3-D WORLD

News For The CADKEY User

July / August 1989
Volume 3, Number 4
Annual Subscription: $29.95

CADKEY, INC. Acquires Microtecture Corporation

CADKEY, INC. announced on June 6, 1989, at **A/E/C SYSTEMS '89** in Anaheim, California, its agreement to acquire Microtecture Corporation of Charlottesville, Virginia. This acquisition represents the merger of two truly 3-D CAD companies, a union of strengths. Each company's products occupy a leading position in its market segment. CADKEY 3™ is the most widely used CAD software product for mechanical engineering in the world. DataCAD™ is the second most widely used CAD product for architectural, engineering, and construction applications in the world. The American Institute of Architects has formally honored DataCAD. DataCAD is the only computer-aided design product that AIA has ever endorsed by offering it directly to the organization's 30,000 members.

"Both CADKEY, INC. and Microtecture Corporation are excited by this acquisition," said Livingston Davies, President and co-founder of CADKEY, INC. "CADKEY and DataCAD have occupied similar places in their markets over the past few years, and both are premium-quality products in their respective mechanical and A/E/C markets."

"This is really a merger of synergies!" said Ted Heywood, Director of A/E/C and Manufacturing Systems at CADKEY, INC. CADKEY's synergy with Microtecture exists on at least three levels. Both companies' products have been truly three-dimensional since inception. Both companies have similar distribution channels. And, both companies's products enjoy a wide range of value-added software products created by third-party developers.

In an article comparing Arris™, AutoCAD™, Cadvance™, DataCAD™, Drawbase™, Point Line™, and Versacad™ that appeared in the February 1989 issue of **Architecture**, Edward W. Wenzler and Bruce F. George, members of the American Institute of Architects, wrote:

DataCAD has it all — architectural orientation, one of the best 3-D functions, seamless integration between 2-D and 3-D, a competitive database, programming language, shading/rendering, and low cost. In each of these categories, DataCAD is best or among the best, leading us to the inescapable conclusion that no other CADD program has the range of capabilities and ease of use demonstrated by DataCAD.

IN THIS ISSUE:

Microtecture...has made an obvious commitment to meet the needs of architects. ... When we started this evaluation, we expected all seven CADD programs to offer roughly the same features. This proved not to be the case.

DataCAD ... is the only program we recommend without reservation.

Other products developed by Microtecture include DC Modeler™ (a 3-D design and editing package), DataCAD *Velocity*™ (a photo-realistic, high-resolution, 3-D solid-rendering system), and DataMERGE™ (a PC-based program that combines all the elements of building design and construction into a single database).

Founded in 1983 by professionals actively working in architectural engineering and construction engineering, Microtecture has always developed software applications targeted for use by A/E/C firms. CADKEY's acquisition of Microtecture "catapults CADKEY, INC. into the leading ranks of A/E/C CAD suppliers," said Livingston Davies. "It represents a horizontal diversification of CADKEY's product line and establishes CADKEY as a clear #2 in the over-all PC-CAD market."

New Products To Benefit Both CADKEY and DataCAD Users

CADKEY, INC.'s industry-catching acquisition of Microtecture Corporation and its products broadens CADKEY's product line to the benefit of both companies' users. In addition to award-winning CADKEY 3, CADKEY SOLIDS, CADDInspector, bidirectional IGES and DXF translators, as well as several direct translators, CADKEY customers -- new and old -- will benefit from Microtecture's full product line including DataCAD™, DataMERGE™, and DataCAD *Velocity*™. Microtecture's customers will benefit from CADKEY's R & D resources, technical support, and commitment to the growth of truly three-dimensional computer-aided design and drafting among professionals of every relevant engineering discipline.

DataCAD is a sophisticated computer-aided design package developed specifically for architects and construction engineers. It allows you to draw doors, windows, walls, floors, ceiling grids, stairs, elevators, electrical fixtures, and plumbing fixtures, automatically, in a seamless 2-D/3-D environment. Whatever you draw in two dimensions for drafting, you can view in three dimensions for design work. Further, it automatically dimensions drawings along user-specified points, and it recalculates those dimensions as you make changes. DataCAD also features hidden-line removal and global editing.

DataCAD gives you the ability to create a symbol database, and to assign specification and price values to the symbols. Built-in database capabilities compile costed bills of material based on user-defined values to provide a running estimate of construction costs.

DataMERGE is the ***first*** PC-based program that combines all the elements of building design and construction into a single database. DataMERGE allows you to specify all the materials necessary for a project and automatically creates building specifications from your DataCAD drawings. It automatically estimates the cost of materials and labor, too. DataMERGE also recalculates the project's specifications and estimates as you make changes in the building's design. It even breaks out specifications and estimates on a room-by-room basis.

DataMERGE compares up to 99 bids, computes an ideal bid, and tracks construction costs. You may choose to compare bids in total or item by item. At the same time, DataMERGE verifies the accuracy of each bid, and calculates an average of all of the bids compared. In computing an ideal bid, it takes the lowest bid for each item and compiles the *lowest possible* bid. By tracking construction costs, DataMERGE alerts you when actual costs are exceeding project budgets. You can then use final costs to update your existing database.

After construction, DataMERGE helps to manage the building's assets by tracking furniture and equipment room by room. It even delineates leasable and non-leasable areas in the building.

DataCAD *Velocity* is the ***first*** photo-realistic, high-resolution, three-dimensional, solids rendering system for assigning real-world surfaces to all 3-D wire-frame drawings. *Velocity* allows you to choose surface colors from a palette of 16.7 million colors. You can select surface materials such as plastics, metals, and alloys, all with smooth shading, edges, and surface highlights. You can select surface textures such as wood, brick, marble, stone, shingles, etc., as well. *Velocity* also allows you to assign multiple lighting environments, and to define the degree of transparency in glass to display smoked, clear, or tinted glass.

The union of CADKEY and Microtecture product lines is a true union of strengths!

Historic Achievement!

CADKEY 3 Contributes To Largest Single-shot Investment Mold Ever Built!

Walt, Tom, Bill Schrey, and their associates in Schrey & Sons Mold Company of Chatsworth, California, watched with some excitement on May 1, 1989 (the date of the company's twentieth anniversary); for the first time, Bob Crosse and a team from Precision Castparts Corp. of Portland, Oregon, injected wax into the largest, single-shot, investment mold ever made. Schrey & Sons used CADKEY 3™ to define and design the mold.

A Study in Contrasts

"Most investment casting tools weigh between 10 and 50 lbs.," Paul Kowal, head of Schrey's design department, said. "90% are under 200 lbs. This tool weighs 10,000 lbs., and it's made of aluminum!" The mold is 100 inches long, 48 inches wide and 32 inches high. Yet, most of its cavity dimensions are +/-.003 of an inch in tolerance. Tom Schrey added, "There were only five flat surfaces on the entire part. The remaining surfaces were mostly a blend of conical radii along a tapered diameter." Paul Kowal continued, "The size of this tool made for unique design and construction problems." Schrey & Sons used a combination of CADKEY 3, Surfcam™ and Mastercam™ to produce this mold.

In addition to the wax-pattern mold, the tooling package included nine soluble-wax molds used to form three duct passages inside the primary mold. These soluble-wax molds receive cast in stainless steel locator bars that are 40 inches long. These soluble molds added 9,000 lbs. to the weight of the tooling, for a total weight of 19,000 lbs..

