Chapter 16

Parametric Technology

Parametric Technology Corporation was founded in May 1985 by Dr. Samuel P. Geisberg as SPG Consulting Corporation. Born in St. Petersburg, Russia in 1936, Geisberg earned a Ph.D. in mathematics and became a professor of mathematics at Leningrad University. He emigrated to the United States in 1974 with his 11-year-old son. His wife, Mira, and their six-year-old daughter had to stay behind because of her work on several defense related projects. It would be several years before she was able to join him in the United States.

Geisberg first worked for Computervision and then for Applicon. At both companies, particularly at Applicon, he proposed developing a radically new approach for CAD software, one that would be based on solid geometry and would use feature-based parametric techniques for defining parts and assemblies. When neither company agreed to fund his proposals, he decided to start a new company to produce the advanced design software he was contemplating.
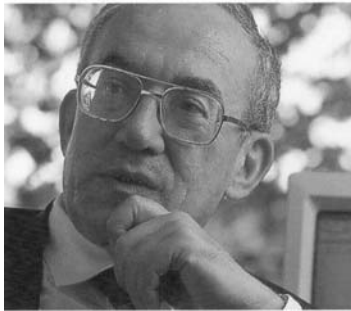

Figure 16.1
Dr. Samuel P. Geisberg

The reader should not assume that Geisberg was the only software developer working on these techniques. Some aspects of the fundamental ideas behind what eventually became Pro/ENGINEER were already being implemented by Matra Datavision, Intergraph and others. What separated PTC from these other vendors was the overall completeness of Pro/ENGINEER and its single data model concept for all design, analysis and manufacturing applications although it would be some time before this became clear to users and competitors.

PTC got started when Sam's brother Valdimir, who had emigrated from Russia in 1980 and had also worked at Computervision, suggested that Sam speak to an attorney named Noel Pasternak about setting up and financing a new company. Pasternak rounded up $150,000 in seed funding that enabled Geisberg to start work on the prototype for Pro/ENGINEER. Geisberg insisted that Pasternak put up $25,000 of the money personally. The company was incorporated in May, 1985. In the August 29, 1993 issue of the *Boston Globe*, Pasternak was quoted as saying, "I think having come from Russia, Sam wasn't sure who his friends were and who his allies were …. He felt that if I had

some money up, I would fight even harder for him."[1] More than 20 years later, Pasternak is the company's non-executive chairman of the board.

In all, about $750,000 in initial seed funding was raised from Adage, Charles River Ventures and others. The key step was building an organization that could complete the development of Geisberg's software ideas and bring the resulting product to market. The bulk of the early development work was done by Geisberg and four or five associates. Mike Payne, who had spent a number of years at Prime Computer as director of CAD/CAM research and development, joined PTC in March 1986 and a month later became vice president of development.

Being basically a mathematician and software developer, Geisberg and his backers recognized fairly quickly that they needed someone with more management experience to run the company on a day-to-day basis and as a consequence the company hired Steven C. Walske as president and chief executive officer in December 1986. Walske received an MBA from Harvard Business School in 1978 and was CFO of Computer Corporation of America prior to joining PTC. Under his leadership the company grew from a cold start to over $1 billion in revenue 12 years later.

After Walske joined the company, Geisberg became executive vice president of research and development. Six months later, Dick Harrison was hired as vice president of sales and the company's name was changed to Parametric Technology Corporation. Harrison had previously been a sales executive with Celerity Computing and Prime Computer.

In mid-1987 the company raised an additional $3.6 million in venture capital funding from Charles River Ventures[2] and others and began to prepare Pro/ENGINEER for launch later that year. About the same time, the company began demonstrating an early version of the software to the press. Publications including *CAD/CIM Alert* and *The Anderson Report* were suitably impressed. While most CAD software vendors had a preferred computer platform on which the company developed software and then ported the software to other platforms, PTC took the approach of developing its software on multiple platforms at the same time. Initially, this included workstations from Sun, DEC, Apollo, SGI and NEC. Except for using VMS on the DEC systems, PTC focused on UNIX as its primary operating system. While there was talk of a version that would run on an IBM System/2 PC or an Apple Macintosh, the PC version would have to wait for Microsoft's release of Windows NT in 1993.

According to Geisberg at the time:

> "The goal is to create a system that would be flexible enough to encourage the engineer to easily consider a variety of designs. And the cost of making design changes ought to be as close to zero as possible. In addition, the traditional CAD/CAM software of the time unrealistically restricted low-cost changes to only the very front end of the design-engineering process."[3]

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[1] *Boston Globe*, August 29, 1993
[2] One of the general partners at Charles River Ventures was Don Feddersen, a former president and CEO of Applicon who was a director at PTC for a number of years.
[3] Teresko, John, *Industry Week*, December 20, 1993

Prior to Pro/ENGINEER's formal release, the expected base price for the software was $12,500. The entire suite consisted of about ten different modules including basic sketching, feature-based modeling, drawing generation, assembly modeling, surface geometry, data management, etc. Eventually these modules, along with many other capabilities, would become part of the basic Pro/ENGINEER product. Although all modeling was done with solid geometry, users could work with either wireframe or hidden-line images as well as shaded images. Most early users worked predominately with wireframe images due to the performance of contemporary workstations.[4]

Beta testing of Pro/ENGINEER began in September 1987 with the first public demonstrations taking place at AUTOFACT in Detroit, Michigan in November 1987. Commercial shipments began in January 1988. The price for the basic software which consisted of parametric geometry creation, drawing generation, assembly modeling, and IGES 3.0 was reduced to $9,500. The company's initial distribution plan was to use dealers (Value Added Resellers or VARs) and OEM resellers. At product introduction, PTC had lined up four domestic dealers and two in Japan. The plan was to have 50 dealers by the end of 1988. It was not long before the company incurred significant conflict between these outside firms and its internal direct sales force.

Functional Description of Pro/ENGINEER

Although individual aspects of Pro/ENGINEER had appeared earlier in competitive software products, this product's introduction in late 1987 was the first time these capabilities had been grouped together in a single software suite together with a fairly straightforward user interface. Two basic principals drove the early development of Pro/ENGINEER. One was the use of parametric, feature-based solids modeling while the other was the concept that all applications in this software suite would use a common data structure.

While competitive products such as Computervision's CADDS 4X and McAuto's Unigraphics II were fundamentally wireframe based with solids added as an extra capability, Pro/ENGINEER was implemented from the start as a solids-based system. Everything was done with double-precision solid geometry and NURBS surfaces.

To create a model, the user typically started by creating a profile of the object. This shape was then converted into a solid model by translating it through space or revolving it around a centerline. Additional geometry could be added or subtracted from the base model. Some of the geometry was in the form of features such as holes, bosses, ribs, etc.

A key characteristic of Pro/ENGINEER was that as the model was created, the software recorded each step the operator took. This was referred to as a "history tree." The software also recoded geometric aspects of the model such as whether two surfaces were parallel or the fact that a hole was a specified distance from the edge of the part. Each dimension used to define the part was also recorded. If the user placed a through hole in a block and the thickness of the block was later increased,

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[4] *CAD/CIM Alert*, July 1987, Pg. 11 and *The Anderson Report*, July 1987, Pg. 3

the length of the hole would increase proportionately. With older solid modelers, the user would have been left with the hole ending inside the block.

One aspect of Pro/ENGINEER that was an early strength but would later be a problem was the fact that the model was always fully constrained. That meant that there were no redundant constraints nor could the model lack any information that fully defined its geometry. If a critical dimension or constraint was missing, the software would alert the user of this fact and would not proceed until the necessary information was provided.

If the user decided to change a dimension, the software would use the saved history tree to regenerate the model. For small models, this was nearly instantaneous but as models became larger, the time increased significantly. These changes were incorporated into the history tree so that as more and more changes were made, the regeneration time would increase. As an example, if a hole was initially placed in the model and later removed, each time the model was regenerated the software would insert the hole and then remove it. Users got around this problem by placing portions of the model on separate layers and only regenerating the layers they were currently working with.

Part designs were stored in separate files. Designers could then combine these parts, some custom and some standard, in an assembly. Rather than creating copies of the individual parts in the assembly model, Pro/ENGINEER referred back to these individual part files. If a part was subsequently changed, the new version could propagate throughout the assemblies that used it.

The fact that constraints and dimensions could propagate between parts in an assembly was particularly impressive at the time. If one part had a projection that fit into a slot on another part and the size and shape of the projection changed, the slot would also change when the assembly was regenerated. Although not obvious at the start, another powerful aspect of PTC's software was that all applications worked off the same database. Within the Pro/ENGINEER suite of software, there was no need to translate model data from one format to another when the user switched applications.

The common data structure enabled PTC to incorporate bi-directional associativity between software modules. A change to the solid model resulted in changes to relevant drawings, analysis models and machine tool paths while a change to a drawing could change the model from which that drawing was derived. Users could decide whether this associativity was to be activated or not.

The weakest aspect of Pro/ENGINEER when it was launched probably was its inability to create engineering drawings without first building a model of the part or assembly. Many projects required simple two-dimensional drawings. Users ended up acquiring simpler packages such as

AutoCAD for these tasks or to add details to Pro/ENGINEER drawings that PTC's software was incapable of handling.

Early versions of Pro/ENGINEER were particularly amenable to the design of families of parts where the general shape of the part did not change, just one or more key dimensions.

Changing the design paradigm

The first two copies of Pro/ENGINEER were sold to Deere & Company for $14,000 in September 1987 by Dick Harrison. Delivery of production software began in January 1988. Within a year, PTC shipped nearly 900 copies of the software to about 150 customers and both potential customers and the media began to pay attention to this industry upstart. According to *The Anderson Report*, the aisle in front of the company's booth at AUTOFACT '88 was jammed and the company was profitable starting with the quarter in which it began shipping software. The expectation was that the company would have revenues of $10 in the fiscal year ending September 1989.[5] (It actually did slightly better with revenues of $11 million during its first full year of shipments.)

