Chapter 15

Patrick Hanratty and Manufacturing & Consulting Services

No history of the CAD/CAM industry would be complete without an in-depth discussion about Dr. Patrick Hanratty and his software company, Manufacturing and Consulting Services (MCS). In many quarters, Hanratty is considered the "father of CAD/CAM." This recognition was earned by the fact that software he developed at MCS and at a predecessor company, Integrated Computer Systems, was used by nearly a dozen companies as the basis for their commercial products in this market. In addition to licensing its software for resale, MCS, at various times over the years, also sold these tools directly to end users, some of whom are loyal users to this day. Of all the early developers in the CAD/CAM industry, Hanratty is one of the few who is still personally writing software in the 21st century.

Hanratty grew up in the San Diego area and like many of his cohorts went off to fight in the Korean War soon after high school. After spending over a year recovering from injuries suffered in Korea, he took a battery of tests as part of his rehabilitation and found that he was well suited for work in a scientific environment. Without a college degree, he managed to get hired by Convair in 1954 in San Diego as a programmer working on IBM 650 and UNIVAC 1103 computers. One typical project was to calculate the distance required for an aircraft to take off under various load conditions.

Describing himself as always restless, Hanratty responded to an ad placed by General Electric in 1956 for programmers in the Phoenix area. One of Hanratty's early projects while at GE was the development of an early numerical control software package called PRONTO (Programme for Numerical Tooling Operations). It basically took machining statements that an NC specialist entered onto coding sheets and processed these statements in a batch mode after they had been keypunched into punch cards and produced the actual digital instructions the machine tool controller needed to operate the machine tool. PRONTO was a point-to-point NC package developed for the Kearney & Trecker Milwaukee 3 machine tool used at GE's Schenectady, NY facility

Another program developed around the same time was the General Electric Machine Tool Director or MTD. This program handled limited 2 ½-axis contouring operations. It could machine parts at different Z levels, but it could not machine complex surfaces. Tool movements were defined in either absolute coordinate terms or symbolically. As an example, the part programmer could have the software determine where a straight line intersected a circular arc using a symbolic name for the point of tangency. NC machining was a relatively new manufacturing technique in the late 1950s and this was one of the first programs that facilitated programming these machines. These projects apparently initiated a life-long interest in NC machine control for Hanratty.

The actual group Hanratty was working for eventually became GE's process control unit. (Ten years later, I would work closely with this GE organization developing a petroleum product movement control system for the Lago oil refinery in Aruba.). GE shipped Hanratty off to western Pennsylvania to work on control systems the company was installing at several steel plants. He worked on systems for rolling mills operated by

Jones & Laughlin and Bethlehem Steel. Along the way he completed his B.S. degree in mathematics from Arizona State University.

Numerical control software development at GM

In late 1962 Hanratty left GE and went to work for General Motors in Michigan. As he puts it, "good job, good salary and good benefits." But he also found that GM was a hard place to sell ideas.

A misconception of which I am guilty of propagating along with many others, that Pat Hanratty was instrumental in the development of DAC-1, needs to be put to rest. Although he was employed by GM Research Laboratories from late 1962 to late 1966, DAC-1 was more a software development platform that he apparently used rather than a project he was intimately involved in. None of the papers published by DAC-1 participants mention him by name. One of the byproducts of working with the DAC-1 project team, however, was that he developed a relationship with several of the programmers on the project, among them Jerry Devere and Art Larsen, whom he would subsequently work with for a number of years. (See Chapter 3 for a detailed description of DAC-1.)

Hanratty's work at GM focused mostly on numerical control software. His title was Corporate Coordinator for Numerical Control Research. The primary platforms he worked on were the 7094 with the DAC-1 display console followed by an IBM System 360 computer with 2250 displays. Hanratty feels that the most significant innovation associated with the 360 was IBM's move to 8-bit code, replacing the earlier 6-bit code that had limited programmers to 64 different alphanumeric and special characters.

Shortly after joining GM, Hanratty became aware that the company was having problems producing tooling for the 1964 Cadillac trunk. He volunteered to produce the control tape for the NC machine that would make the die. His boss didn't think it could be done in the six weeks available but Hanratty believed he could. This became a point of contention (actually it is hard to visualize Pat Hanratty taking orders from anyone). In order to get authorization to proceed, Hanratty wrote an undated letter of resignation and stated that if he failed, the letter would be effective. Even though he was also working on his masters degree in systems engineering at the time which he eventually received from West Coast University, he managed to complete the task on schedule. Not only was it done on time, but the styling studio was impressed with the quality of the tooling that was produced. There was no need to put a date on the letter. The tool paths for the trunk lid are shown in Figure 15.1. (This image is also reproduced in an article written for the *IEEE Annals of the History of Computing Vol. 16 No. 3, 1994* written by Fred Krull, one of the DAC-I project leaders.)

For the next several years Hanratty concentrated on taking complex surfaces and producing toolpath data for NC machines. As he describes it, these surfaces were described by 5^{th} degree polynomials which made it particularly difficult to machine surface edges. The surface data was taken off the stylists' clay models using a scanner developed by IBM. Given the scanned data, Hanratty developed ways to define actual parts.

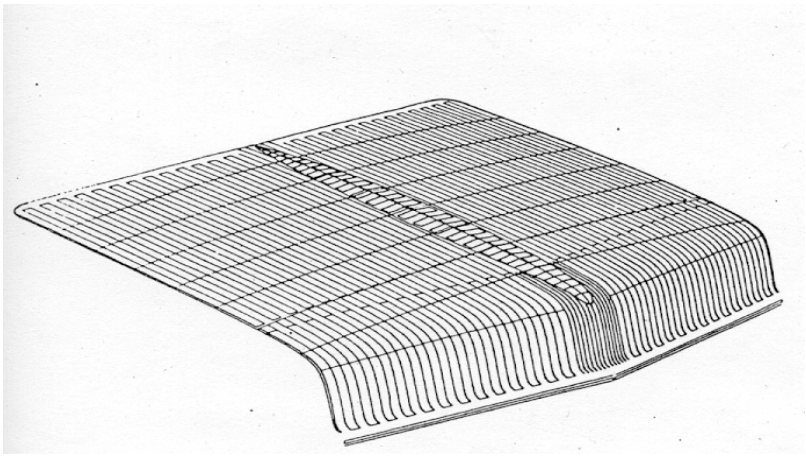

Figure 15.1
Trunk Exterior Toolpaths Created Directly from Math Data

Back to California

It was now time to move back to California. In early 1967 Hanratty went to work for Astronautics Corporation to help them develop computer-based design technology. For a while he continued to do work for GM on a consulting basis in areas such as surface machining technology. One particular project involved machining gears for the first collapsible steering column. This dual responsibility went on for about six months.

Eventually, Hanratty hired Jerry Devere, Art Larsen and several others from GM to work on software for mechanical and electrical design using a Xerox Sigma 7 computer with Tasker refresh vector graphics terminals. While this work was underway, Astronautics was acquired by McDonnell Douglas which had its own in-house CAD system, CADD, under development. According to Hanratty, this led to conflict between the two groups and eventually the work at Astronautics began to wind down.