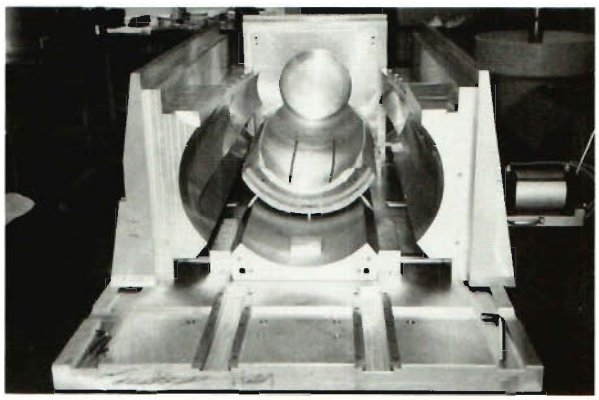
The wax pattern cast from this single-shot investment mold is an airframe component, 64 inches long and 22 inches in diameter. Precision Castparts will use the "lost wax" process to cast the actual production part in titanium. "The `lost wax' process of casting dates from the time of the ancient Babylonians," Paul Kowal noted. "Nowadays it is most frequently used to cast fine jewelry. In the aerospace industries, it is used to mold superalloys into highly toleranced forms and shapes."

Seven-year Project

The injection of the wax mold on May 1, represented the culmination of a project that has been "in the works" since the early 1980's. Schrey & Sons produced this mold for the Titanium Business Operation of Precision Castparts Corp., Portland, Oregon. Precision Castparts will use this mold to produce the largest, single-shot, titanium investment casting ever made to fulfill a commitment to Martin Marietta Corporation of Orlando, Florida.

In Orlando, Alan Mortensen and David Stires of Martin Marietta recalled how this project had begun in 1982 as a research hypothesis about the potential size and shape of a large single-shot casting in titanium. They were working together in Martin Marietta's Central Casting and Forging Design Group at the time. As manager of "Central Casting," Alan Mortensen directed this investigation aimed at reducing the cost of making airframes. As chief design engineer, David Stires produced the current configuration of this particular casting.

Martin Marietta's engineers started the design process using a CADAM™ system to create their CAD model. They transmitted this CAD data to Precision Castparts in IGES



Internal structure of the mold with soluble waxes in place to be "lost" during "lost wax" process of casting.

Bill and Tom Schrey measuring the 64-inch pattern cast in non-soluble wax.

(Initial Graphics Exchange Specification) format on magnetic tape. Martin Marietta also sent a set of some 20 hardcopy plots of the CADAM design so that Precision Castparts could double-check the accuracy of the translation of the original CAD data from IGES format into the Calma system's format used at the foundry.

Robert Crosse, a tool engineer and mold maker, is Precision Castparts' concept-to-completion project manager for the tooling aspect of the mold for the airframe component. James Mangan, CAD/CAM system manager, and Richard Hill, a design engineer, work with Bob Crosse. Jim Mangan routinely handles IGES files related to Precision Castparts' projects. However, this time there were problems with Martin Marietta's IGES tape. Dick Hill decided to re-create the design data in his Calma system from the 20 detailed drawings that had accompanied the tape. After completing additional design work on the project, Precision Castparts sent the data files on floppy disks, in IGES format, to Schrey & Sons in August, 1988.

Paul Kowal now began his involvement in the project with a team of twelve craftspeople. Due to the size and complexity of the tooling, Schrey & Sons organized its team into four smaller units supervised by master mold makers Scott Bond, David Olsen, Chuck Coe, and Mike Cowan.

Data Into CADKEY 3 Via IGES

"The translation from Calma to IGES, and from IGES to CADKEY was extremely accurate," Paul said. "At least 90% of the entities in this enormous database translated correctly." The mold makers separated the data into more than 100 levels and sections corresponding to the blueprint views of the part. Each mold maker at Schrey has a personal computer on which to do his own design and production work as part of the team.

Schrey's mold makers analyzed the data to verify that it conformed to the dimensional engineering-requirements report furnished by Precision Castparts. These analytical data files consisted of single and multiple cross sections, as well as views looking lengthwise through the part. "CADKEY's three-dimensional capabilities and data-manipulation features helped to maintain consistency from one cross-section to the next," Walt Schrey said. "CADKEY's rotational capability allowed us to view the various part sections in the proper perspective, and to cut the part without losing sight of where our individual items of data were located in 3-D space." Tom Schrey added that the casting's surfaces, which they had received from Martin Marietta and Precision Castparts, were sections. "CADKEY's splines allowed us to connect the individual sections together," Tom said.

CADKEY 3 To CADL To Surfcam To Mastercam

Two Schrey programmers, Mike Cowan and Dave Olsen, converted the part files of the sections into CADL™ (CADKEY Advanced Design Language) files. They input these CADL files into Surfcam to develop offset surfaces from the surface sections and splines. The Surfcam system also created the tool-cutter paths for computerized machining. They then converted Surfcam's output INC (Intermediate Numerical Control) code to the NCI (Numerical Control Intermediate) format used by Mastercam. The Mastercam system post-processed the numerical control code that Schrey & Sons used to run their Sharnoa DNC (Direct Numerical Control) system to perform the actual machining of the mold. The Sharnoa DNC system directly controlled the operations of six numerically controlled milling machines (Sharnoa TIGER 4, Cincinnati Milacron ACRAMATIC, and Hasbach OMICRON) as they cut the mold in aluminum.

Bob Crosse of Precision Castparts remarked, "I have never met or even heard of another company that committed to such an effort to meet a production goal. They worked 7 days a week, 18 hours a day. They even had a person, Scott Bond, camped in a motor home in the parking lot to monitor the machining through the night. Schrey & Sons' intensity and commitment to this program enabled us at Precision Castparts to meet our production date."

"To do this type of state-of-the-art tooling," Bob continued, "you must have a very good engineering-design department and a very good CAD system. In my opinion, there is no finer investment mold designer in the country than Paul Kowal. He may have an equal, but you won't find anyone better."

"The success of this project was due to the team effort between Schrey and PCC," Bob added. "To keep the project's milestones on time, Bill Schrey made a video of the project every three weeks and brought it to Precision Castparts. Those videos really helped us at PCC to understand what we had to do on our end." Bill Schrey had originally obtained the order for this mold from Precision Castparts with the watchwords: "If you can draw it, we can build it!" Each day Bill coordinated all the requests for engineering changes to make the mold virtually error free.

More Than One *Industry First*

Bob Crosse and his team from Precision Castparts also performed an "industry first" themselves when they injected the first wax into this mold to produce a pattern, on site, at Schrey & Sons' facility, using a high-tech, portable, wax-injection machine that PCC's own manufacturing-engineering department had designed. This was the first time that this portable wax-injection machine saw active service. "No foundry in the world has ever done that before," Bob said.

On May 8, 1989, Precision Castparts presented to Bill Schrey an ***Outstanding Job Award to the Team at Schrey & Sons Mold Company for the largest investment casting mold ever built***. Walt Schrey summed up everything: "This phenomenal project could not have been accomplished without the excellent teamwork of all of our employees." Bob Crosse echoed Walt Schrey: "Good communications and real teamwork among all the companies involved in this project: Martin Marietta, Precision Castparts and Schrey, make me proud to have been part of this project. This is a tribute to U.S. technology and skilled craftsmen working together as a team, in free enterprise, under a very very tight schedule."