Fairly quickly, PTC began adding applications to the Pro/Engineer suite of software starting with a program for generating finite element meshes. By early 1989 these packages included:

Pro/MESH – This software supported the automatic generation of input data for finite element analysis directly from the Pro/ENGINEER model. Loads and boundary conditions were applied directly to the model and when the model changed, these changes were applied to the Pro/MESH generated data. Unwanted details such as bolt hole threads were suppressed at the user's option. This software was developed jointly with PDA Engineering. Price was $4,000.

Pro/DETAIL – PTC recognized fairly quickly that it had to support a reasonable level of production drafting. Drawing images were directly derived from the Pro/ENGINEER model such that changes to the model were immediately reflected in the drawings. Probably unique at the time was the bi-directional relationship between model and drawings. Not only were model changes reflected in the drawings but changes to the drawings also changed the model. Price was $3,000.

Pro/INPUT – This module enabled a user to input IGES 3.0 geometry and use that geometry as a non-parametric feature in a part model or as a component in an assembly. Price was $2,000.

Pro/ASSEMBLY – Although the basic Pro/ENGINEER software supported assembly modeling, Pro/ASSEMBLY provided additional features for working with large assemblies including hierarchical linked layouts, global dimensions and reference planes. Price was $2,500.

Pro/DEVELOP – This was a software development toolkit that enabled programmers to access the Pro/ENGINEER database. Price was $30,000.

The company's sales strategy involved a combination of Value Added Resellers, OEM resellers and direct sales. As of early 1989, 40 percent of sales was coming from international distributors while the domestic balance was 25 percent OEM, 20 percent

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[5] *Anderson Report*, March 1989, Pg. 3

VARs and 15 percent direct. Early OEM partners were Control Data Corporation and PDA Engineering.

   The Anderson Report interviewed several companies for its March 1989 article on PTC. The feedback was very positive. Jack Wiley of Deere & Company was quoted as saying:

> "Pro/ENGINEER is the best example I have seen to date of how solid modelers ought to work. The strength of the product is its mechanical features coupled with dimensional adjustability. The benefit of this combination is a much friendlier user interface plus an intelligent geometric database."

Similar positive feedback was reported by users at Harris Corporation and Noma Outdoor Products. The newsletter summed up its evaluation with:

> "The Pro/ENGINEER product is a real winner…..The Pro/ENGINEER product has been on the market long enough to expose any major technical flaws and there does not seem to be any." [6]
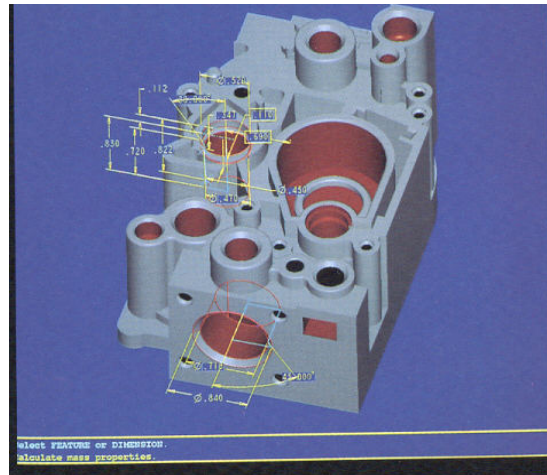

Figure 16.2
Typical Pro/ENGINEER Model

Problems with the OEM Sales Model

   In mid-1989, Auto-trol Technology also became an OEM reseller. The difference between the OEMs and VARs was that the OEMs were responsible for both pre-sale and post-sale technical support and software delivery. Customers actually purchased software licenses from the OEMs while PTC processed orders initiated by the VARs. For undertaking these responsibilities, OEMs received a substantial discount while the VARs were paid a commission on what they sold.

   From PTC's point of view, these OEM relationships were a way of jump-starting Pro/ENGINEER sales. The OEMs saw it as a way of expanding their traditional sales.

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[6] *The Anderson Report*, March 1989, Pg. 3

Auto-trol was a good example.[7] The company was having difficulty incorporating advanced solids modeling into its mechanical design software, Series 7000. Gary Germanis, a marketing manager in the mechanical software group, suggested that the company resell Pro/ENGINEER as a front end to Series 7000 which had strong drafting and NC capabilities. Initially, this was a sales strategy Auto-trol used without much success. In 1990, the company's focus shifted to selling Pro/ENGINEER on its own merits in specific geographic areas such as the West Coast.

The latter approach was starting to work when Auto-trol found itself competing with PTC's direct sales force. The issue was what defined a major account that would be the responsibility of PTC's own sales personnel. This was not resolved up front and Auto-trol found itself doing much of the account spade work only to have PTC subsequently declare that the prospect was a house account. The two companies were on a collision course over this issue when PTC simply decided in 1991 to terminate all its OEM reseller contracts and to offer those companies the ability to become more traditional VARs. Auto-trol declined this offer.

PDA Engineering's relationship with PTC was longer lasting than Auto-trol's. After a rocky start during which PDA threatened to sue PTC over a series of contractual issues, the two companies expanded their agreement in May 1990 to include a jointly developed software package, P/CONCEPT, that combined PDA's finite element technology with PTC's Pro/ENGINEER. Eighteen months later there was an announcement that the two companies had signed an expanded strategic agreement under which PDA's PATRAN 3 software would be able to directly access Pro/ENGINEER data.

Pro/ENGINEER – Is it for real?

In February 1990, Steve Wolf, the publisher of *Computer Aided Design Report*, decided that it was time to see if Pro/ENGINEER was for real. He had been taken aback by statement made by Geisberg and other PTC executives at AUTOFACT '89 that attempted to position PTC as a vendor comparable to industry leaders such as Prime Computer (Computervision), Intergraph and SDRC. He further thought that Geisberg's statement that PTC would become a billion dollar software company farfetched (it took nearly a decade but PTC did hit the billion dollar mark in 1998).

Wolf interviewed a number of Pro/ENGINEER users and came to the conclusion that while the software had a number of attractive capabilities it was far less mature than what the company claimed. His biggest concern was the difficulty designers had using this software to create complex surfaces. Wolfe felt that other vendors were farther ahead in doing this. Pro/ENGINEER's ability to handle complex parts and large assemblies was also questioned given the current state of UNIX workstation performance. Regeneration times as slow as 45 minutes for parts with 100 features were noted. Wolfe was also concerned by the fact that there were limits on the ranges of parameters as illustrated in Figure 16.3 below.[8]

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[7] For about a year from late 1989 to late 1990, I was responsible for much of Auto-trol's Pro/ENGINEER sales activity in the United States.

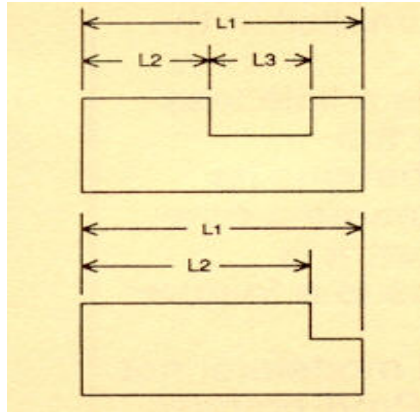[8] *Computer Aided Design Report*, February 1990, Pg. 1

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Figure 16.3
Pro/Engineer placed limits on the range of parameters.
(A designer could not increase the dimension of L2 to point that L3 vanished.)[9]

Wolfe went on to describe problems that an orthodontic manufacture had trying to do a Pro/ENGINEER benchmark. To avoid problems such as what this prospect encountered, PTC's application engineers were trained to use standardized demonstrations whenever possible. One they used extensively in the 1990 time frame was a household blender. The application engineers were well trained on these standard demonstrations which were implemented such that they illustrated the most positive features of Pro/ENGINEER and avoided any of the problems.

PTC Quickly Gains Market Momentum

Walske quickly put together an aggressive management team with Dick Harrison heading up sales, Lou Volpe as vice-president of marketing, Mike Payne running development and Mark Gallagher handling finances. Revenue grew rapidly from $11 million in the fiscal year ending September 1989 (the first full year of Pro/ENGINEER shipments) to $25.4 million in fiscal 1990 and $44.7 million in fiscal 1991.

Along the way, the company went public in December 1989 at $12 per share, more for the visibility and financial credibility than for the money it raised since PTC was profitable every quarter once it began shipping Pro/ENGINEER. Within two months the stock price more than doubled. It is interesting to note that two of the company's early directors, Donald Grierson, at one time been responsible for GE's Calma operation, and Noel Pasternak, a local lawyer, were still on PTC's Board of Directors 18 years later and Pasternak was the company's non-executive chairman.

According to Volpe:

"They (competitors) would present the CAD/CAM purchase decision as one so strategic that it should be made only with an old-line CAD/CAM vendor. At that time it was not so much a technology sell as one of credibility, as in 'Would you commit your CAD/CAM investment to a

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[9] ibid

company that may not be around long enough to capitalize on its technology?'"[10]

I personally experienced the reluctance of potential customers to commit to radically new technology while responsible for Auto-trol's Pro/ENGINEER sales activity on the West Coast in 1990.

In sprite of the intrinsic conservatism of engineers, sales of Pro/ENGINEER did take off like a rocket. By mid-1991, the company had shipped 3,800 seats of its software, had established an impressive list of third party software partners and was turning out a new release of Pro/ENGINEER every six months like clockwork. In one break with industry tradition, PTC started to tout the number of enhancements (they were never considered bug fixes) in each release. For example, Release 7.0 issued in March 1991 was promoted as having 250 enhancements.