Developing his own CAD system

Hanratty had been involved for eight years in developing CAD/CAM technology for large companies. At the end of 1969 he decided to set out to create his own software without having to fight corporate inertia. On January 2, 1970, with seven people from McDonnell Douglas including Devere and Larsen and $100,000, he started Integrated Computer Systems. They planned to develop a complete CAD/CAM solution on a REDCOR minicomputer using TPL (The Programming Language), an Algol-like programming language written by Larson. By that fall they were ready to show the software at the 1970 International Machine Tool Show in Chicago.

ICS demonstrated the entire cycle from design through drafting and NC tape preparation. Technically, the software was well received but potential customers objected to the use of TPL. As good of a programming language as it might have been, it had virtually no following. As an interesting sidelight, 13 years later Applicon would run into the same problem when it programmed BRAVO! in a proprietary version of PL-1. This goes to prove that users, particularly at large companies, are more interested in standard

technology than trying to push the envelope with potentially better proprietary technology.

The ICS software product was called INTERAPT. Apparently the name was derived from its interactive capabilities and its focus on machine tool control since APT was an NC programming language that stood for Automatically Programmed Tools. INTERAPT contained a number of modules including:

- EUCLID – Basic three-dimensional geometric construction using either interactive graphics or a batch language.
- EXTENDED Euclid – Advanced three-dimensional geometric construction covering the standard surfaces supported by the APT NC programming language.
- ICAD-M – Interactive computer aided drafting – mechanical.
- ICAD-IC – Interactive computer aided drafting – integrated circuit.
- ICAM-2+ – Interactive computer aided machining in two-dimensions plus depth.
- ICAM-3 – Interactive computer aided machining in three-dimensions (this module supposedly also supported five-axis machine tools).
- DISECT – Dynamic interactive section properties.

Since this was nine years before Matra Datavision was founded, there was no conflict with that company's use of the EUCLID brand.

There are many features of INTERAPT that would show up in subsequent versions of Hanratty's design and NC software products including ADAM, AD-2000 and ANVIL. One consistent theme has been the ability to drive the software by means of a specialized APT-like language. Since interactive graphic terminals were very expensive in the 1970 time frame, the ability to design parts off-line, enter the geometric definition data on punch cards and then have the computer create a model of the part as a batch process was perceived to be an efficient alternative. In INTERAPT, this capability was known simply as the EUCLID Language Option. It evolved over the years into what was called GRIP (GRaphics Interactive Programming language) in ADAM as described below, and is known today as GRAPL-IV. Figure 15.2 illustrates a sample EUCLID part program while Figure 15.3 shows what the resulting part would look like.

```
PARTNO LANGO1O
VIEW/1
ZSURF/.5
PT1=POINT/.5,0.0
LN1=LINE/0.0,.5,0.0,2
FIL1=FILLET/XLARGE,LN1,YLARGE,PT1,RADIUS,.5
PT2=POINT/1.25,3.25
PT3=POINT/DELTA,PT2,1.75,0.0,0.0
LN2=LINE/PT2,ATANGL,LN1,-45
LN3=LINE/PT2,PT3
FIL2=FILLET/YSMALL,LN2,XLARGE,LN1,RADIUS,.625,TRIM
FIL3=FILLET/YSMALL,LN3,YSMALL,LN2,RADIUS,.625,TRIM
LN4=LINE/PARLEL,LN3,YSMALL,.25
FIL4=FILLET/XLARGE,PT3,YLARGE,LN4,RADIUS,3
LN5=LINE/PARLEL,LN1,XLARGE,4.5
FIL5=FILLET/XSMALL,LN5,YSMALL,FIL4,RADIUS,.5
FIL4=FILLET/XLARGE,PT3,YLARGE,FIL5,RADIUS,3
PT4=POINT/END,YSMALL,FIL5
PT5=POINT/4.5,.25
LN6=LINE/PT4,PT5
STG1=STRING/PT1,X,2,Y,0,CCW,.25,90,(DY,.75),CW,.375,
     180,(DY,-.75),CCW,.25,90,X,4.25,Y,0,CCW,.25,90
DELETE/POINTS
DELETE/LN4,LN5
FINI
```

Figure 15.2
INTERAPT Part Program

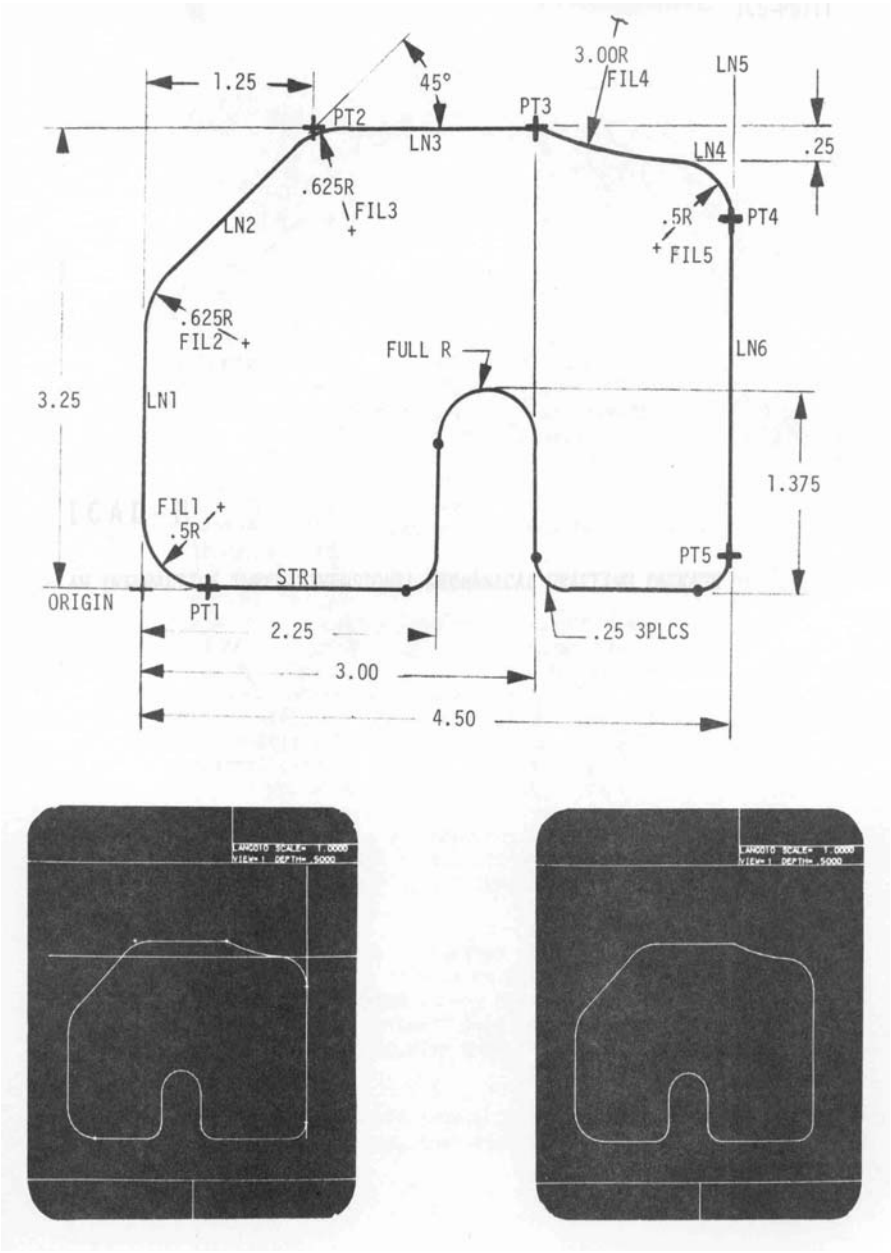

Figure 15.3
Part generated by program in Figure 15.2 – Lower left illustration shows construction points and lines while they have been deleted in lower right.