Reflections Afterward

"The surfaces of this mold were so unusual," Tom Schrey said afterward, "that I don't believe that we could have designed them without CADKEY. Perhaps we could have, but it would have taken two or three times longer than it did." Walt Schrey added, "CADKEY's interfacing capability and its efficiency, running on Wyse 386 20MHz computers with 80 megabyte and 120 megabyte hard-disk drives, allowed us to complete the largest, wax investment-casting mold ever constructed in just 32 weeks, a feat virtually impossible using conventional machining methods."

On A Related Matter...

CADKEY User Active In Mold-Making Apprenticeship Program

Since 1979, Schrey & Sons Mold Company, Inc., of Chatsworth, California, has played an active role in a four-year apprenticeship program to teach young people the science and craft of mold making. Participants who successfully complete the apprenticeship receive certification as journeymen mold makers.

Developed by the Apprenticeship Council of the State of California's Department of Industrial Relations, in collaboration with local industrial leaders, the program emphasizes the academic requirements of apprenticeship: mathematics, blueprint reading, traditional and computer-aided drafting, machine-tool technology, and numerical-control machining. The student develops skills in specific applications, such as mold-making, through on-the-job training with her/his employer. The program's 3-4 hour sessions take place during the evening, twice a week at Los Angeles Pierce College in Woodland Hills, California.

For additional information about this apprenticeship program, contact Tom Schrey, Schrey & Sons Mold Company, 9167 Independence Avenue, Chatsworth, CA 91311, (818) 998-1646, or Professor Gordon Eisenbart, Los Angeles Pierce College, 6201 Winnetka Avenue, Woodland Hills, CA 91371, (818) 347-0551.

CADKEY 3 (Version 3.5) Makes Debut at NDES

The introduction of CADKEY 3 (Version 3.5) along with demonstrations of RenderMan and DRAFT-PAK, highlighted CADKEY's participation at the Spring National Design Engineering Show (NDES) in Chicago, IL, April 24-27. Seven CADKEY dealers (Advanced Technology, CAD Professionals, Ellison Machinery, E.L. Mattson, Mateer Associates, PFB Concepts and Software Firm) participated in the NDES program with CADKEY, INC.

CADKEY's exhibit featured a live concept-to-completion demonstration, constructing a hair dryer using CADKEY 3 (Version 3.5) and related third-party products, DRAFT-PAK and SmartCAM. The demonstration began with the initial design of the hair dryer's wire-frame geometry in CADKEY 3. DRAFT-PAK, activated from within CADKEY 3, served to dimension the part. DRAFT-PAK is a product of Baystate Technologies. CADKEY SOLIDS created a solid model of the hair dryer's handle. SmartCAM, a product of Point Control Company, generated the CNC-machining tool-path data. A Roland DG CAMM 3 milling machine used this tool-path data to cut the handle in wax, live on the show floor. CADDInspector demonstrated quality control and reverse engineering by verifying the hair dryer handle's dimensions and recreating its wire-frame geometry from the actual wax model produced on the Roland CAMM 3.

A CADKEY/RenderMan photo-realistic imaging of a guitar and demonstrations of CADKEY/UX (the Unix version of CADKEY 3 (Version 3.5) on Silicon Graphics' Personal IRIS also proved to be popular attractions at the show.

Special thanks to Paul Bergetz, Dennis Mitchell and Bob Bean.

The Danger Of Believing Everything You Read

by Gary Delius

Computer-aided design represents one of the fastest growing and most competitive segments of American business. As a major player in the industry, CADKEY is often one of the subjects of a CAD review. Usually we end up as the top choice of the review. In fact, CADKEY has received more awards for technical excellence than any of our competitors.

Occasionally we don't win. If the review has been fair, we take the hit, lick our wounds, and go on. However, if the review portrays our product in an inappropriate light, then we have to respond.

In the issue of MACHINE DESIGN dated May 11, 1989, there is a reference on page 154 which you need to know about. The article refers to a recent evaluation of PC CAD systems, identified as coming from the U.S. Department of Commerce. However, this evaluation took place between October 1987 and March 1988, by a group of engineers in the employ of the U.S government, on a *time available* basis. The version of CADKEY reviewed was version 3.01. The review team based their evaluation on a one-day visit in February 1988, to a local CADKEY dealer in California.

There are several problems with the review of which you should be aware:

1. The review has received publicity beyond its intended purpose. The review was a part-time project done by a group of engineers to ascertain the "state of the art" of PC CAD, prior to acquiring systems for use at a laboratory. It does not reflect the view of the U.S. Department of Commerce.

2. The review is actually an evaluation of drafting and dimensioning systems, and it is heavily biased toward those systems which perform best as automated drafting engines. Drafting and dimensioning received 10 points in the overall, weighted rating scale, while three-dimensional design received 2 points.

3. The review does not appear to be totally objective. At the time of the review, and continuing today, the reviewers had a substantial investment in Computervision systems. Coincidentally, Computervision received the highest rating. Other systems reviewed appear to have scored well in proportion to the proximity of the vendor's headquarters to the reviewers' offices.

4. The rules of the evaluation do not appear to have been evenly applied. According to the CADKEY dealer who participated in the review, timing benchmarks were not conducted, and times for tasks were not recorded. Yet, the report includes timing analyses and a section describing the time allotted for each test.

5. There are obvious errors which defy explanation. The overall analysis chart shows the CADKEY software system costing considerably more than the Computervision system reviewed. However, simple addition of the costs in the report show that the Computervision system costs twice as much as the CADKEY system. Equally confusing, the report shows CADKEY as having one of the poorest response times; yet in its conclusions, the report cites CADKEY's speed as one of the overall strengths of the system.

6. Among the most blatant errors is the fact that in rating splines, the reviewers actually rated systems which do not have splines in their database as superior to CADKEY which does have rigorously, mathematically correct splines. This is absurd! Clearly, the reviewers are either ill-informed or biased.

Some of the points raised in the review regarding the capabilities of CAD systems were true at the time of the review. However, readers should be informed about the age of the report, its apparent biases, and the features of today's CADKEY software. All of the valid weaknesses related to CADKEY cited in this report were corrected before this report was published in July 1988.

Editor's Note: Gary Delius is Director of Marketing at CADKEY, INC. He has been an active participant in computer-graphics marketing since 1983.

CADKEY User Donates CADL Utility As Shareware

Haig Saadetian, Managing Director of Carr-Sawyer Systems, Inc. of Weston, Ontario, Canada, has donated a CADL program, SPLPAR.CDL, as shareware to the CADKEY Forum on the CompuServe℠ Information Service.

SPLPAR.CDL is a utility that Haig designed to respond to a question that one of his customers raised about CADKEY 3 and splines. It took Haig approximately half a day to design and write this program.

Several CADKEY users have requested that **3-D WORLD** publish the code of an actual, but not too complicated, CADL program as an example of how to construct a good CADL program. With Haig's permission, the complete code of SPLPAR.CDL appears in this article.

SPLPAR.CDL is not on the diskette of CADL programs that you received when you purchased CADKEY 3. You may obtain your own copy of SPLPAR.CDL by downloading the file, SPLPAR.ARC, from Library 1 (General/New Uploads) in the CADKEY Forum on CompuServe. Or, you may create your own copy of SPLPAR.CDL by keying it into a file, character by character, from this article.