The pace with which PTC added applications to the Pro/ENGINEER suite also started picking up momentum. Among the packages introduced in 1990 and 1991 were:

Pro/DRAFT – Used to create two-dimensional drawings and add text and non-associative geometry to Pro/DETAIL drawings.

Pro/FEATURE – This package enabled users to create their own features and save them in a library for later use.

Pro/SURFACE – Early versions of Pro/ENGINEER were somewhat weak in terms of surface geometry definitions. Pro/SURFACE enabled users to add complex surface geometry to their models.

Pro/SHEETMETAL – This software enabled users to create sheet metal parts and prepare output for manufacturing the parts.

Pro/MANUFACTURING – Early releases of Pro/ENGINEER envisioned the use of third party packages for generating NC tool paths. Customers pushed PTC into developing its own NC software which worked directly with Pro/ENGINEER data. A change to the model could quickly be reflected in manufacturing data. It would take a number of releases, however, before this software measured up to industry demands.

Pro/LIBRARY – This was a library of over 20,000 parts and features that could be incorporated in Pro/ENGINEER parts and assemblies.

Pro/PROJECT – Pro/PROJECT was PTC's first attempt to offer project data management software. It was soon superceded by Pro/PDM.

In general, PTC tended to release new applications as quickly on the assumption that it was better to get them in the hands of users as soon as possible in order to garner feedback on what needed to be improved rather than wait until marketing said the package did everything they perceived customers wanted. The result was that some key applications such as NC manufacturing were released before they were ready and caused an unacceptable level of grief with customers. In other cases, this strategy worked well.

Although the base price for Pro/ENGINEER stayed at $9,500, the typical seat price was between $14,000 and $20,000 once users added the applications they needed for a complete solution. The computer and electronics industry was the main source of revenue for PTC with 60 percent of sales coming from this area. Aerospace made up 10 to 15 percent and automotive 5 to 10 percent.

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[10] Teresko, John, *Industry Week*, December 20, 1993

In addition to its partnership with PDA Engineering described above, PTC also was working closely with Swanson Analysis (ANSYS), Structural Research & Analysis Corporation and Rasna. All three firms were finite element analysis software companies with Rasna being somewhat different in that it focused on design optimization. As described below, PTC would eventually acquire Rasna while Dassault Systemes would eventually acquire SRAC.

According the June 1991 issue of *The Anderson Report*:

> "Parametric Technology came out white hot in 1988 and has cooled very little since….Its parametric geometry is just as appealing to users today as it was three years ago. It could be said that parametric modeling has become an industry standard since it is a check-off item on many users' CAD system spec sheets. And the scramble by other vendors to included some parametric capability demonstrates just how much PTC has raised user expectations for tools to make their jobs easier."[11]

Even Steve Wolfe became a believer by the end of 1991. In the December issue of the *Computer Aided Design Report* Wolfe wrote:

> "Parametric Technology Corporation's Pro/Engineer (sic) has become the hottest product for three-dimensional mechanical design………..The breathtaking growth of Parametric Technology should not surprise anybody."

Wolfe went on to list the reasons behind this attitude.
- PTC produced two releases of Pro/ENGINEER per year while competitors were lucky to get out one.
- Pro/ENGINEER was machine independent and PTC did not seem to have a favored platform vendor.
- New releases were available on all platforms at roughly the same time.
- The software was visually attractive and the software's menus used meaningful engineering terminology.
- Pro/ENGINEER only worked with solid models while competitive systems dragged along obsolete wire-frame and surface functionality.
- PTC's sales force worked hard and sold hard.[12]

In the right place at the right time
The early to mid-1990s were a time of very rapid growth for PTC. Many large user organizations had invested millions in first and second generation CAD systems and were beginning to realize the limitations of what they had installed. This led many users to re-evaluate the relationships they had with their current vendors and to look around to see if something better was available. PTC was the new kid on the block with a new bat and ball and soon everyone wanted to be its friend.

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[11] *The Anderson Report*, June 1991, Pg. 5
[12] *Computer Aided Design Report*, December 1991, Pg.2

In mid-1992 alone, the company secured an 800 seat order from Sandia National Laboratory and a 2,000 seat order from Caterpillar. The latter was a heavily contested battle with EDS' Unigraphics Solutions subsidiary. These were followed by other large orders from Cummins Engines and Ford Motor Company. The company's revenues and earnings were nearly doubling year over year and PTC's stock had tripled between early 1991 and mid-1992 when the installed seat count had climbed to 8,300.

The October 1992 issue of *Engineering Automation Report* tried to put PTC's growth in perspective. It identified a number of reasons why the company was successful while its competitors were struggling. As I wrote at the time:

> "When opportunity came knocking, Parametric Technology was there to answer the door. To appreciate why PTC has been so successful, you need to look at the history of the CAD industry and where the technology stood when the company was formed in 1985."[13]

The article went on to explain that competitive systems such as CADDS, BRAVO, Unigraphics, DDM, CADAM and CATIA had roots that went back to the late 1960s in some cases. These packages mostly evolved from two-dimensional drafting-centric applications with three-dimensional and solids data added at a later time. They were mainframe or minicomputer based with considerable software implemented to compensate for the shortcomings of early hardware products and operating systems. The software relied on proprietary operating systems and carried forward code needed to support legacy hardware which was not longer of interest to new buyers. For the most part, these systems were hard to maintain and enhance and were particularly difficult to port from one computer platform to another. In some cases, portions of the code was still written in assembly language.

PTC sought to achieve a competitive advantage by creating new technology tuned to the characteristics of networked UNIX workstations. Pro/ENGINEER was implemented from the start with a double precision database, written in the highly portable C programming language and took advantage of the latest capabilities provided by most UNIX operating systems. The one exception was support of DEC's rather mature VMS operating system. But even here, PTC supported DEC's single-user workstations, not its multi-user minicomputers.

As described earlier, the result was a software product line that was built around a single database, parametrically defined geometry, feature-based solids modeling, and bi-directional associativity between applications. In the latter case, the extent to which a downstream application could change the geometry of the original model was controllable by the user or system administrator. The resultant system had a user interface that incorporated many of the latest on-screen menu techniques and color coded feedback mechanisms. It was designed specifically to function in a distributed network of workstations and was implemented on all supported platforms in parallel.[14]

By the late 1992, Pro/ENGINEER was at Release 10 with another 700 enhancements and over 25 application packages supported. Some of the more recent additions included Pro/MOLDESIGN, Pro/CABLING, Pro/DIAGRAM and

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[13] *Engineering Automation Report*, October 1992, Pg. 6
[14] *Engineering Automation Report*, October 1992, Pg. 6

Pro/HARNESS-MFG. More and more, PTC was offering a nearly complete design, drafting and manufacturing solution - relying less and less on third-party applications except for analysis and some specialty areas such as high-end visualization, rapid prototyping and documentation. The software was primarily sold in suites such as the Production Package which consisted of Pro/ENGINEER, Pro/ASSEMBLY, Pro/DETAIL, Pro/FEATURE, Pro/INTERFACE and Pro/PLOT, all for $18,000.

Problems with parametric design

The *Engineering Automation Report* article also began to explore the question about the extent with which users had to plan their design work in order to avoid having to start over if major changes were made to the design. The problem with a pure parametric design technique that is based upon regenerating the model from its history tree is that as geometry is added it is dependent upon geometry created earlier. This methodology has been described as a parent/child relationship except that it can be many levels deep. If a parent level element is deleted or changed in certain ways it can have unexpected effects on child-level elements. In extreme cases (and sometimes in cases that were not particularly that extreme), the user was forced to totally recreate the model.

The way around this problem was to carefully plan the design, defining ahead of time which major elements would be dependent upon other elements. Some people described designing with Pro/ENGINEER to be more similar to programming than to conventional engineering design. Competitors, particularly SDRC, which used an alternative technology called "variational design" that did not require the model to be fully constrained at all times, claimed that their software avoided this type of situation.

The other problem with Pro/ENGINEER that was beginning to concern users was the reduced performance when working with large assemblies or very large individual parts. These models could take a considerable amount of time to load (retrieve from disk memory and prepare for interactive manipulation) and to regenerate when changes were made. Faster computer systems helped but users were starting to build increasingly complex models. Model size was increasing faster than the speed of the newest computers could handle.

In succeeding years, PTC would invest considerable development resources addressing both of these problems.

PTC matures as a company

PTC ended 1992 with a quarter that saw revenue grow 97 percent to $32.5 million. I was fairly enthusiastic about the company's future and predicted that PTC would be a $500 by 1995. I was close in that the company reported revenues of $394 million for the fiscal year ending September 30, 1995 and $600 million the following fiscal year.[15]

I was not the only writer who was becoming enthralled with PTC. In the November 1992 issue of *Computer Aided Design Report* Steve Wolfe stated:

> "The secret of PTC's success is not hard to understand. It delivers a three-dimensional CAD/CAM system that is significantly easier to use than the established systems. Its dimension-driven modeling capabilities,

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[15] *Engineering Automation Report*, February 1993, Pg. 15

employment of features instead of drafting elements, and fast interactive response all contribute to the product's ease of use."[16]

One negative was that PTC was gaining the reputation as being a overly aggressive company in regards to its sales force, particularly as an increasing portion of sales were being handled by the company's own personnel. It was not at all uncommon for a PTC salesperson to pick up the telephone and call the president of a company if he or she felt that the people responsible for selected a CAD vendor were leaning towards a competitor. Many of these calls were not particularly flattering in regards to these lower level individuals. The result was a significant number of engineering managers who would have nothing to do with PTC even if the company's systems might have been a good solution for their needs. A decade latter, PTC was still trying to convince the marketplace that it was a "kinder and gentler" vendor.