With few customers ICS was rapidly running out of money in early 1971. This was well before the days of venture capital firms spreading millions of dollars around like there was no tomorrow. TRW approached Hanratty about buying ICS, but he felt that the process of doing so would take too long and the company would be out of money before the acquisition could be completed. To the rescue came Systems Science and Software, commonly known as S^3.

With S^3 came a new player, Dr. David Albert, who had joined that company a short while earlier after working for the National Security Agency and receiving a Ph.D.

from Catholic University. Albert was doing some consulting work for Sandia Laboratories in Albuquerque, New Mexico and had channeled some electronic design development work to ICS. When ICS began to run out of money, Albert got S^3 interested in acquiring the company. This deal was completed around mid 1971.

S^3 offered all the ICS employees the same salary they had been making if they would stay with the company. Most accepted the offer. The assumption was that Hanratty would also stay to be the guiding force behind future software development. Such was not the case. Hanratty simply decided not to show up for work when S^3 took over. He called in that morning and resigned.

MCS is born

Several months later, on November 1, 1971 Hanratty formed Manufacturing and Consulting Services in Costa Mesa, California and set out to develop a new machine-independent version of the software that been started at ICS. This soon became known as ADAM, Hanratty's idea of it being the first in a new generation of design and manufacturing software packages. ADAM also stood for Automated Drafting And Machining. The package was initially written for the 16-bit REDCOR RC-70 minicomputer which was first delivered to customers in March 1969. REDCOR was a small computer manufacturer headquartered in Canoga Park, California.

The software utilized a Computek terminal which was built around an OEM version of the Tektronix 4010 storage tube display. MCS' initial business strategy was to develop software such as ADAM and license it to other companies to market and sell to end users. By licensing the software, these companies would be required to provide training and technical support, relieving MCS of that responsibility. The first such licensee was Gerber Scientific which used ADAM to jump start its entry into the CAD marketplace with emphasis on the CAM portion of the process.

This was followed by a license to United Computing, also for resale to end users. United Computing was one of the early NC software firms with a batch product called UNIAPT. The intent was to use ADAM as the basis for providing an interactive version of the company's software. This eventually led to the initial development of the Unigraphics software package prior to United Computing being acquired by McDonnell Douglas Automation (McAuto). In addition to Gerber and United Computing, MCS also sold ADAM to some end users. Hanratty provided me with a copy of the ADAM menus printed in 1972 by Xerox in El Segundo, California (most likely the former Scientific Data Systems facility).

S^3 felt that ADAM was basically the same software as what it had acquired when it aquired ICS. As a result, S^3 initiated a lawsuit to prevent MCS from selling or licensing additional copies ADAM. MCS then countersued with its own lawsuit. It is possible that some of the transactions mentioned above actually happened after the lawsuit was filed.

The situation changed dramatically when S^3, which had started out as a technical consulting organization in San Diego, was acquired by a large retail organization which had little desire to develop CAD software. It was more interested in using the S^3 talent to develop retail transaction technology. The CAD development portion of the company was sold to Computervision which intended to use the S^3 technology as the basis for its CADDS-3 software. Albert, Devere and about a dozen other employees became Computervision employees with most of them staying in San Diego.

Along with the S^3 CAD operation, Computervision inherited the lawsuit against MCS. According to Albert, Computervision wanted to settle the suit as quickly as it could but it also wanted to minimize direct competition from MCS. Hanratty's position to this day is that ADAM was a separate package rewritten from the ground up. According to him, much of the ADAM code at MCS was written by John Tangney, the first full-time employee at the new company. When I first met Pat Hanratty in 1976, he was still furious over the S^3/Computervision lawsuit while in a recent interview he appears to have mellowed with time. The process of preparing for a trial involved taking a number of depositions. Working with his lawyer, Gar Schallenberger, Hanratty personally participated in these depositions, the objective of which was to prove that the MCS code was different than the ICS code.

According to Hanratty, Marty Allen, the president of Computervision, called him and offered to settle. Under an agreement finalized in 1973, Computervision licensed ADAM on a non-exclusive basis, agreed to pay Hanratty a $10,000 per month consulting fee for a year as well as MCS' legal fees. One of the issues over which there is still some confusion is whether or not the settlement limited the work MCS could do in the CAD area for a period of time. Hanratty used some of this time to obtain his Ph.D. in information and computer science at the University of California, Irvine.

AD-2000 provides a substantial improvement over ADAM

Subsequent to the agreement with Computervision, Hanratty moved MCS to Irvine, California. The user interface for ADAM consisted of 22 menus, each with five to 14 commands that covered the full range of three-dimensional design, drafting and NC. The software provided for 171 distinct command selections. Even at this early date, MCS claimed to be able to handle 5-axis machining which was a vital requirement in the aerospace industry. According to the menu listing, the package handled surfaces of revolution, tabulated cylinders, developable surfaces, ruled surfaces, and curved mesh surfaces. Both fixed and variable radius fillets were provided.

About the same time as the move to Irvine, Hanratty began the development of his next generation of mechanical design and manufacturing software, AD-2000. It had a vastly increased number of commands as compared to ADAM and was written for the new generation of 32-bit minicomputers that were starting to show up. The software still ran on 16-bit minicomputers, however, such as the DEC PDP-11.

AD-2000, which was initially released in 1976, had 42 different menus with a total of 405 commands. Major functional enhancements compared to ADAM included:

- An interactive software development capability called GRAPL (GRaphical Associated Programming Language later changed to GRaphical Application Programming Language) which enabled users to create specialized applications.
- Expanded surface geometry and an initial implementation of solid objects.
- Expanded drafting functionality.
- 2-D and 3-D analysis including mass properties.

Although AD-2000 presumed to provide extensive functional capabilities there was one problem - some of it simply did not work. Not all 405 commands were implemented, at least not in early releases. In some case, when a command was selected, a message would appear on the screen simply stating that the function was not available.

When questioned about this at the time, Hanratty's response was that the menu structure had been established to reflect planned development as well as existing capabilities. In later versions of its software MCS would be clearer about what was still under development.