SPLPAR.CDL creates a 2-D or 3-D cubic spline offset from an existing spline in a CADKEY part file. This CADL program mathematically offsets the nodes (or knot points) of a new spline from the nodes of the original spline.

NOTE WELL: The new spline's offset is mathematically correct only at the nodes.

The new spline itself is not necessarily parallel to the original spline. The number of nodes in the original spline determines how closely parallel the new offset spline will be to the original spline. The more nodes there are in the original spline, the more truly parallel the offset spline will be.

SPLPAR.CDL works correctly for 2-D splines and for 3-D splines in which at least one of the coordinates of every node (x, y, or z) is constant in a single plane.

SPLPAR.CDL does not work for 3-D splines in which all three coordinates of a node (x, y, and z) can be on different planes.

Editor's Note: Those lines of SPLPAR.CDL that are tabbed far from the left margin are part of the preceding line which must be keyed as a single line of code.

```
rem*******************************************************
rem This is a CADL file to create the points for an offset spline.
rem Presently set up for 2-D and 3-D Cubic splines.
rem Offset points will be produced at the knot points
rem of the selected spline. These points can then be joined
rem to produce the required spline.
rem This routine will work for a closed spline. Note that
rem checks have not been included to ensure the offset is
rem always on the correct side. This shortfall can be overcome by
rem running the routine twice and asking for a positive
rem as well as a negative offset.
rem*******************************************************
:select
set mask, 5
getent "Select the SPLINE you want to offset", enttype
if enttype != 5
  goto select
deft = 0.25
getflt "Enter the OFFSET required (%f) =>",deft,thick
if @intdat[8] == 0
  goto dim2
if @intdat[8] == 1
  goto dim3
pause "SPLINE type selected is not supported. PRESS
                                                RETURN"
  goto exit
:dim2
pause "2-D SPLINE selected with %d segments.PRESS
                                                RETURN", @intdat[11]
i=0
j=0
col =@color + 1
lev =@level + 1
levels 1, lev
:loop1
i=i+1
if i >@intdat[11]
  goto lab1
:loop2
k1=j + 8*(i-1)
A=@fltdat[k1]
k2=j+1+8*(i-1)
B=@fltdat[k2]
k3=j+2+8*(i-1)
C=@fltdat[k3]
k4=j+3+8*(i-1)
D=@fltdat[k4]
k5=j+4+8*(i-1)
E=@fltdat[k5]
k6=j+5+8*(i-1)
```

(Continued on next page.)

```
F=@fltdat[k6]
k7=j+6+8*(i-1)
G=@fltdat[k7]
k8=j+7+8*(i-1)
H=@fltdat[k8]
x1=D
y1=H
if C==0.0
 goto zero
dydx1=G/C
 goto cont
:zero
ang=90.0
 goto jump
:cont
ang=atan(dydx1)
:jump
x1new = x1 - thick*sin(ang)
y1new = y1 + thick*cos(ang)
POINT x1new, y1new, @depth, col, lev, 0, 0, 0
if i == @intdat[11]
 goto loop3
goto loop1
:loop3
x2=A + B + C + D
y2=E + F + G + H
den=(3.0*A+2.0*B+C)
if den==0.0
 goto zero1
dydx2= (3.0*E + 2.0*F + G)/(3.0*A + 2.0*B + C)
 goto cont1
:zero1
ang=90.0
 goto jump1
:cont1
ang=atan(dydx2)
:jump1
x2new= x2 - thick*sin(ang)
y2new= y2 + thick*cos(ang)
POINT x2new, y2new, @depth, col, lev, 0, 0, 0
 goto exit
:dim3
pause "3-D SPLINE selected with %d segments.PRESS
                                        RETURN", @intdat[11]
i=0
j=0
col =@color + 1
lev =@level + 1
levels 1, lev
:loop10
i=i+1
if i >@intdat[11]
 goto lab1
:loop20
k1=j + 12*(i-1)
A=@fltdat[k1]
k2=j+1+12*(i-1)
B=@fltdat[k2]
k3=j+2+12*(i-1)
C=@fltdat[k3]
```

(Continued in next column.)

```
k4=j+3+12*(i-1)
D=@fltdat[k4]
k5=j+4+12*(i-1)
E=@fltdat[k5]
k6=j+5+12*(i-1)
F=@fltdat[k6]
k7=j+6+12*(i-1)
G=@fltdat[k7]
k8=j+7+12*(i-1)
H=@fltdat[k8]
k9=j+8+12*(i-1)
M=@fltdat[k9]
k10=j+9+12*(i-1)
N=@fltdat[k10]
k11=j+10+12*(i-1)
O=@fltdat[k11]
k12=j+11+12*(i-1)
P=@fltdat[k12]
x1=D
y1=H
z1=P
if C==0.0
 goto zero2
dydx1=G/C
 goto cont2
:zero2
ang=90.0
 goto jump2
:cont2
ang=atan(dydx1)
:jump2
x1new = x1 - thick*sin(ang)
y1new = y1 + thick*cos(ang)
POINT x1new, y1new, z1, col, lev, 0, 0, 0
if i == @intdat[11]
 goto loop30
goto loop10
:loop30
x2=A + B + C + D
y2=E + F + G + H
z2=M + N + O + P
den=(3.0*A+2.0*B+C)
if den==0.0
 goto zero3
dydx2= (3.0*E + 2.0*F + G)/(3.0*A + 2.0*B + C)
 goto cont3
:zero3
ang=90.0
 goto jump3
:cont3
ang=atan(dydx2)
:jump3
x2new= x2 - thick*sin(ang)
y2new= y2 + thick*cos(ang)
POINT x2new, y2new, z2, col, lev, 0, 0, 0
:lab1
:exit
```

Worcester Polytechnic Institute

CADKEY 3 Does Double Duty in PC-Based Robotic Workcell

Two teams of engineering students at Worcester Polytechnic Institute, Worcester, Massachusetts, have developed substantial enhancements to a flexible, robotic manufacturing workcell. Designed at WPI, the robotic workcell assembles printed-circuit boards. CADKEY 3™ played two roles in these enhancements, developed as independent theses to qualify for Bachelor of Science degrees in Manufacturing Engineering. The simulation team (Joseph DiPietro, John McCue, and Scott Metivier) used CADKEY 3 and CADL™ (CADKEY Advanced Design Language) to create a robotic simulator/offline programmer for the workcell's robot. The gripper team (Gregory Thomson and Geoffrey Charron) used CADKEY 3 to design a new type of flexible gripper for the robot's pick-and-place operations. WPI's Manufacturing Engineering Applications Center (MEAC) has been engaged in this robotic application since 1986. Dr. John M. Sullivan, Jr., served as faculty advisor for both projects.

CADKEY 3 And Robotic Simulation/ Programming

Joseph DiPietro, John McCue, and Scott Metivier have developed a low-cost Work-cell-design, Simulation and Off-line-programming (WSO) system using CADKEY 3 and CADL with the Adept One™, Model 850, robot to perform flexible pick-and-place operations, using the gripper designed by Gregory Thomson and Geoffrey Charron (See **CADKEY Designs Flexible Robotic Gripper** on page 11 of this issue of **3-D WORLD**).