PTC also had a reputation among resellers as being very hard to work with. As a consequence, there was a lot of turnover among the companies reselling Pro/ENGINEER. One exception was Rand Technologies, a Canadian-based reseller with numerous offices in the United States. Actually, it was the operating arm of a company named Rand A Technology Corporation. Rand, which had been established in 1986 as a reseller of Computervision software, was headed by Brian Semkiw. It sold a number of complementary software packages as well as hardware on which to run these programs.

As of early 1994, when the company went public in Canada, 38 percent of its total revenue consisted of Pro/ENGINEER software and related PTC applications. It claimed to have sold seven percent of all Pro/ENGINEER seats installed worldwide. The company stated that its success was a result of the high level of support it provided customers. But even this close relationship with PTC would eventually blow up and the two companies would part ways with much animosity.

Explosive growth continues

From a reported $163 million in fiscal 1993, PTC's revenues exploded to $809 million in fiscal 1997. Along the way, the company's earnings increased from $43.5 million to $219 million and the cumulative number of seats of Pro/ENGINEER sold exceeded 100,000. It seemed as if the company could do no wrong. One point that needs to be emphasized is that this revenue involved pure software along with some consulting services. The company's major competitors had traditionally sold hardware either manufactured themselves or OEMed from computer and other hardware manufacturers.

As the market price of computer hardware plummeted, these companies had a hard time increasing revenues or even maintaining them at historical levels. When PTC ported its software to PCs running Windows NT, it did not matter to the company that the hardware cost for a seat of Pro/ENGINEER had dropped significantly since it received the same revenue for Pro/ENGINEER whether it ran on a $40,000 UNIX workstation or a $4,000 PC. In fact, if anything, the trend to lower priced hardware enhanced PTC's position in that customers could use a larger portion of their budget for software since they were spending less for hardware.

Mentioning Windows NT, when Microsoft announced its new operating system on May 24, 1993, PTC was one of the first software companies to jump on the

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[16] *Computer Aided Design Report*, November 1992, Pg.1

bandwagon. The company said that it would have Pro/ENGINEER running on Windows NT when the operating system began shipping in July. The company didn't quite make that date but it did begin shipping a Windows NT version of Pro/ENGINEER certified on the Compaq DESKPRO 5/60M in August. Because of slight differences between PCs, PTC planned to test the software on each preferred configuration before giving that combination of hardware and software its blessing.

By late 1993, large million dollar plus orders were coming fast and furious. In particular, companies that had installed a few seats of Pro/ENGINEER to evaluate the technology liked what they saw and decided to roll out the software to their entire design staff. A good example was Paccar, the builder of Kenworth and Peterbuilt heavy trucks. They started with seven seats at Kenworth, liked what they saw and subsequently ordered another 63 seats.

According to the November 1993 issue of *Engineering Automation Report*:

"The speed with which existing PTC customers are upgrading their installations is impressive. We see two messages here. On one hand, these companies are finding Pro/ENGINEER to be an effective tool and they are willing to commit increasingly large sums to purchase additional copies of software and hardware on which to run it. But the second issue is that there appears to be a huge pent-up need for new engineering design technology that was not being met by the previous software vendors these companies were using. The vendors of these legacy systems have provided a window of opportunity to PTC and PTC is taking advantage of it."[17]
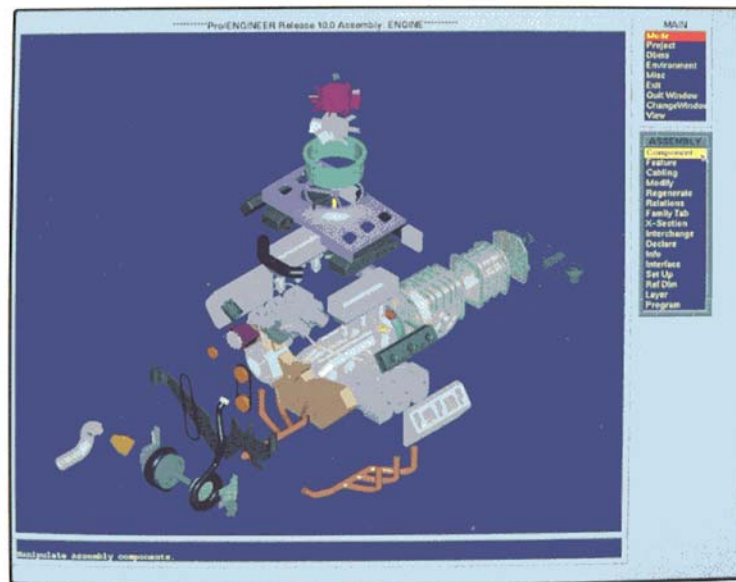

Figure 16.4
Pro/ASSEMBLY circa Pro/ENGINEER Release 10

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[17] *Engineering Automation Report*, November 1993, Pg. 5

Cleaning up its manufacturing software

In late 1993, PTC began shipping Pro/ENGINEER Release 12 with a number of sketching and design enhancements and support for a total of 27 individual applications. The most significant enhancement, however, was a substantial overhaul of Pro/MANUFACTURE. While the initial versions of this software had some strong capabilities, especially the bi-directional associativity with the Pro/ENGINEER database, it was awkward to use and did not provide sufficient ability for users to directly create and edit tool paths. This had resulted in a near revolt among a number of PTC customers, led particularly by Caterpillar.

The Release 12 version of Pro/MANUFACTURING improved the software's user interface by tailoring the number of menu options presented to the user. For example, if the user was doing three-axis milling, only commands applicable to that type of machining would appear on the screen. Fundamentally, the software was rewritten to more closely reflect the way manufacturing engineers worked.

The other significant change was that the user was now provided more control over machining operations rather than depending on the automatic generation of tool paths. In fact, the manufacturing engineer could totally bypass the automatic generation of tool paths and create them interactively. This interactive set of tool paths was remembered by the system as a feature and if the model shape changed, then the interactive tool paths could be automatically updated.

PTC also added a Pro/PIPING module that enabled designers to add pipe and tubing components to an assembly model. The software included a library of components that had design specifications associated with them. If a user inserted a piece of copper tubing in an assembly, the software would check to ensure that it did not exceed bend limitations contained in the specifications for that size tubing.

Release 13 came out in early 1994 with more enhancements to Pro/Manufacturing including the ability to machine across multiple surfaces. This software also incorporated additional decision making logic such as the ability to make a sequence of machining operations dependent upon the thickness of a plate. The result would be if the plate were thin then holes would be punched but if the plate was thicker than a specified amount or if the correct size punch were not available, then the holes would be flame cut.

Several new applications were made available with Release 13 including Pro/FEM-POST. This software enabled a user to create a finite element mesh with Pro/FEM, send the data to a FEA program, receive back the results and view them with Pro/FEM-POST and then make changes to the model geometry based upon these results. In effect, the user could stay in Pro/ENGINEER through the entire process except for the actual analysis step.

Another new application was Pro/SCAN-TOOLS which allowed users to take data from three-dimensional scanning devices and convert that data to Pro/ENGINEER-compatible surface geometry. Since a lot of industrial design was still being done by creating clay or wood models, this software closed an important gap in automating the design process. Pro/SCAN-TOOLS could also be used to reverse engineer existing parts.[18]

Just about every month during the 1994 and 1995 time frame, PTC announced million dollar plus contract awards from Sharp Corporation, Whirlpool, Ford Motor,

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[18] *Engineering Automation Report*, April 1994, Pg. 12

Groupe Schneider, Mannesmann AG, Steelcase, Sharp, Eaton, Cincinnati Milacron, AMP Incorporated and others.

PTC's management changes

PTC started a new phase of its evolution as a significant technology firm in August 1994 when Steve Walske replaced Sam Geisberg as chairman of the company's board of directors and Dick Harrison was promoted to the position of president and chief operating officer. Geisberg stayed with the company for a short while as chief scientist and then retired. Lou Volpe, who many people thought might get the COO position, left the company later that year.

Meanwhile, the company kept chugging out new Pro/ENGINEER software releases every six months. This continued to impress most industry observers. The following comment in the December 1994 issue of *Computer Aided Design Report* was typical of what was being written at the time.

> "Parametric Technology may lose its edge and go the way of the turnkey CAD vendors if it doesn't keep up with technological trends. At this point, however, it shows no signs of doing so. It is constantly improving its core software and related applications. It seems better positioned than other high-priced competitors to take advantage of the shift from Unix work stations to Windows NT and personal computer hardware. It is expanding aggressively outside the U.S. and it has a respectable, if not large, dealer channel selling $40 million worth of new software each year. None of the old-time CAD vendors is doing all these things, let alone doing them well. Parametric Technology is becoming the market leader because it has better software, adds requested improvements more rapidly than its competitors, sells aggressively, keeps in step with hardware trends, and provides good application engineers to help train its customers. It continues to baffle us that the other large CAD vendors don't respond in kind."[19]

Creating a lower cost alternative

A significant product announcement occurred in January 1995 when PTC launched Pro/JR. The intent was to provide a lower cost solution to the estimated 600,000 potential users who needed greater capability than that provided by low-cost mechanical drafting packages but something less than what was provided by the full Pro/ENGINEER suite of software. Pro/JR. was a subset of Pro/ENGINEER Release 14 and was available in both UNIX and Windows NT versions. The price was initially set at $8,000 for a node-locked license and $9,000 for a floating licenses that could be moved from computer to computer in a network as needed.