There is little question but that it was AD-2000 that established Hanratty's reputation in the CAD industry. For the most part, MCS' focus continued to be licensing the software to other companies for resale. AD-2000 was licensed to Control Data Corporation which sold it as CD-3000, Kongsberg which sold it as CDM-300, Tektronix which sold it as DDN and Auto-trol Technology which initially repackaged it as GS-2000 and later as Series 7000. Apparently, Gerber and United Computing (perhaps after the latter was acquired by McAuto) also upgraded from ADAM to AD-2000. In addition, MCS licensed the software to NASA which made it available to certain contractors under its IPAD (Integrated Program for Aerospace Design) initiative. To a lesser extent, AD-2000 was sold to several large manufacturing companies for internal use including Caterpillar.

One area where MCS had success selling AD-2000 directly to end users was in the ship building industry. Newport News Shipbuilding, Bath Iron Works and Todd Shipyards all used the software for defining flame-cutter tool paths.

Personal experience with AD-2000

I was personally involved with two of the companies that licensed AD-2000, Tektronix and Auto-trol Technology. Tektronix signed a license agreement with MCS in 1978. The software was intended to be the core product in what initially was called the Dimension Series but later simply DDN for Design, Drafting and NC. My role was to manage the field sales and support for this activity. It took nearly a year to interface the MCS software with new Tektronix graphics hardware.

Hanratty felt that the work could have been accomplished in less time except that the Tektronix team under John Rowley seemed to want to do software development on the smallest system available. He very much liked the new write-through capability Tektronix had added to its 4014 storage tube displays. A basic characteristic of a storage tube display was that the entire image had to be redrawn when anything was deleted or moved. The write-through feature enabled the use of dynamic menus which could be changed without having to regenerate the entire image being displayed. It also permitted a limited amount of image dragging on the terminal.

Tektronix sold its first DDN system to Bethlehem Steel in June 1979. This was followed by a large order from Reynolds Metals and a smaller order from Pratt & Whitney. Other accounts included Eastman Kodak and Aerojet General. One of the major problems Tektronix had selling its version of AD-2000 was that it started to run into competition directly from MCS. The Tektronix marketing personnel were never able to articulate why its version of the software was preferable to the MCS version.

Just as this business was starting to gain some real momentum, Tektronix decided in November 1979 to get out of the CAD systems business. While Hanratty felt that this was a shortsighted move on the company's part, he also felt that he was well treated by Tektronix when it negotiated a settlement with him. It is not clear what happened to most of the installations Tektronix had sold - Reynolds Metal was very upset and probably received some form of compensation from Tektronix while Pratt & Whitney continued

using Hanratty software, dealing directly with MCS. In a January 1987 article on MCS in *The Anderson Report*, Pratt & Whitney was reported to have 150 seats of MCS software installed on a variety of IBM mainframes using IBM 5080 displays at its West Palm Beach, Florida plant.[1] This could have been Tektronix business if the company had persisted in the CAD market.

The experience at Auto-trol was somewhat different. That company signed a license agreement with MCS for AD-2000 in mid-1979. As described in Chapter 9, Auto-trol's primary system at the time was called the AD/380. It was built around a Sperry Univac V77-600 minicomputer and used Tektronix storage tube graphic terminals. In late 1979 the company introduced an advanced graphics workstation called the CC-80 which incorporated a Texas Instrument microprocessor as a local controller. An AD/380 system could support up to 12 CC-80 workstations. Auto-trol had tried unsuccessfully to develop its own mechanical software for the AD/380 called GS-200.

Upon licensing AD-2000 they dropped the GS-200 project and began to port the MCS software to the AD/380 and the CC-80. It took about six months before the company had deliverable software which was called GS-2000. That was about the point in time when I joined Auto-trol as director of product planning although in that role I had little to do with the development and marketing of GS-2000. I was aware that the developers had serious problems keeping their modifications in sync with new releases of AD-2000 coming from MCS. Eventually it reached the point where Auto-trol felt that a fully paid up license with no further enhancements was the preferable way to go. They paid MCS $1 million in the latter part of 1980 and MCS gave the company its latest AD-2000 source code and terminated all future royalty payments.

It is hard to tell if that was a good move or not since MCS was in the process of developing a new, more stable version of its software called ANVIL-4000. Auto-trol continued to sell its version of the software for the next 15 years. It was ported to the Digital VAX 11/780 and eventually to Apollo, Sun and Digital workstations under the Series 7000 brand. Over time, much of the original AD-2000 code was replaced with new software developed internally by Auto-trol personnel although it never became a major source of revenue for the company. Starting in 1990, Auto-trol attempted unsuccessfully to develop a new mechanical design package from scratch.

MCS becomes a real software company

Until 1980 MCS and Hanratty focused on developing advanced mechanical design and manufacturing software that would either be resold by turnkey systems companies or MCS would sell it to large organization that had the technical resources to tailor the package to their specific needs. In particular, MCS software was fairly widely used by the nuclear weapons community with installation at Los Alamos, Sandia Laboratory, etc. They liked AD-2000 and the capabilities of subsequent MCS software to machine complex surfaces and were willing to put up with the software's idiosyncrasies.

With the introduction of ANVIL-4000 in 1981, that business strategy changed and MCS became a more typical software firm selling directly to end users. While the company still licensed its software to companies such as Harris Corporation and Graphtec for resale, the major focus shifted to developing a direct sales capability.

[1] *The Anderson Report*, January, 1987, Pg. 3

The name ANVIL came from Hanratty's idea that MCS was the "computersmith," providing users with tool kits. An anvil is an important tool for a blacksmith so it was not a huge leap to call the software ANVIL. As AD-2000 had added many capabilities to ADAM, ANVIL-4000 was an equally significant upgrade of the company's AD-2000 software. ANVIL-4000 contained 80 distinctly different menus with approximately 1,080 commands as compared to 42 menus and 405 commands in AD-2000. This time, MCS acknowledged that some of the commands such as dimensions in feet and inches, data graphing, a finite element interface to ANSYS, and piping design were still in development. When ANVIL-5000 came out around in 1986, some of these, such as feet and inch dimensions, had been implemented while others including piping design never made it into the package.

Two differences from AD-2000 were that ANVIL-4000 was more standards oriented and it had the capability to support two-byte characters. The latter feature made it feasible to support Asian languages such as Japanese and Chinese. One problem users had to adapt to was that the menu structure changed significantly between AD-2000 and ANVIL-4000, requiring users to learn where old commands were on the new menus as well as learn the new functionality. Even on menus for creating simple geometry such as points and lines, some of the commands either were changed or were in subordinate menus. In general, most of the added capabilities extended existing functions that were already in AD-2000 rather than creating entirely new areas of design and drafting.

According to the August 1982 issue of *The Anderson Report*, ANVIL-4000 was written entirely in FORTRAN and was intended to run on computers with a word size of 24 bits or larger. In some situations MCS also used the ANVIL-4000L nomenclature for this package. While the article did not mention which computer systems the software was currently available on, it did list eight different manufacturers whose terminals were supported: Tektronix, Megatek, Lexidata, Ramtek, Imlac, Genisco, Vector Automation and Vector General.[2]

ANVIL-4000L was packaged in five different modules which could be purchased in a variety of combinations:

- A basic package for control and viewing of geometry ($31,000)
- Drafting ($15,000)
- Extended geometry ($28,000)
- Numerical control ($26,000)
- Analysis ($7,000).