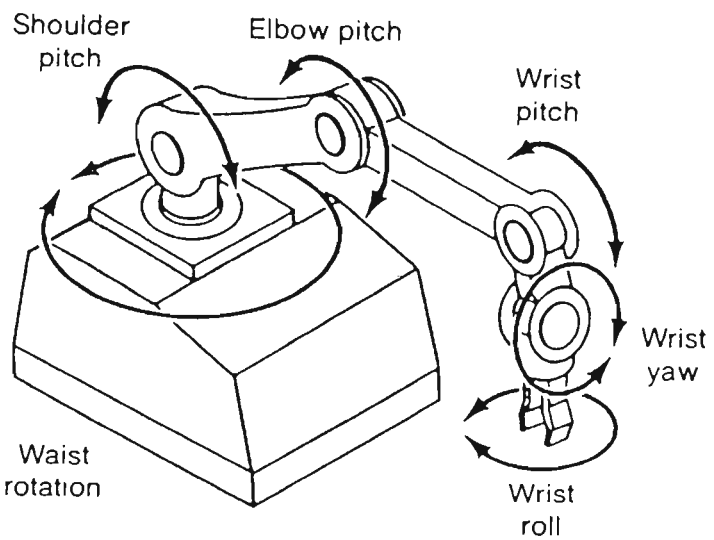
Affordable

The simulation team's interest in creating a PC-based, industrial WSO system stems, at least in part, from the fact that currently, no PC-based WSO system exists in the commercial marketplace. Commercially available WSO systems are generally too expensive for most small manufacturing businesses or educational institutions. The simulation software alone can cost approximately $100,000. Moreover, the simulation software frequently resides on a large mainframe computer. The cost of the software coupled with the hardware maintenance and/or purchase expenses requires an investment of $200,000 or more. And, this does not include the cost of the robot and its control unit. However, the WSO system designed by the WPI team is under $10,000 (CADKEY 3 included), and it runs on PC systems. This, too, does not include the cost of the robot and its control unit. The low cost investment makes the WPI system attractive to small companies while rivaling other well established systems in usefulness.

The Workcell

The Adept One, Model 850, manufactured by Adept, Inc., is a four degree-of-freedom, selectively compliant arm for robotic assembly (SCARA) manipulator and a control unit. The Adept One robot uses VAL II™ as its native language.

The Adept One's manipulator arm possesses two rotational joints and one joint capable of rotation and prismatic motion. The two rotational joints move the manipulator in the *x* and *y* directions while the remaining joint provides the *z* motion as well as roll, the rotational orientation of the end effector. The end effector is the task-specific device attached to the end of the robotic arm. End effectors include devices such as grippers, welding heads, or suctions cups. The current configuration of the robot manipulator at WPI's MEAC uses a flexible gripper specifically designed at WPI to handle electronic-component



At any x-y-z location the robot manipulator can move in an up/down motion (pitch), left/right sideways motion (yaw) and rotational motion (roll). The total collection of x-y-z-pitch-yaw-roll location points that the manipulator can reach is its work envelope.

insertions in printed-circuit boards.

The robot control unit performs several essential functions. It stores, compiles and runs instructional programs. It performs kinematic modeling; that is, it calculates both the direct and the indirect solutions of the arm's joint angles for any specified *x-y-z-roll* coordinate within the manipulator's reach. It controls all the actuator motors in the robot. The control unit also links the robot to the manufacturing process which takes place in the workcell by means of sensors and vision systems.

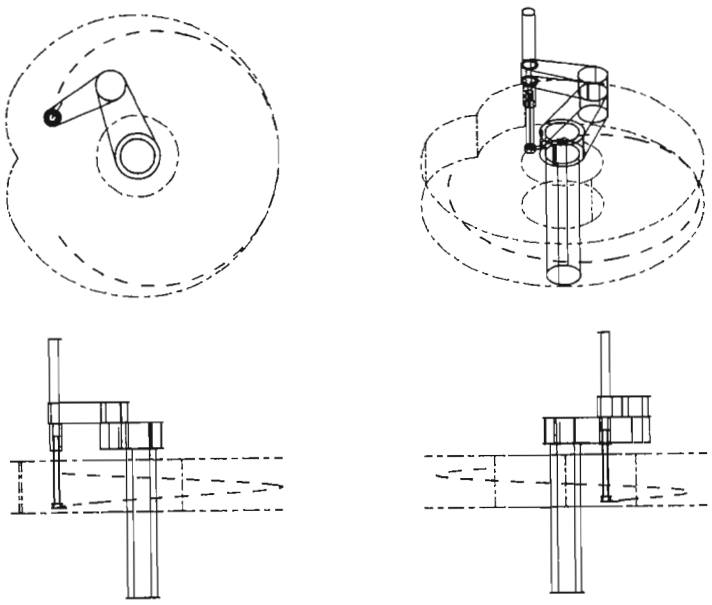
The current MEAC workcell is well suited to low-volume (less than 1,000 insertions per hour) or mixed-volume production of printed-circuit boards. The Adept One receives standard-drilled, printed-circuit boards on a controlled conveyor system. The robot selects each component from a feed tray, and "populates" the board. After each printed-circuit board is properly "stuffed," the conveyor system moves it away, and presents a new blank board.

Two Methods of Simulating/Programming

The simulation software allows a user to simulate and program the robot's movements in a DIRECT-INPUT METHOD or in a CAD-INTERACTIVE METHOD. These two methods can be used interchangeably.

DIRECT-INPUT METHOD

The DIRECT-INPUT PROGRAMMING METHOD permits the user to write a program in VAL II as ASCII text using any word processor or text editor. The preprocessor program checks the VAL II code for correct syntax and "flags" errors. The software then translates the VAL II code into a CADL (CADKEY Advanced Design Language) program creating a displayable simulation of the robot's motion. The preprocessor also creates a file listing all the location variable names that it found in the VAL II code.



Four views of CADKEY's 3-D simulation of the Adept One robot manipulator's work envelope.

The user creates a 3-D wire-frame representation of the robot's workcell as a part file in CADKEY 3, placing pattern files of equipment and parts at their appropriate locations in the workcell. The Workcell Generator program creates a single-level CADL file of all of the CADKEY line, arc, and circle entities contained in the workcell displayed on the screen.

The file of VAL II variable names created earlier now serves as input into the Location Table Generator program. After reading the data file of variable names, the Location Table Generator prompts the user, in the CADKEY environment, to locate the point in the 3-D representation of the robot's work envelope that corresponds to each variable name.

After the user specifies each location, the Location Table Generator verifies that the joint angles of the robot manipulator's first three joints are indeed within the robot's work envelope. Then, it prompts the user to assign the angle of the fourth joint, the roll angle of the gripper. The user specifies this roll angle either by entering its exact roll angle or by selecting, on the screen, two points or a line entity with which the gripper is to be aligned.

After the user has assigned a location for each variable name, the Location Table Generator sends this information to two data files: one to be used by the simulator; the other to be appended to the VAL II code before it is sent to the Adept One's control unit.