This price seemed to be somewhat high compared to Pro/ENGINEER's base price of $9,500 except that one needed a fair number of optional modules to make Pro/ENGINEER a useable solution. PTC packaged these in suites called the Basic Package and the Advanced Designer package for $16,000 and $20,000 respectively. Pro/JR. included a subset of Pro/ENGINEER and Pro/DETAIL along with a number of

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[19] *Computer Aided Design Report*, December 1994, Pg.9

the capabilities provided in Pro/FEATURE and Pro/INTERFACE as well as a version of Pro/PLOT. Overall, Pro/JR. was a decent collection of functions at what was then a reasonable price. PTC described it as 50 percent of the Basic Package at 50 percent of the price. (Other sources said 40 percent of the functionality for 40 percent of the price.)

Pro/JR. utilized a streamlined version of Pro/ENGINEER's menu structure. Functions that were not applicable were removed making the menus simpler to use. A developer's toolkit was available for $6,000 that enabled third party software firms to adapt their Pro/ENGINEER applications to Pro/JR.

Initially, it appeared that PTC had come up with an attractive product that filled a significant gap in the industry's product offerings. There were a vast number of organizations that either could not afford a full-functioned Pro/ENGINEER license for every design engineer or were not ready for the extensive changes in design procedures that software necessitated. Pro/JR. clearly offered a more integrated solution than Autodesk's AutoCAD Designer product which sold for $6,750 and greater mechanical design capability than Bentley's MicroStation Modeler. The company was clearly aware of the pending introduction later that year of SolidWorks and Intergraph's Solid Edge, the two packages that would help establish a new market for mid-range solutions.

So why did Pro/JR. fail to catch fire and excite the market?

- It was probably priced somewhat too high. The sweet spot for this type of application was probably closer to $5,000 than $8,000. Also, $1,400 annually for full maintenance and support per copy was considered quite high.
- The choice of the name for the product was probably a mistake. Engineers did not want to be assigned to use a "junior" product.
- The use of Pro/JR. by existing Pro/ENGINEER customers was limited by the fact that while data created with Pro/JR. could be imported and used by Pro/ENGINEER, Pro/JR. could not import and use Pro/ENGINEER data. This was more a marketing decision by PTC than a technical limitation.
- No optional Pro/JR. applications were available from PTC. If a customer wanted to machine a part created in Pro/JR., either a new third-party package developed for use with Pro/Jr. had to be purchased or the data had to be exported to Pro/ENGINEER.
- The fact that Pro/JR. was sold only through the company's reseller channel resulted in sales conflicts between the VARs and PTC's direct sales force.
- There was no company provided training. The only options were training programs offered by the VARs or self training.[20]

PTC expands through acquisitions

In the February 1995 issue of *Engineering Automation Report*, I noted that PTC had accumulated over $230 million in cash reserves and that I would not be surprised to see them use this money to acquired either a product data management or electronic design software vendor.[21] The company moved sooner than I expected and in directions other than what I had expected.

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[20] *Engineering Automation Report*, February 1995, Pg. 10
[21] *Engineering Automation Report*, February 1995, Pg. 14

The first move the company made was to announce on April 12, 1995 its plan to acquire Evans & Sutherland's industrial design and visualization software business unit for $33.5 million in cash. The deal included E&S' Conceptual Design and Rendering System (CDRS) and 3D Paint products and the staff that had been working on them. This group had software revenues of about $8 million annually. The key product was clearly CDRS which was a functionally rich industrial design and styling software package. Many PTC customers already used software products from Alias and Wavefront, both of which had recently been acquired by Silicon Graphics.

E&S was formed in 1968 by Dr. David Evans and Dr. Ivan Sutherland, both of whom were computer science professors at the University of Utah at the time. The initial plan was to develop graphics hardware that could be used for computer-based simulation applications. This led the company into the business of developing and producing graphics hardware for aircraft flight simulation systems. E&S subsequently established a partnership with a British simulation firm, Rediffusion, which resulted in the company having exclusive rights to provide visualization systems for Rediffusion's commercial flight simulators. Many of today's commercial aircraft pilots were trained on these systems. E&S went public in 1978.

Sutherland stayed with the company for just a few years while Evans remained CEO until 1994. During the 1980s, the company expanded into new graphics markets including general visualization, industrial styling and solids modeling having acquired Shape Data and that company's Romulus package in 1981. CDRS was introduced in 1990 and although it was a visually impressive package, it never sold well, partially due to the lack of an adequate sales and marketing organization but perhaps more importantly, its high price. Initially, CDRS was only available on E&S workstations and a complete single user system sold for $250,000. Subsequently, CDRS was ported to other UNIX workstations but was still priced at $55,000 to $85,000 for just the software, The 3D Paint visualization software was only available on SGI's high-end Onyx workstations and was priced at $15,000.

James Oyler joined E&S in 1994 as president and CEO and he soon began to refocus the company on its core competencies: simulation training, high-end visualization and digital theaters. Corporate sales were slipping since Rediffusion was no longer a customer and E&S had incurred its largest loss in a decade in 1994. CDRS and 3D Paint did not fit into Oyler's plans for the company.

CDRS, along with the 3D Paint software, was expected to provide PTC with an integrated industrial design and product engineering solution suite. While the surface geometry capabilities in Pro/Surface were adequate for many design tasks, CDRS had far superior overall surface creation and editing functionality, particularly as used in the design of automobile bodies. Integrating the CDRS technology into the Pro/ENGINEER product would end up taking much longer than initially expected.

There was also an ulterior motive for PTC in this acquisition. Ford Motor Company was a major user of CDRS and Ford was currently engaged in the process of selecting a primary CAD vendor. PTC was in the running for this business and one has to assume that the company thought the addition of CDRS to its product offering would provide a competitive advantage. This gambit did not work and Ford ended up selecting SDRC as its primary CAD vendor.

Dr. Thomas Jensen, who received his Ph.D. from the University of Utah in 1984, had earlier joined E&S in 1978. He became general manager of the company's design software group in 1993. As soon as the acquisition was completed, Jensen moved from Salt Lake City to Waltham and became vice president of R&D at PTC. Jensen never seemed to fit in with the Massachusetts-based developers at PTC and left the company in 1998. He subsequently became vice president of R&D at think3, a position he held until around 2003. [22,23]

Within a few months, PTC repackaged CDRS and 3D Paint as Pro/ENGINEER options. CDRS became Pro/DESIGNER, priced at $12,000 per copy or less than half what E&S had been charging. Data was transferred between Pro/ENGINEER and Pro/DESIGNER using a neutral format based on IGES. For customers using CDRS in a stand-alone mode or with other CAD solutions, PTC offered Pro/CDRS, priced at $25,000 per copy. Other E&S software was repackaged as Pro/PHOTORENDER, Pro/ANIMATE and Pro/PERSPECTA-SKETCH. A bundle of Pro/ENGINEER, and the former E&S software was offered at the extremely attractive price of $20,000 per copy. One problem in this area was that the E&S software only ran on IBM and SGI workstations and it would be sometime before these capabilities would be available on other UNIX workstations and running under Windows NT.

A few months after the CDRS acquisition, PTC made a significantly more impressive move when it acquired Rasna Corporation, a vendor of design analysis and optimization software, for approximately 3.8 million shares of stock worth about $205 million at the time. Rasna was founded in November 1987 by George Henry and several associates who had worked on similar technology at IBM's Almaden Research Center in San Jose, California. The company's MECHANICA software differed from traditional finite element method packages in that it used a technique called Geometric Element Analysis (GEA). A GEA model uses significantly fewer elements and these elements can contain fairly complex geometry. Within the mechanical analysis community, these were known as p-elements where the p stood for polynomial.

A key aspect of Rasna's MECHANICA software was that it not only handled structural, thermal and motion analysis of parts and assemblies but that it could also be used to optimize the shape of individual parts. Initially, Rasna worked closely with Autodesk to provide this technology to AutoCAD users but the company soon switched focus to Pro/ENGINEER. The MECHANICA process as of 1995 worked as followed:

1. Basic part geometry was defined in a CAD system such as Pro/ENGINEER, CADKEY, AutoCAD or I-DEAS.

2. The geometry was imported into Applied Structure, one of the MECHANICA modules.

3. The user created a p-element model using automated and interactive techniques. Typically, a Rasna model had about one fiftieth the number of elements that a traditional FEA model for the same part would have.

4. Loads and boundary conditions were applied.

5. The user defined which parts could be changed such as the width and/or thickness of a particular portion of the model and what was to be optimized such

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[22] *Engineering Automation Report*, April 1995, Pg. 5
[23] *Computer Aided Design Report*, April 1995, Pg. 5

as weight or stress. Minimum and maximum values were also defined at this point.

      6.   The software would then iterate through the analysis until it found an optimum shape for the part. In the mid-1990s, these runs typically took from several minutes to several hours on a UNIX workstation. Traditional FEA models could take several times as long on much larger and more expensive computers to simply do the analysis.

      7.   The modified geometry was exported to the originating CAD system and the model was interactively changed to conform to the optimized shape.[24]

In addition to Applied Structure, which handled basic linear analysis, Rasna also offered thermal, motion, nonlinear, and buckling modules. The software at the time of the acquisition ran on UNIX workstations, Windows NT and several supercomputers. Software was available to transfer geometry between MECHANICA and a number of CAD packages although Pro/ENGINEER seems to have been the preferred CAD system. This was expensive software with prices starting at $16,000 for a one station license. It could pay for itself on one design assignment, however, by reducing the weight of a part – especially if that part was to made in the millions.