It is assumed that MCS probably offered discounts from these individual prices if a company wanted to buy the complete suite or wanted multiple copies. While $107,000 sounds high by today's standards, it was actually fairly reasonable in 1982. An IBM mainframe could easily support 12 or more terminals, bringing the price of the software down to less than $10,000 per seat. The software could also be leased from MCS for about 5% of list price per month. It is not clear what the company charged for software maintenance and whether the lease prices included maintenance and support.

MCS also offered a two-dimension version of the software called ANVIL-3000D which was intended for mechanical drafting applications. This software supported a wide range of international drafting standards and included capabilities for users to create their

[2] *The Anderson Report*, August, 1982, Pg. 3

own standards. In addition to orthographic drawings, ANVIL-3000D could also be used to create isometric drawings. According to *The Anderson Report* article, this package supported IGES, a fairly new interoperability standard at the time, as well as the ability to exchange files with ANVIL-4000L.

The ANVIL-3000D software was only available on a monthly lease basis, $1,750 for one or two terminals on up to $4,000 per month for 37 or more terminals. One of the more interesting features of ANVIL-3000D was a computer-aided instruction capability that the company felt would significantly reduce the time needed to learn the software. This would continue to be a training theme at MCS in the future.

MCS becomes a turnkey systems vendor

In 1982, MCS made its first attempt to sell packaged systems and terminals configured specially for MCS software. One product was a turnkey system called ANVIL-3000. It was based on a Hewlett-Packard 1000F minicomputer, a high-resolution raster display and the ANVIL-3000D software. It was priced around $90,000 with a single display terminal and $105,000 with two. In addition, MCS offered two graphics terminals specifically configured for its software. The ANVIL-1200 IID system was based on the Genisco G-1000 monochromatic raster display with 1,000-line resolution. It incorporated a Zilog Z8001 microprocessor with 320KB of memory and supported local manipulation features such as zooming, panning, dragging, rotating, cursor tracking, and erasing as well as digitizer support. Prices for this unit started at $15,750. It had initially been introduced at $18,750 but, apparently, that was not a very competitive price.

The second terminal was the ANVIL-1600 IID which was based on an Imlac DYNAGRAPHICS II stroke refresh display and an Intel 8086 microprocessor with 192 KB of memory. Resolution was 2048 by 2048. In both cases, the user still needed to provide a host computer system. By using microprocessors in the terminal devices some of the interactive functionality of the ANVIL software was implemented on the terminal, improving user performance. Other vendors such as Auto-trol Technology and Computervision were taking similar steps at that time with their terminal hardware.

To the best of my knowledge, MCS did not sell very much specialized hardware. The business was predominately software. *The Anderson Report* estimated that in 1982 MCS was doing about $5 million in annual revenue with all sales being handled out of its Irvine headquarters. Daratech reported in its *1983 Survey and Buyers Guide* that MCS had agreed to sell Impell Corporation 21% of its stock for $5 million.[3]

In mid-1983, MCS announced that the ANVIL-1200 IID terminal would henceforth be sold directly by Genisco Computers with a new price of $12,000. In September 1983, the MCS organization expanded with Tom Yarker promoted to vice president of technology, Ross Stoutenborough promoted to director of technical development and Morton Chonoles hired as national sales manager.

Starting around this time, MCS negotiated agreements with Digital Equipment, Prime Computer and Data General for these companies to resell ANVIL-4000. To the best of my knowledge, only Digital made any significant effort to build the necessary staff and aggressively promote the MCS software. In May 1984, Hewlett-Packard joined this list with an agreement to provide ANVIL-4000 on HP 9000 series computers.

[3] Daratech Corporation, *1983 Survey and Buyers Guide*, Pg. 18-205

In May 1984, HP acquired a 10% interest in MCS. According to Hanratty, this upset the other computer manufacturers who were selling his software and they ceased doing so. Hanratty soon became concerned because at the same time one HP group was acquiring an interest in MCS, another group within HP was in the process of acquiring a software company in Germany. This latter deal led to HP products such as ME-10 and ME-30, the establishment of that company's Mechanical Engineering Division and its eventual spin off as CoCreate.

Leaping into the world of personal computers

In late 1984, MCS introduced ANVIL-1000MD, a two-dimensional drafting subset of ANVIL-4000 implemented on an IBM PC/AT. The original plan was for IBM to use the package during the launch of the PC/AT and to subsequently market the software. A complete configuration including a PC/AT with 640KB of memory, a 20MB hard disk, a floppy disk, an 80287 math coprocessor, the IBM Professional Graphics Controller/Color Graphics Display, a B-size plotter and the software sold for $15,885. The software alone sold for $2,995. Although ANVIL-1000MD was technically well done, according to Hanratty it was error free when it was released, it ran into political problems at IBM.

For a number of years IBM had been selling CADAM, a mechanical drafting package developed by Lockheed which ran on the company's mainframe computers. Apparently, the thought of having IBM's upstart PC division selling a low cost alternative upset the mainframe part of the company and they lobbied successfully to stop IBM from selling ANVIL-1000MD. Three days before the formal launch was scheduled, IBM cancelled its contract with MCS even though Hanratty had prepared 10,000 copies of the software in anticipation of expected orders from IBM.

With IBM out of the picture, Tom Yarker, who had been instrumental in the development of ANVIL-1000MD, asked Hanratty if he could take over the marketing and sales of the package. Yarker set up a company called Integrated Design Consultants (IDC) and was fairly successful selling ANVIL-1000MD. According to Hanratty there were probably 5,000 copies still in use in 2000 and MCS frequently received calls from users who were interested in upgrading to ANVIL EXPRESS which is described below.

While the $2,995 price was more than what other PC-class drafting software from vendors such as Autodesk sold for at the time, it had more extensive capabilities. In addition, it was far less expensive than drafting software available from mainstream CAD vendors. Sales into the MCS customer base were handicapped by the fact that an interface between ANVIL-1000MD on one hand and ANVIL-4000 and ANVIL-3000 on the other hand, did not exist when the product was first introduced. Also, IDC was slow to develop an effective distribution channel for ANVIL-1000MD that was capable of competing effectively with Autodesk. MCS would come back to the PC as its primary platform, however, in later years. See Figure 15.4.

In early 1985, MCS announced that, working with Hewlett-Packard, it had initiated a development program to embed much of the ANVIL-4000 software code in silicon. Since many graphics functions that had initially been performed in software were becoming incorporated into display hardware, doing the same with CAD functions seem like a logical extension of what was going on in the computer industry.