The user can now run the CADL simulation program (that the preprocessor created) imitating the movement of the robot's manipulator arm. The screen displays the user's 3-D representation of the workcell. It displays the robot in its home position along with its work envelope. The robot then proceeds through its programmed routine. The Path Generator embedded in the

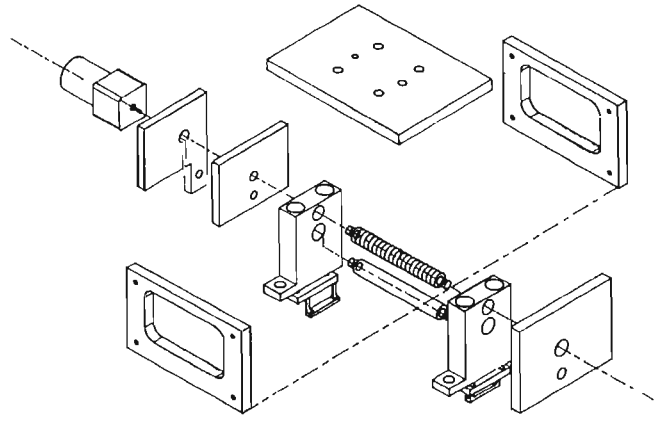
robot's Move module calculates and displays the exact path of the robot's movements. If the movement is a linear motion, the Path Generator simply draws a straight line from the starting point to the ending point to represent the motion. If the movement involves a joint-interpolated motion, the Path Generator calculates and displays a three-dimensional spline to represent this motion. This path-generation feature of the simulation provides a visual collision-avoidance tool.

CAD-INTERACTIVE METHOD

The simulation software also allows a user to program the Adept One by selecting commands from a menu of VAL II commands, with prompts for specific data, stepping one's way through the creation of a robot program. This **CAD-INTERACTIVE PROGRAMMING METHOD**, *CADEPT*, was created by merging sections of the Location Table Generator and the Move module. The user enters commands, location data, delay durations, etc. through the keyboard. *CADEPT* translates these entries into a VAL II program.

When the user enters a move command, *CADEPT* prompts her/him for the location name to which the manipulator will move. This may be a NEW location name or an OLD location name. After the user has entered the location variable name, *CADEPT* displays the robot's work envelope. The user indicates an *x-y-z* location within the work envelope and the desired roll angle for the gripper. *CADEPT*'s Move module uses the location data to calculate the manipulator's joint angles, and to verify that the location is within the work envelope. Once the location has been verified as valid, the Move module's Path Generator calculates and displays the robot's path to that location. The user has the option to accept or to reject the path, as well as to examine the path from any view accessible through CADKEY. If the location and path are satisfactory, the robot on the screen moves to that location. *CADEPT* stores the step-and-move data, and returns to its main menu for the selection of the next step.

After the user has completed programming this step-by-step simulation of the robot's motions in the workcell, she/he can run the simulation again as a complete sequence. The user can also transfer the VAL II code to the Adept One's control unit to run the robot via the serial-communication program of the simulation software.



Exploded assembly drawing of the flexible gripper designed with CADKEY 3.

CADKEY 3 Designs Flexible Robotic Gripper

Gregory Thomson and Geoffrey Charron comprised the gripper team at Worcester Polytechnic Institute. They used CADKEY 3 to design a new versatile gripper for the insertion of variable-sized electronic components into printed-circuit boards. The team was also responsible for the fabrication and testing of the unit.

Compliance

Because the gripper handles a variety of electronic components whose shapes and sizes differ markedly, compliance is a critical factor. The gripper has to be able to yield horizontally when its fingers encounter the component, so that in grasping the component it does not damage the component's body or leads. The gripper also has to be able to yield vertically when its fingers insert the component into its proper place, or more importantly, when the part is not correctly aligned for proper insertion into the printed-circuit board, to avoid crushing the component.

The compliance system serves double duty. Improper component insertions trip the vertical compliance sensors which call force-feedback software routines. Essentially, these routines accommodate misalignment due to dimensional tolerances by adjusting the programmed target locations followed by reinsertion attempts.

Where To Now?

Dr. John Sullivan indicated that the on-going relationship between CADKEY 3 and the robotic-workcell project at Worcester Polytechnic Institute will continue during the 1989-1990 academic year. For additional information, contact Dr. John M. Sullivan, Jr., Manufacturing Engineering Applications Center, Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA 01609, (508) 831-5633.

TRADE SHOW UPDATE

CADKEY at the following trade shows in 1989:

AUSGRAPH '89, July 10-14
Sydney, Australia

SIGGRAPH '89, August 1-4
Hynes Convention Center, Boston, MA, Booth #2921

Federal Computer Conference, October 23-25
Washington Convention Center, Washington, DC, Booth #2718

AUTOFACT, October 31 - November 2
Cobo Conference/Exhibition Center, Detroit, MI, Booth #2300

COMDEX / FALL '89, November 13-18
Las Vegas Convention Center, Las Vegas, NV, Booth #W0148

Call Danielle Provencio, Trade Show Manager, for the availability of discounted admission tickets one month before the show.

Dealers Present CADKEY 3 at Regional Trade Shows

SME APEX SHOW, September 12-14
Grand Center, Grand Rapids, MI

Rochester Computer and Business Show, September 19-21
Riverside Convention Center, Rochester, NY, Booth #131-133,
QMC Technologies, Inc.

SME APEX SHOW, September 26-28
Sabin Cincinnati Convention Center, Cincinnati, OH

Central Ohio Industrial Product Exhibition, September 27-28
Ohio Center, Columbus, OH, Booth #206

Buffalo Computer and Business Show, October 10-12
Buffalo Convention Center, Buffalo, NY, Booth #255-257,
QMC Technologies, Inc.

Tennessee Industrial Show, November 14-15
Chattanooga Convention Center, Chattanooga, TN

Dayton Industrial Exhibition, December 5-7
Dayton Convention Center, Dayton, OH

TRAINING SCHEDULE AT CADKEY, INC.

We have Training dates scheduled through August 1989. Please call Lisa Varvelli in the Product Support Department to register (203) 647-0220.

Course	July	Aug.	Sept.	Oct.
Introduction to CADKEY	17-19	7-9 28-30	4-6	16-18
Advanced Geometric Modeling	20-21	10-11 31-1	7-8	19-20
System Customization	26-28		13-15	25-27
Introduction to CADL	31-2		18-20	31-2
CADKEY Solids	24-25		11-12	23-24

THIRD-PARTY NEWS

GIFTS™ FEA Software Now Offers User-Definable Menus

Computer-Aided Structural Analysis/GIFTS, Inc., of Tucson, Arizona, announced that GIFTS™ (Version 6.4.0) will feature a user-definable menu interface. GIFTS is a complete, standalone, finite element analysis system. GIFTS integrates with CADKEY 3 through CADL (CADKEY Advanced Design Language). "To the best of our knowledge," said Tom Ruhoff, CASA/GIFT's Marketing Manager, "no other FEA program provides menus that can be altered by the user."

GIFTS is capable of performing static, dynamic, transient, heat-transfer, composite, substructuring, and gap analysis. GIFTS includes complete pre- and post-processing capabilities. Recognizing that some users prefer to use commands rather than menus, Dr. Hussein Kamel, President of CASA/GIFTS, said, "For these users, GIFTS' new interface provides optional prompting."

GIFTS' new menus guide users through the simplest as well as the most complex capabilities of the program. Each user can modify the menus to suit her/his own individual needs, as well as switch automatically between menus and commands at will. The operator can use a mouse, keyboard, or custom-digitizer overlay for data entry, and can call any menu from any other menu regardless of her/his current position in the menu tree. Customizable menus offer many prospective applications.

For additional information and a FREE demonstration diskette, contact Thomas J. Ruhoff, Marketing Manager, CASA/GIFTS, Inc., 2761 North Country Club Road, Tucson, AZ 85716, (602) 795-3884.

