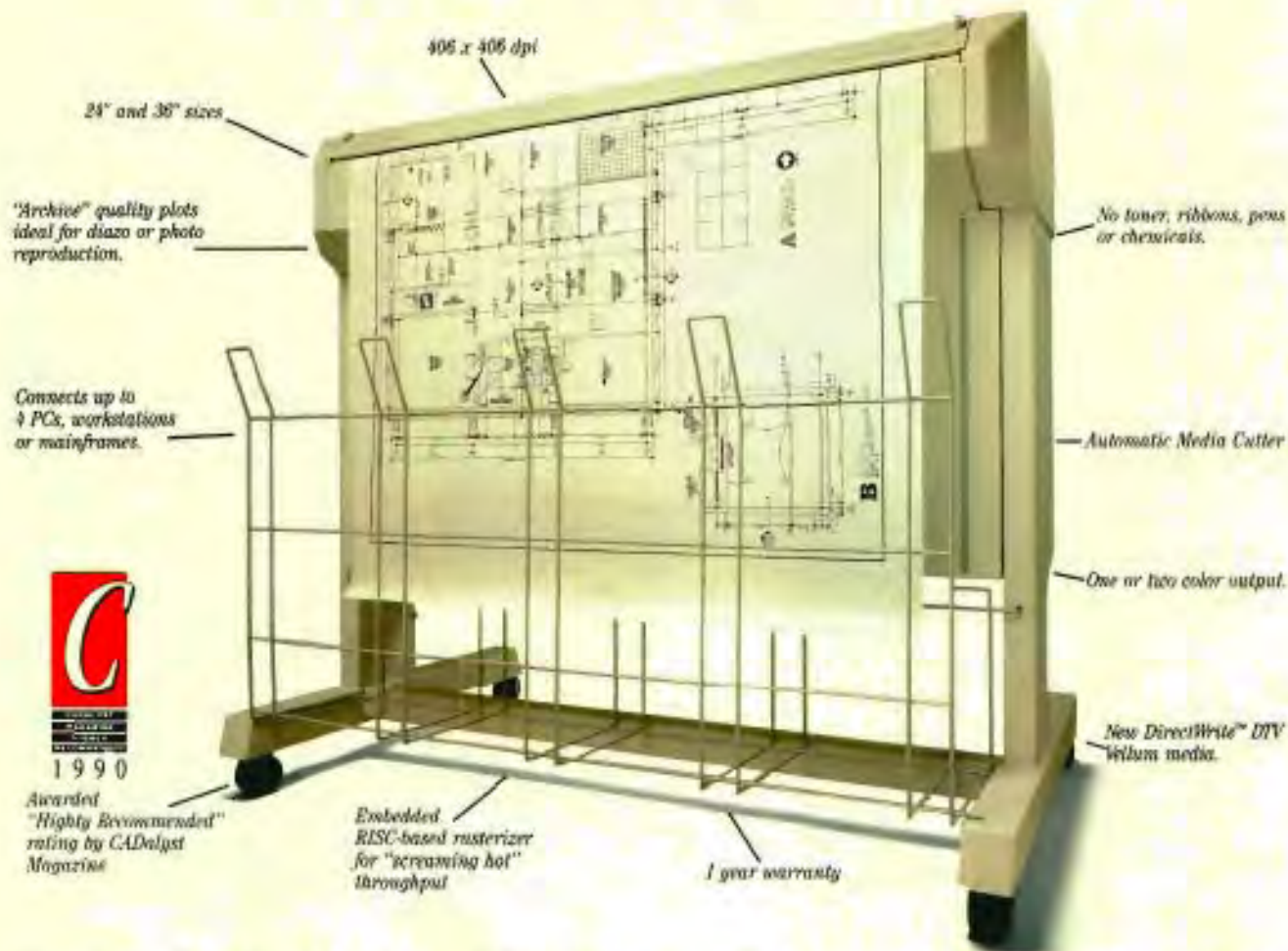
Ron Shea is president of Quality CAD Inc. in Gig Harbor, WA and a regular contributor to Key Solutions.

EndView is a user sounding board for commentaries and opinions. We invite your contribution on almost anything related (even remotely) to concurrent engineering. Subjects can range from national issues to philosophy and may be treated seriously or humorously. Send to Editor, Key Solutions, P.O. Box 207, Clack, WA 99119.

Now!
Direct Imaging
on Vellum.

Hotter Plotter.

Introducing DrawingMaster Plus



DrawingMaster® Plus is hot to plot.

In fact, it was specifically designed to run with the fastest CAD systems—taking just minutes to do jobs that take pen plotters hours.

And high throughput doesn't mean low resolution. At 406 X 406 dpi, you get exceptionally clean lines that rival laser and electrostatic plotters.

For fast checkplots, select QuickPlot® mode and cut plotting time almost in half.

While DrawingMaster Plus is hot, complicated it's not.

There are no pens, no toner and no chemicals involved. You simply load a roll of paper or film and plot—more than 50 E-sized plots completely unattended.

DrawingMaster Plus is exceptionally reliable too. Plus it's backed by a standard one year on-site warranty.

And no other 406 dpi plotter comes close to DrawingMaster Plus in price.

Warming up to our new hot plotter? For more information and our new Free Guide to Media, call us today at: **800-932-1212.**

We draw on
your imagination.™


A Lockheed Company

©1991 CalComp. DrawingMaster, QuickPlot, DirectWrite and No Draw are your imagination are trademarks or registered trademarks of CalComp. CalComp, P.O. Box 2024, Andover, MA 01810. In Canada, call 416-835-2112.

CIRCLE CARD NO. 240

YOU'RE LOOKING AT A \$5,500 ERROR THAT COULD HAVE EASILY BEEN AVOIDED.

CAD/CAM data incompatibility and transfer errors are big problems for automated machine shops. A recent NTMA* study found that **51%** of companies surveyed experienced data translation difficulties, and **25% had to completely re-create data.** Every "miss" costs between \$4,000 and \$5,500 in scrap, rework and delivery delays, not to mention a reduction in competitive position and lower profits.

Why take chances? With CADKEY® and Cutting Edge® you'll have 100% failure-free



Cutting Edge features simultaneously active viewpoints (tool path shown here).

CAD to CAM data transfer. You can also transfer files from another CAD with IGES, DXF and CADL® utilities included with Cutting Edge. Cutting Edge can also be used as a stand alone CAM system for 3-axis milling, drilling, boring, reaming, slotting, pocketing, tapping and contouring. Tool path prove out — the immediate and



complete verification of the tool path before cutting — reduces material waste. A choice of 100 post processors assures maximum flexibility.

Cadkey's family of desktop concurrent engineering tools now make the seamless integration of *all* design, analysis and manufacturing functions not only possible, but affordable.

CADKEY is easy to learn and use. A common data base makes it possible to integrate reverse engineering, inspection, rendering, solids and surface modeling tasks into any design and manufacturing operation.

Get the most flexible and versatile CAD/CAM system you can buy. Call your nearest Cadkey dealer or contact Cadkey today.

3-axis machining with 100% data transfer reliability.

 **CUTTING EDGE**

Cadkey, Inc.

4 Griffin Road North, Windsor, CT 06095
(203) 298-8888 • FAX: 298-6401 • 800-654-3413

CADKEY, Cutting Edge, CADL are registered trademarks of Cadkey, Inc. *A 1991 study done by the Detroit Chapter of the National Tooling and Machining Association found that database errors cost tool and die shops an average of 8% in excess costs per tooling job; \$4,000 to \$5,500 lost PER JOB in scrap and rework and a 23% to 27% increase in lead times.