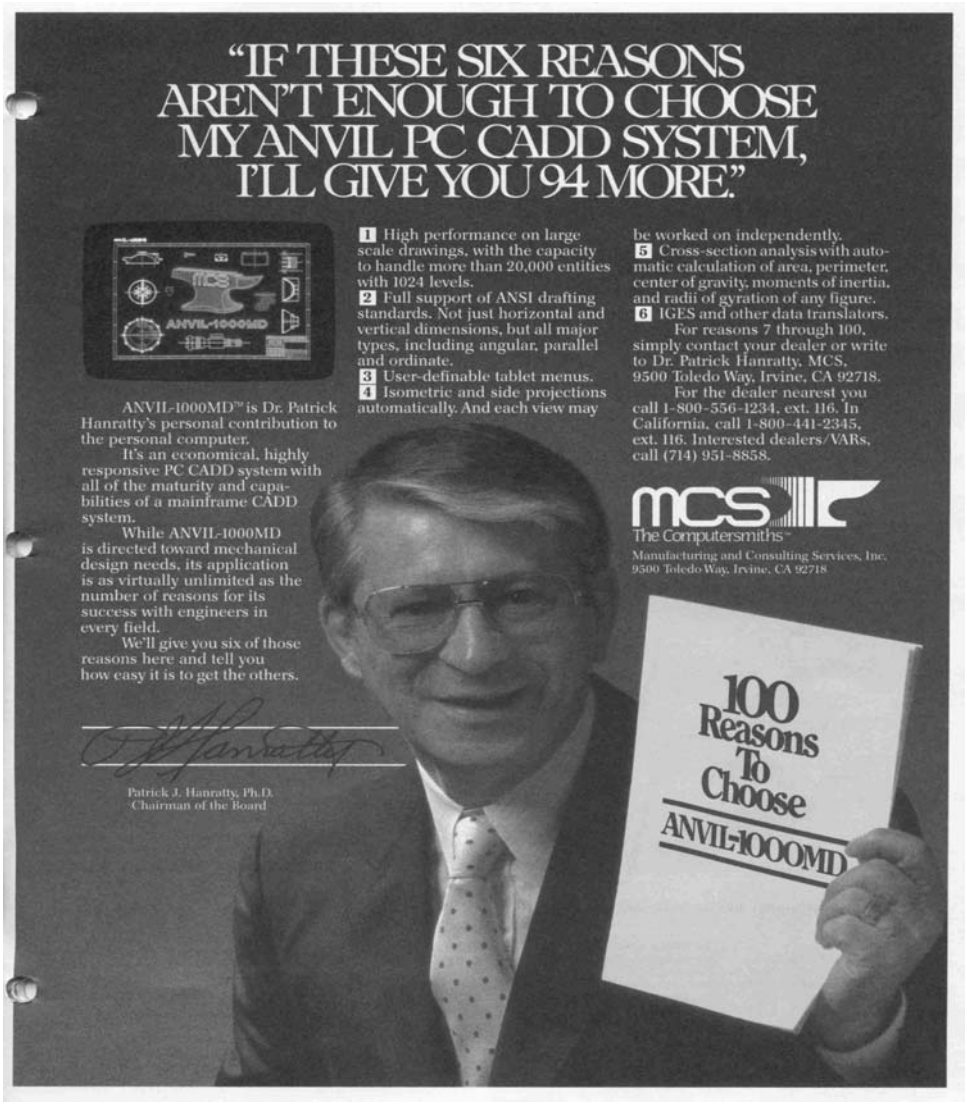

Figure 15.4

Pat Hanratty and advertisement for ANVIL-1000MD from *CAD/CIM Alert CAD/CAM/CAE Product News Supplement* - March/April 1986

The plan was to have key ANVIL routines available by late 1985 and the entire million lines of ANVIL code converted in two to three years. Hanratty felt that this could speed up complex operations such as those involved in solids modeling by a factor of 100 to 200. It never happened. My expectation is that it was a combination of cost and technical challenges that prevented this from occurring. Also, around the same time, the computational performance of computers was starting to improve at an accelerating rate.

MCS software matures with introduction of ANVIL-5000

The next product in the ANVIL family was ANVIL-5000 launched in January 1986. It was targeted at UNIX workstations such as those offered by Hewlett-Packard, Apollo, and Sun Microsystems as well as legacy computer systems sold by Digital and

IBM. As with ANVIL-4000, ANVIL-5000 was also implemented to run on IBM mainframes at the request of major customers such as Martin Marietta and Pratt & Whitney. MCS continued to support IBM mainframes for a number of years until the cost of doing so for a fairly limited market became prohibitive.

ANVIL-5000 implemented a consistent user interface across applications as well as a common double-precision database for wireframe, surface and solid models and all the applications that used this data. In this regard, it was several years ahead of Parametric Technology. The new software had 335 distinct menus which supported over 2,000 commands.

One of the more significant additions was a new optional solids modeling module called OMNISOLIDS which had a list price of $25,000. The result was one of the first CAD/CAM packages that tightly integrated wireframe, surfaces and solids. Some of the company's competitors would not reach this point with their software for another five years or more. In addition, the product's geometric design, drafting, and NC control functions had expanded significantly from those available in ANVIL-4000. These new developments helped MCS win a significant contract to provide design software to 12 Department of Energy sites in the fall of 1986.

According to an in-depth profile in the January 1987 issue of *The Anderson Report*, ANVIL-5000 was available in twelve different combinations of six basic modules: 3-D Design and Drafting, Surface Modeling, OMNISOLIDS, OMNIFEM, Numerical Control Machining and 5-axis Numerical Control Machining. Separating 5-axis machining from basic NC control was a recognition that this capability was far more complex than standard machining operations.[4]

The double-word database meant that parts could be designed and machined to 15 decimal digits of precision. Here also, MCS was several years ahead of most of its competition. As mentioned earlier, the ANVIL software was widely installed within the nuclear weapons community mainly for its ability to design and machine accurate weapon components. While ANVIL-5000 excelled as a part design and manufacturing tool, it was not particularly strong in regards to the design of complex assemblies, but neither were its competitors at the time.

Pricing for ANVIL-5000 ranged from $5,000 per seat in a 12-seat configuration running the basic design and drafting module to $19,000 per seat for the complete suite of software on the same 12-seat configuration. There were several problems associated with the introduction of ANVIL-5000. As with the transition from AD-2000 to ANVIL-4000, ANVIL-5000 users had to learn new ways to do some of the same tasks they had been doing previously with ANVIL-4000. In addition, there was no software initially available to move ANVIL-4000 data to ANVIL-5000. Some users resorted to using IGES for accomplishing this task. Also, the broad range of hardware MCS was attempting to support may well have overtaxed the company's development staff.

Meanwhile, MCS, in conjunction with IDC, was continuing to market the drafting-centric PC packaged it had introduced several years earlier, ANVIL-1000MD. It now supported a broad range of tablets for data and command entry as well more than 30 different models of plotters. Working with Kurzweil Applied Intelligence of Waltham, Massachusetts, MCS had implemented a voice actuation capability for ANVIL-1000MD in the spring of 1986. Several other vendors including Calma were experimenting with

[4] *The Anderson Report*, January, 1987, Pg. 3

voice actuation at the same time. In general, the user community rejected this technique of entering commands and data and it has never caught on for engineering design and drafting applications. MCS now had software that could exchange data directly between ANVIL-1000MD and the company's high-end packages.

According to *The Anderson Report*, MCS had about 100 employees and was doing about $10 million in annual revenue as of the beginning of 1987. The newsletter also estimated that the company had sold approximately 5,000 seats of ANVIL-4000 and ANVIL-5000 and perhaps 3,000 ANVIL-1000MD systems. About 60% of its high-end software was installed on Digital VAX computers with much of the rest on UNIX workstations. Apollo was the fastest growing segment of its market. Many of these customers would continue using MCS software well into the following decade and even beyond. This was particularly true for companies that designed parts that used injection molding for their manufacture. ANVIL-5000 proved to be an excellent package for machining molds for producing these parts.