THIRD-PARTY NEWS

Two CADKEY Users Independently Create Video Tapes To Learn CADKEY

CADKEY Fundamentals

Visual Education Associates of Provo, Utah, and 3-D CADWare of Temecula, California, have teamed up to produce *CADKEY Fundamentals*. This video tape presents CADKEY 3 to people who are becoming exposed to computers and computer-aided design and drafting for the first time. Jim Neeley's step-by-step instructions take viewers from installing CADKEY 3 and configuring it to match your hardware, through using a "start file," creating and modifying geometry in a sample part, and immediate-mode commands. For additional information, contact Visual Education Associates, 2218 North Canyon Road, Provo, UT 84604, (801) 373-4616.

The CADKEY Videos

Gary Bertoline and Len Nasman of Ohio State University, Columbus, Ohio, have produced *The CADKEY Videos*, a set of 10 instructional video tapes that grew out of their experience teaching CADKEY in the Department of Engineering Graphics. Each tape focuses on a specific type of design work as a learning goal. *The CADKEY Videos* present CADKEY through a conversation between an instructor and a student who already has some experience with computers. A transparent CADKEY display overlays the scene. As the instructor creates and modifies geometry on CADKEY, the viewer sees that geometry displayed both on the computer monitor and on the transparent CADKEY overlay. For additional information, contact Microcomputer Education Systems, Inc., 3867 Braidwood Drive, Columbus, OH 43026, (614) 433-7305 or (614) 876-8422.

CADKEY Training In The U.S. And Canada

Several authorized CADKEY Training Centers have scheduled courses in addition to the training available at CADKEY's world headquarters here in Manchester, CT. The following is a list of who is doing what, where and when:

State	CTC	Location/Contact	Course	Dates
Ala.	Auburn University	O.D. Smith Hall Auburn, AL Bret Smith (205) 844-2372	*Intro. to CADKEY*	Sept.13-15
Calif.	California Polytechnic State University	San Luis Obispo, CA Karl Lilje (805) 756-2119	*Intro. to CADKEY*	July 12-14
	Golden West College	15744 Golden West St. Huntington Beach, CA John North (714) 895-8209	*Intro. to CADKEY*	Sept.27-29 Nov. 17-19
	Poelman's Design Service	901 Campisi Way, #360 Campbell, CA Mike Poelman (408) 377-3585	*Intro. to CADKEY* *CADL* *CADKEY SOLIDS*	Sept.11-15 Dec. 5-9 Aug. 7-11 Nov. 6-10 July 10-12 Oct. 2-4
Colo.	University of Colorado at Denver	1200 Larimer St. Denver, CO Andreas Vlahinos (303) 556-2370	*Intro. to CADKEY*	Aug. 14-16
Conn.	Central Conn. State University	1615 Stanley St. New Britain, CT Paul Resetarits (203) 827-7262	*Intro. to CADKEY* *Advanced CADKEY*	Aug. 21-23 Aug. 24-25
	Computer Training Institute TCBC	856 Main St. Manchester, CT Lars Marshall (203) 649-3724	*Intro. to CADKEY*	Sept.25-27
	Waterbury State Technical College	750 Chase Parkway Waterbury, CT Stephen Colwell (203) 575-8084	*Intro. to CADKEY*	Sept.26-28
D.C.	University of D.C.	4200 Connecticut Av. NW Washington, DC Harold Goldstein (202) 282-7349	*Intro. to CADKEY*	Aug. 22-24 Dec. 18-20
Fla.	Gateway Computers	10901 Roosevelt Blvd. St. Petersburg, FL Bryan Dreibelbis (813) 576-0549	*Intro. to CADKEY* *Advanced CADKEY* *CADKEY SOLIDS*	July 5-7 July 18-19 Call for Schedule

CADKEY Training In The U.S. and Canada (continued)

State	CTC	Location/Contact	Course	Dates
Fla.	Jacksonville State University	Jacksonville, FL Dr. P.S. Yeh (205) 231-5781, x 5229	*Intro. to CADKEY*	July 12-14
Iowa	Iowa Lakes Comm. College	300 S. 18th St. Estherville, IA Roger Patocka (712) 362-2604	*Intro. to CADKEY*	Aug. 8-10
Md.	Anne Arundel Comm. College	101 College Parkway Arnold, MD Ken Stibolt (301) 541-2435 Continuing Ed. (301) 541-2325	*Intro to CADKEY*	Aug. 14-17
	Catonsville Comm. College	800 S. Rolling Rd. Catonsville, MD Thomas Barrett (301) 455-4298	*Advanced CADKEY*	July 17-21
Mich.	Lansing Comm. College	P.O. Box 40010 Lansing, MI Kathy Bender (517) 483-1993	*Intro. to CADKEY*	July 24-28 Aug. 21-25
	CIM Solutions	1970 Briarfield Canton, MI Robert Jastrzebski (313) 397-2486	*Intro. to CADKEY* *Advanced CADKEY*	July 11-13 Aug. 1-3 Sept.12-14 Aug. 15-16 Sept.25-26
Minn.	Anderson-O'Brien	2575 N. Fairview Av. St. Paul, MN Gail Lenzmeier (612) 636-2869	*Intro. to CADKEY* day & eve.	July 17-21 Aug. 14-18 Sept.18-22 Oct. 16-20
	Anoka Ramsey Comm. College	11200 Mississippi Blvd. Coon Rapids, MN George Heron (612) 427-2600	*Intro. to CADKEY* *Advanced CADKEY*	July 30 to Aug. 2 Aug. 8-10 Aug. 15-17 Aug. 22-24
N.Y.	Rochester Institute of Technology	1 Lomb Memorial Dr. Rochester, NY Bob Heffner (716) 475-2205	*Intro. to CADKEY* *Advanced CADKEY*	Sept.18-19 Nov. 6-7 Sept.20-21 Nov. 8-9
Ohio	CAD CAM, Inc.	2844 E. River Rd. Dayton, OH Tom Sarvey (513) 293-3381	*Intro. to CADKEY* *Advanced CADKEY*	July 17-19 Aug. 14-16 Aug. 28-30 Aug. 14-16
	Progressive Computing Company	P.O. Box 770176 Cleveland, OH (216) 228-3850	*Intro. to CADKEY* *Advanced CADKEY* *CADL*	July 19-20 Aug. 23-24 Sept.20-21 July 5-6 Sept. 6-7 Oct. 3-5

CADL CORNER (Part 2)

How One CADKEY User Is Using *SHAPES*

SWF Machinery of Sanger, California, designs and produces box-forming equipment for the manufacture of corrugated boxes. Mark Arnett uses CADKEY 3 to create the technical illustrations in SWF Machinery's technical manuals. Mark also designs exploded-view drawings of assemblies to identify spare parts for maintenance purposes.

Mark is using the menu structure in *SHAPES* to help design menus for looking up spare parts by prompting for a part's variable parameters. For example, an icon for a bushing prompts a user to enter parameters such as Outside Diameter, Inside Diameter or other variable. After the user has entered one or more parameters, the system displays on the screen the part number, description, and material composition of all the bushings whose parameters match those that the user had entered.

Editor's Note: For additional information about *SHAPES*, see **3-D WORLD**, March/April 1989 (Volume 3, Number 2), page 15.