In the January 1995 issue of *Engineering Automation Report* I provided an update on Rasna and suggested that the company, which was expected to do around $35 million that year, would go public before the year was over. When Rasna opted to be acquired rather than go public, I asked David Pidwell[25] why the acquisition rather than a public offering. He responded: "The synergistic benefits are tremendous, both in the sales and the product areas….If we didn't join them, we would end up fighting them." Pidwell went on to say that merging with a fast growing company (PTC was growing about 45 percent per year at the time) was similar to an IPO without the aggravation and expense an IPO would have entailed. He described it as "an instant IPO."[26]

Of Rasna's more than 1,200 customers at the time of the acquisition, perhaps half used a CAD system other than Pro/ENGINEER. The early word from PTC was that the company would continue to sell MECHANICA to these users. This never really happened to any extent for two reasons: 1)PTC saw MECHANICA as a competitive advantage when selling Pro/ENGINEER particularly against companies such as SDRC that had their own analysis software and 2)PTC fired most of the Rasna sales staff soon after the acquisition. The company did land a $1.9 million contract from McDonnell Douglas for MECHANICA software in September 1995 but there were few others of this ilk. PTC expected its own 300-person sales staff to sell about $60 million of analysis software in fiscal 1996. This proved to be widely optimistic but a more than decade later Pro/MECHANICA is still an important part of PTC's software product line.

PTC shifts into an even higher gear

By mid-1995, it appeared that PTC would soon become the dominating company in the CAD industry. It was growing rapidly while most of its competitors were

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[24]*Engineering Automation Report*, April 1993, Pg. 6

[25] David Pidwell subsequently joined a venture capital firm, Alloy Ventures, while Keith Krach, Rasna's COO went on become founder and chairman of Ariba.

[26] *Engineering Automation Report*, July 1995, Pg. 1

struggling. Since PTC had never built or resold computer hardware, it did not suffer the withdrawal pains experienced by competitors such as Computervision, Applicon, Intergraph or Auto-trol Technology. Pro/ENGINEER created a paradigm shift in the world of mechanical design software, a change that competitors were just catching up to.

Not only was PTC's revenue continuing to grow at an impressive pace, but the company was also significantly profitable due to a number of factors.

- As the company's revenues increased, there was not a commensurate growth in the company's overhead staff. PTC was a very lean operation in the mid-1990s.

- The company prided itself in the size and aggressiveness of its sales staff. The plan was to have 375 sales people on board by the end of fiscal 1995 (they actually ended up with 400). These individuals were responsible for over 90 percent of the company's revenue while resellers handled the balance. Combined, the two sales forces sold 15,900 seats of Pro/ENGINEER during 1995 at an average price of $18,100. As mentioned earlier, the sales force's aggressiveness had negative connotations as well as positive. PTC management recognized this problem and already was starting to talk about toning down the rhetoric.

- PTC's sales staff effectively used a technique sometimes referred to as "guerilla sales." The concept was to sell a few seats of Pro/ENGINEER to a department within a large corporation and then use the success of those systems to eventually have the customer commit to making the software a corporate standard. Autodesk also used this technique very effectively.

- While feature-based parametric design was what initially caught the attention of potential users, the single integrated database for multiple applications eventually was seen as being equally important.

- Since Pro/ENGINEER was implemented from the start to be platform independent, PTC had to spend far less effort porting its software than did competitors.

- In general, PTC had good relationships with third-party software vendors, even after acquiring Rasna.

- The company encouraged users to submit requests for enhancements and set up user committees to help review these requests. The manufacturing software committee was particularly vocal in its opinion of what the company had to do to make that software more effective.

- Pro/ENGINEER customers were beginning to reduce or even eliminate drawings as part of the design process and were transferring design data directly to manufacturing suppliers such as tool and die shops in the form of Pro/ENGINEER models. This required the suppliers to also use Pro/ENGINEER.

- While other software companies tended to spend 20 percent of more of their gross revenues on product development and software maintenance, PTC was spending just 6.5 percent. At the end of fiscal 1995, PTC had only 340 people involved in product development as compared to nearly 1,100 people in the company's sales and marketing organization.

In general, PTC kept cranking out new releases of Pro/ENGINEER every six months, typically with 500 or so enhancements and several new applications. Release 15

was no different although it was delayed a few months in order to incorporate Pro/DESIGNER. While the basic interface had not changed much since the software's first release, PTC did work hard to make it more effective. As an example, Release 15 allowed a user to interrupt the design of a part, create a new customized feature and then insert that feature in the model. At the time, this was an impressive capability. The company was also starting to pay more attention to the performance problems associated with working on large assemblies.

Pro/JR. had gotten off to a slow start with sales of $5 to $7 million in fiscal 1995 but the company expected this to grow to $20 to $30 million in fiscal 1996. In October the company reduced the price of that package from $8,000 to $4,995. Obviously, PTC was starting to become concerned about new mid-range competitive solutions such as Intergraph's Solid Edge which was priced at $5,995, SolidWorks which was initially priced at just $3,995 and Autodesk's Mechanical Desktop priced at $6,250.

PTC was also beginning to pay more attention to product data management issues. Pro/PROJECT morphed into a newer packaged called Pro/PDM where PDM stood for Parametric Design Manager. Unlike Pro/PROJECT, Pro/PDM did not require an active Pro/ENGINEER license in order to be used. PTC saw Pro/PDM as project-level or department-level data management software and was comfortable at the time working with other software vendors such as Sherpa and Workgroup Technology that provided enterprise-level data management applications.

By mid-1995 PTC had installed over 40,000 seats of Pro/ENGINEER and Pro/JR. at more than 6,200 organizations around the world. It was adding 600 new customers and about 4,000 seats a quarter. In the August issue of *Engineering Automation Report* I wrote:

> "PTC has its sights set on becoming a $1 billion company by the end of the decade. If the market potential is as real as they believe it to be, there are no competitors currently strong enough to prevent the company from meeting this objective. It is unlikely that the growth will come purely from mechanical design. We believe that PTC will need to become a more significant factor in the rapidly growing PDM market."[27]

To put the potential growth in perspective, The company finished fiscal 1995 with revenues of $394 million, up 48 percent from the prior year.

In September 1995, Edwin Gillis joined PTC as chief financial officer. He had previously held the same position at Lotus. In addition to Walske and Harrison, other key executives were Marc Delude, senior vice president of marketing, Dr. Thomas Jensen, senior vice president of research and development and Michael McGuinness, senior vice president of sales and distribution. Among the company's directors were Donald Grierson who had previously headed up General Electric's "Factory of the Future" initiative (See Chapter 11) and Michael Porter, a professor at the Harvard Business School and a leading authority on corporate re-engineering.

A changing sales and low-cost product environment

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[27] *Engineering Automation Report*, August 1995, Pg. 6

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In 1996, revenue was continuing to grow by over 50 percent. Quarterly sales volume was rapidly approaching 6,000 seats with quarterly revenue over $150 million. By mid 1996 PTC had over 600 sales people on board and was talking about increasing that number to 900 by the end of fiscal 1997. The target was to increase revenues to around $850 million during the next year. Walske believed that he could keep a sales force this large productive by a high ratio of managers to direct sales people. In PTC's case this was around one to one.

Having such a large sales force tended to reduce the size of individual sales territories which meant that PTC's people were calling on smaller and smaller accounts. This resulted in an increased level of competition with resellers and PTC decided to change its relationship with its VARs. Except for Canadian-based Rand Technologies[28], the VARs were no longer able to sell Pro/ENGINEER but were limited to selling Pro/Jr. which was renamed Pro/MODELER. It was a more complete product now, however, with several application packages including Pro/MILL, Pro/TURN, Pro/FEA and Pro/RENDER, each selling for $3,000 to $4,000.[29]

A few months later, the nomenclature changed again and this software product line was renamed PT/Products with Pro/MODELER becoming PT/Modeler, Pro/MIL becoming PT/Mill, etc. There was also a library of 34,500 ANSI fasteners called PT/Basic Library which sold for just $1,000. The version of PT/Modeler that was released in the fall of 1996 was based on Pro/ENGINEER Release 17 and was available in both Windows 95 and Windows NT versions. A UNIX version of this software was no longer available.[30] Its price dropped once again in early 1997, this time to just $2,995 and the prices of some optional modules were also lowered. Bundles were available at a discount from the list price of individual packages. A fairly comprehensive suite of design and manufacturing modules was available for just $6,995.

A major issue with PT/ Modeler was that it still used the same UNIX-oriented user interface as Pro/ENGINEER even though it was only available on Windows-based PCs. Users of moderately priced design software on PCs expected applications to have a user interface based on Windows standards. How much this adversely impacted sales of the PT/Products packages is not clear. Possibly more significant was that fact that this software was only sold by resellers who could not sell Pro/ENGINEER. This created conflict with PTC direct sales force and the PT/Products line probably never got the corporate support it needed to be successful.

In addition to reducing prices for the PT/Products packages, PTC once again change its distribution strategy. The company's direct sales force was given authorization to sell these low cost packages which strained PTC's relationship with its resellers even more than it had been. It also was not encouraging to hear the company's CEO putting down the concept of mid-range CAD software. At an analysts meeting on April 10, 1997 Walske commented:

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[28] By the end of 1996, Rand determined that its future was not in selling Pro/ENGINEER and the company announced that it would phase out this aspect of its business by April 1999 and focus on systems integration. In this regard, Rand became PTC's first Preferred Systems Integration Provider and PTC acquired a small equity interest in Rand.

[29] *Engineering Automation Report*, August 1996, Pg. 1

[30] *Engineering Automation Report*, October 1996, Pg. 3

"Our perspective on low-end products has not changed. They provide most but not all of the functions of Pro/Engineer. Our customers demand end-to-end design automation. I don't think SolidWorks will close the gap. SolidWorks [and all the other low-priced systems] are fundamentally flawed."

In response to another question at the meeting, Walske said:

"Our main competition is not with SolidWorks, but with Autodesk."[31]

Focus on automotive market

Towards the end of 1996, Don Henrich was promoted to the position of senior vice president of marketing replacing Marc Delude who left the company to become president of Moldflow, an analysis software company. Meanwhile, multi-million dollar contracts continued to pour in from companies around the world including Matsushita Communications, SKF Group, Sanyo and Lockheed Martin Astronautics. The company ended its fiscal 1996 with revenue of $600 million, up 52 percent from the prior year. This revenue represented 23,000 seats of software at an average price of $20,400.