At this point, MCS told *The Anderson Report* that it was ready to greatly expand its sales activity by opening four to six new sales offices and add about 30 direct sales people. For the most part, this never happened. The company also planned to become more of a system integrator by reselling workstations from Apollo and Sun. The December 1987 issue of *The Anderson Report* reported that MCS had signed $6 million OEM deals with both vendors.[5] As best as I can tell, this did not become a major element of the company's business.

In its January 1987 article, *The Anderson Report* concluded:

> "Pat Hanratty is a brilliant technologist and a natural salesman par excellence. There is little doubt that Hanratty is the dominant and controlling force at MCS. With this highly centralized control the company can respond quickly to market changes and make efficient use of its R&D resources. The bad news is the difficulty of doubling or tripling in size without changing the company structure. We believe MCS is ideally positioned to capitalize on the new era in CAD. They sell software only, that runs on all the popular platforms. Their product is powerful and more complete than previous MCS products. They have a PC strategy in place. We sense a reasonable satisfied and loyal user base from a user group meeting we attended. With these things in place MCS could be one of the fastest growing companies in CAD/CAM. Whether they choose to go for it remains to be seen."[6]

A good example of the difference between developing a good product and adequately marketing it would be MCS' experience with Anvil 1000. In June 1987, *Computer Aided Design Report* reviewed the results of a evaluation the publication had done of several leading PC CAD packages. Anvil 1000 came out as the top rated package in its class. "Anvil 1000 is still the best PC CAD package for mechanical drafting we've seen. It is priced fairly and should work even better on IBM's new PS/2 and other high-performance personal computers."[7]

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[5] *The Anderson Report*, December, 1987, Pg. 7
[6] *The Anderson Report*, January, 1987, Pg. 5
[7] *Computer Aided Design Report*, June 1987, Pg. 1

1987 and 1988 represent a high point in the history of MCS. The business was sufficiently profitable that Hanratty was able to build a 7,000 square foot home in the Luguna Hills section of Orange County. In an attempt to generate incremental revenue, MCS signed an agreement with Tektronix in early 1989 to resell Tektronix 4300 workstations with ANVIL-5000 software. Customers could evaluate the combined package for 90 days by paying just 2.7% per month of the hardware cost. The software was tossed in free during the evaluation. The major flaw in this strategy was that the 4300 never made much of an impression on the CAD/CAM user community and it is doubtful if very many prospects took MCS up on this offer.

One significant development that occurred during the next several years was the porting of ANVIL-5000 to the PC platform, providing customers with similar capability to what they could obtain on UNIX platforms. The 80386 version of design and drafting software sold for $3,995. That was about the same as what a new generation of mid-range vendors led by SolidWorks and Solid Edge (Intergraph) would charge in the mid-1990s. One result of porting ANVIL-5000 to the PC was that 2 ½ D ANVIL-1000MD became somewhat redundant although it did continue to be sold with a suggested retail price of $2,995.

Relocating to Arizona and continuing focus on ANVIL-5000

By early 1990, Hanratty was becoming quite frustrated with the business climate in southern California as well as the air pollution it was necessary to live with. Initially, he thought about relocating the company to some land he owned in the Sierra Nevada mountains of California. This land had been acquired as a result of his earlier settlement with Tektronix. Most of the MCS staff indicated that they were not interested in that idea so Hanratty went to Plan B which was to move the company to Scottsdale, Arizona where it has been since the summer of 1990. About 40% of the Irvine staff made the move to Arizona with Hanratty.

Two of those were Hanratty's sons Brian and Scott. Brian Hanratty joined MCS in 1976 as a system analyst and eventually became senior vice president and second in command with direct responsibility for software development. Brian has a masters degree in computer science from West Coast University in Los Angeles. Scott Hanratty joined MCS in 1981, responsible for corporate marketing. In the 1990s he was vice president, marketing and corporate operations. Scott has a BS degree in business administration from Pepperdine University in Malibu, California. The move to Arizona also encouraged John Tangney to rejoin the company. He had quit in 1977 to escape the smog and overcrowding of southern California and had joined Tektronix in Oregon.

The next several years were fairly quiet with MCS making few significant announcements. Between August 1990 and August 1993, *The Anderson Report* had just one brief news item concerning MCS. It reported in October 1991 that MCS had signed an agreement with Silicon Graphics to bundle ANVIL-5000 with SGI's Indigo UNIX workstation and sell the combined package for just $19,910. It is assumed that this included just the basic ANVIL-5000 design and drafting module. The hardware and software bundle was to be sold by both MCS and SGI as well as their reseller organizations.[8] This was similar to the deal MCS had with Tektronix in 1989. Neither

[8] *The Anderson Report*, October, 1991, Pg. 3

made much headway in expanding the company's business. One indication that MCS was loosing some of its earlier sales momentum was when Sandia National Laboratories, a long time AD-2000 and ANVIL user, awarded PTC an order for 600 copies of Pro/ENGINEER in July, 1992.

While the company might have been quiet on the PR and marketing fronts, it was continuing to enhance ANVIL-5000. Release 3.0 came out in early 1993 with new capabilities such as a more friendly user interface based on the MOTIF standard, faster performance and new NC capabilities. Perhaps the most significant enhancement the company announced at this time was AIM - the ANVIL Intelligent Modeler. It incorporated parametric techniques that facilitated rapid changes of part designs as well the creation of wireframe and surface models. The unit price for AIM was $10,000 for the UNIX workstation version and $6,700 for the PC version. AIM was intended to replace the earlier OMNISOLIDS solids module. Unfortunately, it never lived up to expectations.

The NC software incorporated new electrical discharge machining (EDM) capabilities as well as enhanced multi-surface machining. With the introduction of Release 3.0, MCS also announced that the final two ANVIL-5000 modules, Solids Modeling and 5-Axis Machining, had been ported to DOS PCs. Later in 1993, MCS broadened its product line with a sheet metal package it had acquired from Lennox International of Dallas, Texas, an ANVIL-5000 user that manufactured heating and air conditioning equipment. In April 1994, MCS introduced ANVIL-5000 Release 5.0 including ANVIL-Vision for photorealistic rendering based on LightWorks software and the Lennox sheet metal module.

Indicative of the problems editors had following what was available and what was planned for later delivery, MCS announced AIM a second time in March 1994 at the National Design Engineering Show in Chicago. Then, several months later we received another press release announcing the availability of the EDM software which had originally been included with the release 3.0 announcement.

Engineering Automation Report was started in March 1992 and acquired *The Anderson Report* in October 1995. An indication of the extent that MCS was out touch with the media during the early 1990s is that *EAReport* only mentioned MCS briefly in the context of the company showing new releases of ANVIL-5000 at several tradeshows until it did an in-depth profile in May 1995.[9]

Likewise, *The CAD Rating Guide* in its 1991 Second Edition and its 1993 Third Edition[10] have quite cryptic descriptions of MCS and the company's products. Since the information in the *Guide* was mostly provided by the vendors, it appears that for several years, the company simply did not pay much attention to the media. Its focus tended to be on the company's customer base. During these years anywhere from 125 to 500 people would show up for MCS' annual user conference.