CK-fonts™ Enhance CADKEY Presentations

DESIGN FACETS of Hinsdale, Illinois, offer **CK-fonts**™ to CADKEY users who want to *dress up* their plots with Helvetica fonts for use in presentations. **CK-fonts** provides solid and outline fonts that you can make bold and straight or slanted. Designed for use with CADKEY 3 (V 3.0 and V3.1x), **CK-fonts** supports all CADKEY font characters. The software sells for $195. For additional information, contact Design Facets, Inc., 201 E. Ogden Av., Hinsdale, IL 60521, (312) 850-3418.

CADKEY 3 User Offers Design Services

Throlson & Associates of Albert Lea, Minnesota, now provide their CADKEY 3 design-and-drafting capabilities as a contract service to businesses that have a limited workforce, strict deadlines, and tight budgets. This service specializes in solving re-design bottlenecks for manufacturing companies that have large volumes of existing, hand-made engineering drawings that still see active use to support pre-CAD products. Throlson & Associates created this service as a cost-effective alternative to scanning.

Using CADKEY 3, Throlson & Associates' experienced staff creates part files according to customer specifications. These part files contain all the geometric entities and dimension/tolerance information required for subsequent manufacturing processes.

Throlson & Associates has been specializing in engineering design, drafting, technical illustration, and publishing since 1979. "Throlson & Associates has consistently produced services for its customers that are of the highest quality, on time, and competitively priced," Dave Throlson said with obvious pride in his company.

For additional information and references, contact Dave Throlson or Tom Wencl, Throlson & Associates, 839 Lakeview Boulevard, Albert Lea, MN 55007. Telephone: (507) 373-5253. FAX: (507) 377-7245.

CADKEY Training In The U.S. and Canada (continued)

State	CTC	Location/Contact	Course	Dates
Okla.	Oklahoma State University	502 Engineering North Stillwater, OK George Collington Gerald McClain (405) 744-5709	*Intro. to CADKEY* CADKEY *& Tool Selection* *Advanced CADKEY*	July 10-12 July 13-14 Oct. 2-3
Ore.	CTR Business Systems	825 SW 14th Av. Portland, OR Matthew Van Dyke (503) 227-2414	*Intro. to CADKEY* *Advanced CADKEY* *Conceptual Design & CADKEY*	Individual schedules to meet customer needs.
S.D.	Northern State College	Box 705 Aberdeen, SD Jerry Sauer (605) 622-2571	*Intro. to CADKEY*	July 17-19
Texas	Texas A&I (Agricultural & Industrial) University	Campus Box 203 Kingsville, TX Herschel Kelley (512) 595-2608	*Intro. to CADKEY*	Aug. 14-16
	Texas Tech University	P.O. Box 4200 Lubbock, TX Nancy Turner (806) 742-3451	*Intro. to CADKEY*	Aug. 22-24
Utah	Salt Lake Comm. College	4600 S. Redwood Rd. Salt Lake City, UT Gary Poulsen (801) 967-4303	*Intro. to CADKEY*	July 31 to Aug. 31 (Mon. & Wed., 2 to 4:30 p.m.)
Va.	Virginia Tech University	144 Smyth Hall Blacksburg, VA Allen Bame (703) 961-6480	*Intro. to CADKEY*	Aug. 13-15
Wash.	Walla Walla College	204 S. College Av. College Place, WA Robert Noel (509) 527-2082	*Intro. to CADKEY*	Aug. 8-10

CANADA

Prov.	CTC	Location/Contact	Course	Dates
New-foundland	Memorial University	St. John's, Newfoundland John Allen (709) 737-7473	*Intro. to CADKEY* *Advanced CADKEY*	Sept.28-30 Nov. 30 to Dec. 2
Ontario	CATE Ryerson Polytechnical Institute	350 Victoria St. Toronto, Ontario Brian Whelpton (416) 979-5106	Intro to CADKEY	Nov. 9-10 1990: Feb.15-16 Apr. 26-27

Northeast Regional CADKEY Users' Group To Meet

CADKEY, INC. will host a meeting of the Northeast Regional Users' Group on Wednesday, August 2, 1989, in Room 202 of the Hynes Convention Center, Boston, Massachusetts, at 6:30 p.m. The meeting will take place in conjunction with the **SIGGRAPH '89** conference and exposition, August 1-4. All CADKEY users who plan to attend SIGGRAPH are cordially invited to join us for a special evening of interesting topics! For complimentary tickets to SIGGRAPH, please contact Danielle Provencio at CADKEY, (203) 647-0220.

CADKEY Welcomes Three New Users' Groups!

State	Location/ Contact	Areas Served/ Meetings
Texas	VECTOR CAD 5787 South Hampton Suite 330 Dallas, TX 75232 Steve Roberts (214) 337-8997	Dallas/ Fort Worth Metroplex. Meetings: Monthly.
Utah	MOUNTAIN WEST COMPUTER SYSTEMS 754 South 400 East Suite 200 Orem, UT 84058 Paul Findley (801) 226-1342	Greater Salt Lake City area. Meetings: Semi-annual.
Wisconsin	WAUSAU METALS CORPORATION 1415 West Street P.O. Box 1746 Wausau, WI 54401 Joe Ramuta (715) 845-2161	Merril, Stevens Point, Wausau areas. Meetings: Monthly

New CADKEY Users' Groups Being Sought For Boston, MA, Miami, FL, and St. Paul, MN

Please call Danielle Provencio at CADKEY, (203) 647-0220, if you know about a Users' Group in your area whose activities we have not publicized.

If you are interested in starting a Users' Group, CADKEY is interested in helping you. Call Daniell Provencio for a *START-UP USER GROUP KIT*. The kit will give you ideas about how to start a User Group successfully. CADKEY, INC. will even do a complimentary mailing to users in your area to help make your meeting a success.

CADJET™ and WLDSYM™ Upgrade To CADKEY 3 (V3.5); Offer Money-back Guarantee

"CADJET 3.5 has improved icons and layout," according to Harold Bowers of HLB Technology, "and WLDSYM puts standard welding symbols at your fingertips." For additional information, contact HLB Technology, P.O. Box 527, Blue Ridge, VA 24064, (703) 997-6520. FAX: (703) 977-6531.

CADKEY's National Users' Group Meets At NDES

Eighty CADKEY users attending the Spring National Design Engineering Show (NDES) participated in the CADKEY National Users' Group Meeting at the McCormick Hotel in Chicago, IL, during the evening of April 25.

George Patterson of Industrial Design Products in Chicago, Illinois, described how his company uses CADKEY 3™ to design hearing aids. J.C. Nix of Advanced Technology, a CADKEY dealer in Jonesboro, Arkansas, described the implementation of CADKEY 3 and Mastercam™ at the Nucor-Yamato Steel Mill in Blytheville, Arkansas. Robert Bean of Baystate Technologies presented a user tutorial on DRAFT-PAK™. Peat Marwick Associates gave an overview of a study of Silicon Graphics' products in the world of 3-D graphics. Pixar demonstrated photo-realistic 3-D imaging with RenderMan™. Paul Bergetz of PFB Concepts showed customized CADL™ programs developed by one of his customers, General Parametrics, Inc. of Chicago.

The meeting provided a good opportunity for CADKEY users to ask questions directly of CADKEY management.

3-D WORLD is published bi-monthly by CADKEY, INC., 440 Oakland Street, Manchester, CT 06040-2100. TELEPHONE: (203) 647-0220. FAX: (203) 646-7120. TELEX: 510 600 7223. If you need additional copies, or if there is a change in mailing address, please contact Frank Simpson, Editor.