The company planned to release an exciting new package along with Release 18. Called Pro/ENGINE, it was intended to automate about half the work that went into the design of an automobile or truck engine. Pro/ENGINE combined typical Pro/ENGINEER functionality along with new web technology. The package consisted of three major components as shown in Figure16.5:

- A Web browser-enabled tutorial on designing an engine
- A series of "wizards" that facilitated each step of the design
- Pro/ENGINEER to do the actual part and assembly modeling.

PTC had developed all the parametric relationships between the different parts so when a value such as the stroke of a piston was modified, that change would propagate throughout the entire engine model. The web aspects of this package were intended to also be made available separately to customers as Pro/ Web Modeler.

Typically, this level of design automation was something that large users did for themselves. It would prove interesting to see if a software vendor's more intimate knowledge of its software would offset a customers more intimate knowledge of its work processes.[32] PTC declared 1997 to be "the year of the car." The company's intent was to develop applications that could be used to penetrate the automotive design industry more extensively than PTC had been able to do to date. A Pro/BODY package was being developed to go along with Pro/ENGINE.

Potential customers were expecting PTC to integrate the surface technology acquired with CDRS more closely with Pro/ENGINEER than the current enhanced IGES interface used with Pro/DESIGNER. The Pro/ENGINEER technology model was built around the concept of data associativity between applications. The underlying CDRS architecture was substantially different from that of Pro/ENGINEER, making the integration of the E&S and PTC software more difficult that initially envisioned.

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[31] *Computer Aided Design Report*, May 1997, Pg. 1
[32] *Engineering Automation Report*, November 1996, Pg. 14

Figure 16.5
PTC Pro/ENGINE Screen Image[33]

The company's focus on the automotive industry was starting to pay off by mid-1997. In prior months, PTC announced substantial orders from BMW, Fiat, Ferrari, Toyota, Hyundai, PSA and Volkswagen. Many of these orders involve the design of automotive engines and transmissions where Pro/ENGINEER's solids modeling capabilities were particularly productive.

When I visited PTC's headquarters in May 1997, the company was preparing to ship the first customer versions of Pro/ENGINE. PTC took a team of 20 application engineers and internal consultants, many with extensive experience designing engines, and had them spend 10 weeks developing the detailed procedures for designing a 280-part engine model They actually took several four-cylinder, 16-valve, inline, double overhead cam engines and physically broke them down to the individual part level.

During the visit, I was told that Pro/ENGINE would sell for $500,000 for a site license for a single major type of engine. This price included a substantial amount of consulting services - perhaps 60% of the cost was expected to be made up of professional services.

PTC takes a run at the AEC market

At the June 1996 A/E/C SYSTEMS Conference I was a participant on a keynote panel called "2001, A CAD Odyssey." During my talk, I said that one of the major business developments over the next five years would be PTC's entry into the AEC CAD market. After the session was over, a PTC executive came up to me and asked "What was your source for that statement?" I replied that I had I had no inside knowledge of any PTC plans, that it was just my opinion. He then proceeded to invite me to visit PTC's headquarters as soon as possible, preferably the next week.

At that meeting, I learned that the company was moving in this direction much sooner than I had expected. In fact, PTC was in the process of acquiring a three-

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[33] *Computer Aided Design Report*, February 1996, Pg. 1

dimensional object-oriented modeling and visualization package developed in England called Reflex from Greenshire License Company for a little over $32 million. This software had been developed by a small group led by Jonathan Ingram and Gerard Gartside who had earlier been involved with other modeling packages including RUCAPS and Sonata.

Sonata had been sold to Alias Research in early 1992 but the marketing of this architectural design package never got off the ground and Alias discontinued sales of it before the year was over. Reflex was fairly new technology that had only been used on a few projects in England but PTC believed that it could be the foundation for a comprehensive process plant and building design product line.[34]

Pro/REFLEX was launched a few months later. Like many other new software packages introduced by PTC, this product had fairly limited capabilities at first with its main purpose to collect feedback from potential users. Pro/REFLEX Release 2.0, a more productive suite of software modules, was released in mid 1967. For the most part, Pro/REFLEX focused on the visualization of architectural models.

A key component of this software was Pro/REFLEX VEL (Virtual Element Language) which could be used to create object oriented modeling elements. These elements could be displayed in different representations depending upon the context of their use, for example as a three-dimensional object in a plant model or as a two-dimensional schematic in a flow diagram. The software was only available on SGI UNIX workstations with a Windows NT version promised for late 1997.

In retrospect, PTC paid far too much for the relatively immature Reflex software and grossly underestimated the effort it would take to create a competitive architectural and plant design product line. This is unfortunate, because at the time, PTC had the financial resources to become a major factor in this market and Intergraph, the largest vendor of plant design software at that time, was going through some difficult changes in its own business.

The company took a charge against income of over $32 million in fiscal 1996 related to this acquisition or basically what it had paid for Reflex. Pro/REFLEX never got off the ground and PTC eventually sold the Reflex technology to a Texas-based design-build firm, The Beck Group, where today it forms the core of DESTINI, or DESign ESTimating Integrated INITiative.[35] A number of the PTC people involved in this effort went on to start Revit, a developer of architectural modeling software subsequently sold to Autodesk.

PTC and Pro/ENGINEER mature

In early 1997 PTC launched Pro/ENGINEER Release 18 with significant enhancements to the software's user interface. When Pro/ENGINEER first shipped in 1988, its user interface was state-of-the-art with nearly all interaction done via on-screen menus. For many tasks, the user would select a text item on a menu that would then cause a second menu to appear and sometimes a third. As subsequent software releases were produced, more and more functions were added to this cascading menu scheme and on

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[34] One result of this meeting in Waltham, MA was that PTC contracted with me to produce a report describing the technical requirement for a process plant design system, the typical customers for this software and the competitors they would be facing when they entered the market.

[35] http://www.laiserin.com/features/issue16/feature01.php

occasion, the individual command the user was looking for might have been six or seven menu levels deep. In most cases, to select alternate commands required the user to step back up this menu chain, one level at a time.

By 1997, competitive systems provided more streamlined user interfaces than did Pro/ENGINEER. PTC recognized the need to change its software to conform with these newer industry techniques and Release 18 represented a start in this direction. According to Dick Harrison, Release 18 represented about 25 percent of what the company planned to do in this area and that Release 19, expected later in 1997, would contain the remainder of the planned changes.

By early 1997, over 25 percent of PTC's sales volume was Windows NT based and in many cases the Windows NT version of the software outperformed the same software running on UNIX workstations. Because of the large portion of its sales volume that was UNIX based, PTC was limited in the extent to which it could adopt Windows user interface standards.

Release 18 also included a new application, Pro/TOOLKIT, that was a significant enhancement to PTC's earlier user development program, Pro/DEVELOP. Pro/TOOLKIT enabled the developers of third party software to write to the Pro/ENGINEER database as well as read that data as was the case with Pro/DEVELOP. At this point, the Internet was staring to take on increased importance and PTC responded with Pro/WEB PUBLISH which enabled Pro/ENGINEER users to generate output that could be viewed with most Web browsers.

Pro/INTRALINK - A new approach for managing design data

PTC's customers had been searching for some time for software products that could effectively manage the mountains of information Pro/E produced. Enterprise solutions from companies such as Sherpa and Metaphase involved an excessive amount of custom programming and it was taking as much as four or five years to install some of these systems. By the time they were up and running, the business environment had often changed. Department level solutions such as those offered by Workgroup Technology and Adra, on the other hand, failed to solve the enterprise-wide problems many large companies wanted to address. PTC's own attempts in this area, Pro/PROJECT and Pro/PDM, had also fallen far short of what users were looking for.

Around mid-1995 PTC realized that its customers needed better data management tools than were currently available and if PTC could provide these tools, it would result in substantial incremental business for the company. The first step was to develop an information-oriented programming environment. Known internally as "Delta," this Java-like application programming interface (API) supported over 600 different functions.

PTC used Delta to develop a new client/server data management solution called Pro/INTRALINK which handled traditional product data management (PDM) functions, configuration management and software source control. Introduced in mid-1997, Pro/INTRALINK managed these tasks using a combination of a shared and local databases. The shared database (COMMONSPACE) which was based on Oracle software, was responsible for tracking all design iterations, relationships and configuration information while the local databases (WORKSPACE) enabled each user to work independently. Tools were provided which enable each user's WORKSPACE to access data in the COMMONSPACE and to provide information for updating that shared

database. For the most part, Pro/INTRALINK functions were performed transparently to the user. Simply saving a design file updated the WORKSPACE database and closing a design session updated the COMMONSPACE.

When PTC reviewed the status of PDM implementations among its users, one of the issues that came through loud and clear was that these organizations were spending an inordinate amount of effort linking various systems together within their organizations. The company realized that one way out of this dilemma would be to use intranet and Web technology to eliminate most of the effort required to link the desktop Pro/ENGINEER user to enterprise databases and to provide access to this information for others within the organization who typically used a wide variety of PCs and workstations.

Pro/INTRALINK established an operating environment so that whenever a Pro/ENGINEER object was saved, the WORKSPACE database was updated with all relevant information. Part of this process resulted in creating small bitmap images (what we call thumbnails today) of the objects being stored in the WORKSPACE. When users browsed through their WORKSPACE, these bitmaps were displayed nearly instantaneously, greatly facilitating finding what the user was looking for.