The May 1995 MCS profile in *EAReport* seemed to coincide with an upswing in the company's marketing and promotion activity. It reviewed the company's earlier activities as described above. Much of the article described the current state of ANVIL-5000 with emphasis on AIM. In addition to the earlier described AIM, a two-dimensional

[9] *Engineering Automation Report*, May 1995, Pg. 6
[10] Holtz, Bradley W., *The CAD Rating Guide, 3rd Edition*, 1993, Pg. 182

version was now available that facilitated the creation of parametric drawings. The company described it as "drafting software on steroids."

GRAPL-IV was now included as part of the basic package while a new option, Extended GRAPL-IV, enabled users to directly access the ANVIL database. A viewing and redlining module called Design Review had also been added to the ANVIL suite. MCS' software prices as of mid-1995 are shown in the following table.

ANVIL-5000 Prices

Module	Workstation Price	PC Price
Design/Drafting	$12,000	$8,000
Extended Geometry	$8,000	$5,300
2 ½-Axis NC	$4,000	$2,700
3-Axis NC	$2,000	$1,300
5-Axis NC	$4,000	$2,700
AIM	$10,000	$6,700
2-D AIM	$5,000	$3,000
Design Review	$1,500	$1,500
ANVIL-Vision	$4,000	$3,000

In general these prices were somewhat high when compared to other workstation solutions such as Pro/ENGINEER and the PC prices were quite high when compared to new mid-range solutions such as SolidWorks although, at this point in time, ANVIL-5000 had far more capability than the early releases of SolidWorks.

EAReport summed up its review of MCS with the following:

> "Having known Pat Hanratty for nearly 20 years, our view may be a little biased. He always seems to be several steps ahead of where the rest of the industry's thinking is at any given moment. For many years, we watched MCS almost but not quite hit stride. It appears that the latter part of this decade may be its time in the sun. The company consists of a tightly knit team of dedicated individuals who want to show the world that substance is what counts in the long run.
>
> ANVIL-5000 is a serious product that deserves more attention than it has received in recent years. While the product line is not as broad as that offered by some vendors and the workstations prices are somewhat expensive, it is quality software. If your business is designing and manufacturing complex parts, we recommend that you take a look at the new ANVIL-5000 Release 5."[11]

The depth of data in the1994 Fourth Edition of *The CAD Rating Guide* was more extensive than in earlier editions reflecting an increased interest by MCS in getting the message about its products. The 1997 Fifth Edition reported that prices for ANVIL-5000,

[11] *Engineering Automation Report*, May 1995, Pg. 6

which was now at Release 6.0, had come down substantially. A complete CAD/CAM solution with 5-axis NC could be purchased for $9,500, which was comparable to what SolidWorks with a good third-party NC package cost.[12]

Re-energizing MCS with the introduction of ANVIL-Express

By early 1997, MCS was having problems matching the technical development resources and marketing strength of the major CAD players such as Dassault Systemes, Unigraphics Solutions, PTC and SDRC. Likewise, a new generation of mid-range players such as SolidWorks and the Solid Edge business unit at Intergraph were starting to create increased competitive pressure on the company. MCS had annual revenues in the $20 million range and Hanratty had stepped back from hands-on day-to-day technical management of the company.

One area where MCS was particularly lagging was in the use of solids modeling. The company had taken several shots at delivering this technology such as OMNISOLIDIDS and AIM, but simply did not have the resources to develop a complete solids capability by itself. In early 1997, the company licensed the Parasolid kernel and the Parasolid software development toolkit from EDS' Unigraphics Solutions. The plan was to use the Parasolid kernel for the company's next generation solid modeler. The new solid modeler was intended to form the basis for MCS' ANVIL EXPRESS, a fairly substantial overhaul of the company's flagship ANVIL-5000 software. John Tangney was now director of technical development and was leading the charge.

The objective was to provide an integrated design, drafting and NC package at close to the cost of the new mid-range packages, all of which required third-party packages to handle NC operations. ANVIL EXPRESS differed from ANVIL-5000 in a number of significant ways.

- Although ANVIL EXPRESS utilized many ANVIL-5000 routines, much of the code had been rewritten in C++.
- Whereas prior MCS software had been implemented to run on a wide range of computer systems, ANVIL EXPRESS was aimed specifically at the PC market using several different versions of Windows.
- The new software would maintain bi-directional compatibility with earlier MCS software products.
- ANVIL-5000 had a massive number of discrete menus and individual commands. This was greatly simplified with ANVIL EXPRESS, partially through the use of the Windows user interface.
- Prices were far more competitive - basic drafting started at $2,995, surface modeling at $3,995, solids modeling at $5,995 and design, drafting and 3-axis NC at $8,995.
- The new software included multi-media training and tutorials which could be tailored the user's level of expertise.
- New technology developed personally by Pat Hanratty called AUTOSNAP 3D enabled users to convert 2D drawings into 3D solid models.

[12] Holtz, Bradley W., *The CAD Rating Guide, 4th Edition*, 1994, Pg. 244 and *The CAD Rating Guide, 5th Edition*, 1997, Pg. 245

The latter two features were particularly significant. Unfortunately, AUTOSNAP 3D was still more of a research project than production code in 1997. In fact, five years later, Hanratty was still working on refining this software.

Prior to its release in the fall of 1997, a significant change was made to ANVIL EXPRESS. Rather than complete the development of a solid modeler built around Parasolid, the company decide instead to OEM and resell the SolidWorks package from SolidWorks Corporation, a division of Dassault Systemes. SolidWorks also used Parasolid. Hanratty's statement to me at the time was that the development of a Parasolid-based solid modeler exceeded the R&D resources of MCS.

MCS tried to build some interest in AUTOSNAP 3D by licensing the software to the Solid Edge business unit of Unigraphics Solutions (acquired from Intergraph in early 1998) which planned to sell it as a $495 option. It looked good when demonstrated at a Solid Edge user conference in 2000 but Solid Edge's technical personnel concluded that it didn't handle a sufficiently broad range of cases. As a consequence, the software was never actually marketed by Solid Edge.

Over a four year span MCS shipped several additional ANVIL EXPRESS releases but sales of this product never lived up to early expectations. While some ANVIL-5000 users switched to ANVIL EXPRESS or simply continued using ANVIL-5000, many others switched to competitive products. As the company's revenues began dropping, financial problems began to spring up. The critical moment came in 2001 when SolidWorks demanded payment on past due invoices for copies of SolidWorks MCS had purchased for resale. The money was not available and SolidWorks cancelled the company's resale agreement. This basically shut down the sale of new ANVIL EXPRESS licenses to a trickle and the company laid off most of its employees.

By 2002 MCS was just a shell of what it once was. There were a few employees providing support to a core group of loyal customers and Pat Hanratty was still programming away on the latest version of AUTOSNAP 3D.