The initial implementation of Pro/INTRALINK supported most UNIX workstations and Intel and Digital Alpha versions of Windows NT for both the server and client software. The client software was also supported on Windows 95.[36] One negative was the high cost of this software. Pro/INTRALINK's list price was $5,000 and PTC recommended a copy of the software for each Pro/ENGINEER seat. Obviously, quantity discounts were available and it is unlikely that many companies paid list price for any significant number of licenses.

Unfortunately, software to easily move legacy data from Pro/PDM to Pro/INTRALINK was delayed until well into 1998 and it took some time before Pro/INTRALINK contained all the basic data management functions Pro/PDM had.

PTC acquires Computervision

By 1997 it was obvious to PTC and most other people in the industry that data management was taking on an increasingly important role. Walske and Harrison felt that they could jump start PTC's involvement in this growing market by either acquiring or merging with another company. They held some fairly serious discussions with Netherlands-based Baan Company. That summer, Russ Planitzer, Computervision's CEO, met with Walske and Harrison and proposed that PTC consider acquiring the company's CADDS business unit. They countered that it might be better for PTC to acquire all of Computervision.

To put this in perspective, PTC's growth rate in the latter part of 1997 had slowed to 30 percent, about half what it was a year earlier. In the relatively short time span of less than a decade, however, the company had become the dominating vendor in the CAD industry, predominately on the strength of its geometric modeling capabilities. At the time it appeared that traditional software prices were about to come under intense pressure and the industry was starting to consolidate.

Dassault Systemes had acquired SolidWorks and EDS and Intergraph had announced that they were going to merge their mechanical design software activities. *Engineering Automation Report* took the position that PTC needed to broaden its sights

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[36] *Engineering Automation Report*, June 1997, Pg. 1

and spend some of its $500 million nest egg on a significant acquisition. The one they selected surprised most industry observers and it turned out to have an even more surprising result for PTC.

In October 1997 I was invited to Computervision's headquarters in Bedford, Massachusetts to preview a new mid-range software package called DesignWave (see Chapter 12). The package was to be introduced at AUTOFACT in Detroit that November and I wrote an article about this new software for the November 1997 issue of *Engineering Automation Report* which was widely distributed at the conference. I was in a fairly crowded briefing room for Computervision's formal introduction of DesignWave at 9:00 AM on November 4th when Wayne George, the company's marketing manager for DesignWave, walked into the room and announced: "And at eight o'clock this morning, Computervision announced that it was being acquired by Parametric Technology Corporation." With that simple statement, he terminated the press conference and all discussion of DesignWave.

PTC agreed to pay $490 million for Computervision, $260 million in stock and the assumption of approximately $230 million of debt. Computervision was close to bankruptcy with its bonds selling at about 50 percent of face value. PTC also assumed Computervision's outstanding lease obligations. This turned out to be more costly to PTC than the company probably expected. In announcing the acquisition, PTC stated that about 500 of Computervision's 1,200 employees would be terminated upon completion of the acquisition.

Computervision's sales had been dropping precipitously but were still in the $350 million range on an annual basis.[37] Paying 1.4 times revenue for a company with an excellent group of customers and some reasonably good technology was probably not unreasonable. The question was how well PTC would integrate the personnel, software products and customer base with its existing operations? Computervision's flagship design software at this point was CADDS 5. By 1997 it was being sold predominately on Sun Microsystems workstations although the company had a large installed base of legacy proprietary systems. Computervision had also picked up a number of other software products over the years including MEDUSA, VersaCAD, Calma's DDM and DIMENSION III, and packages for mapping and electronic design. The software products in the latter two areas had already been sold off by the time PTC got involved.

The primary reason PTC was initially interested in Computervision revolved around the latter company's work with large organizations to implement what it called Electronic Product Definition (EPD). This involved a combination of design and manufacturing software (CADDS 5), assembly management (CAMU or Concurrent Assembly and Mock-Up) and product data management (OPTEGRA) as well as strong consulting support to help make it happen.

In spite of aggressive sales efforts on the part of its competitors, Computervision had managed to retain an impressive list of key EPD accounts including Airbus Industries, Rolls Royce Aircraft Engines Group, Fiat, PSA Peugeot Citroen, General

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[37] The acquisition of Computervision was accounted for as a "pooling of interest." As a result, PTC subsequently combined CV's historical financial results with its own which somewhat distorts the company's reported results. For the purpose of this book, I have chosen to use the company's financial results as they were originally reported since this provides a clearer picture of PTC's growth, especially during the 1990s.

Electric, and Raytheon. PTC had long wanted to duplicate what Computervision had accomplished with these major accounts. The company had particularly struggled in the PDM area and adding Computervision resources was expected to be particularly useful in building its large account business. Optegra was expected to provide an enterprise PDM capability to complement the department-level software PTC was currently selling.

CADDS 5 differed from Pro/ENGINEER in that it supported hybrid modeling (wireframe and surfaces and well as solids) and explicit design in addition to parametric design. It was good software that had not received the attention it perhaps deserved because Computervision's financial problems seemed to overwhelm technical issues in the minds of prospects. In the short term, PTC planed to continue CADDS 5 development and stated that they might even expand the effort. The company also planed to develop a direct translator between CADDS 5 and Pro/ENGINEER. At the time, my observation was that within a few years, the two product lines would begin to share technology and perhaps even start to blend together as a single product suite. This is what happened a few years later when Unigraphics Solutions acquired SDRC and its I-DEAS product line.

One major issue was whether PTC would follow through with the release of the recently announced DesignWave software since it would compete directly with PTC's PT/Products mid-range CAD/CAM suite. Another unknown at the time of the announcement was what would happen with new Internet-oriented PDM software being developed by a company called Windchill Technology which CV had been funding. The latter organization, located in Minneapolis, was founded in October 1996 by ex-Metaphase personnel including Jim Heppleman. Windchill would eventually form the basis of a new generation of PDM tools for both Computervision and PTC users.

My conclusion at the time was that if someone like PTC had not come along, it was questionable if Computervision would have been able to survive on its own. Once some organizational redundancies were eliminated, the acquisition was expected to be a profitable move for PTC. I thought it would be particularly beneficial for customers who were using both CADDS 5 and Pro/ENGINEER or companies that were still using CADDS 4X and had been reluctant to upgrade or switch to a new vendor. Between the two companies, they had over 190,000 seats of high-end design software installed at over 20,000 customers. It was an impressive presence in this rapidly evolving industry. The acquisition of Computervision was completed on January 12, 1998.

Windchill changes PTC direction

By early 1998, some aspects of PTC's acquisition of Computervision were starting to take shape. For PTC to regain its sales growth momentum it was becoming increasingly obvious that the company had to become the primary engineering and manufacturing technology provider to large global enterprises, particularly those in the automotive and aircraft industries. Computervision provided entry to a number of large accounts such as Airbus Industries[38], enabling PTC to compete more effectively with the other global enterprise vendors including Unigraphics, Dassault and SDRC.

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[38] In 2006, the French portion of Airbus was still using CADDS 5 software to design about 75 percent of the Airbus 380. The German operation was using CATIA V4 for the balance of the aircraft. In a conversation with Dick Harrison in July 2006, he stated that one of the reasons Airbus was having problems with the 380 was the lack of mockup software in Germany as compared to the former Computervision software the company was using in France.

To pursue this market, PTC planed to establish a large account sales and support organization based on a similar setup that has been particularly successful at Computervision. This group was assigned the task of focusing on the top 20 accounts the combined company then had and it reported directly to PTC's top management.

In a financial conference call in January 1998, the company made it obvious that the most significant development expected at PTC during the next several years would be increased emphasis on Product Information Management (PIM) solutions.[39] In the short term, Pro/ENGINEER users would be sold Pro/INTRALINK while the CADDS 5 users would continue to use Optegra for these applications. PTC already was talking about tying this all together with new technology being developed by Windchill. Steve Walske described Windchill as "a diamond in the rough."

Prior to completion of the acquisition, Jim Heppleman visited PTC and described to Harrison and others Windchill's development strategy. They became intrigued with the ideas Heppleman was proposing and subsequently bought the portion of the company not owned by Computervision from Windchill's founders and employees and it became a subsidiary of PTC. Walske's reaction was "its better to be lucky than smart."

Key Windchill developers including John Gibson, Jim Schoenberg and John Houston stayed with the group while Jim Heppleman, Windchill's chief technical officer, became a senior vice president at PTC. Jim Baum, a senior vice president who had been heading up PTC's PIM activity, retained responsibility for Pro/INTRALINK and the data management elements of Computervision's Optegra line. Wayne Collier, writing in *Engineering Automation Report* commented: "The full price Parametric paid for Computervision seems validated: besides the CV customer base, it has acquired a technical jewel in Windchill."[40]

Two Windchill products were then in development. NetFactor was a broad Web-based Java software environment with vaulting, document management, life cycle management and workflow capabilities. Product Center was a series of vertical applications such as change control and configuration management. Computervision had been beta testing this software at some of its major accounts prior to the completion of the acquisition. PTC planed to add some of its customers to the beta program and to release the software in June 1998.

By itself, the Windchill software was an interesting development. What was even more interesting, however, was PTC's description of this technology as laying the foundation for the company to potentially move into the Enterprise Resource Planning (ERP) market. According to *Engineering Automation Report*:

> "This is an intriguing thought. Most ERP vendors, such as SAP, Oracle and J. D. Edwards, approach ERP from a financial perspective. PTC, on the other hand, will come at it from a product design and PDM perspective."[41]

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[39] In 1999, PTC began using the term Collaborative Product Commerce or CPC. Around 2001 the term changed to Collaborative Product Development or CPD. This was short lived and in 2002, PTC, as other industry vendors already had, began using PLM which stands for Product Lifecycle Management.

[40] Collier, Wayne, "Parametric Lays Siege to the ERP Fortress," *Engineering Automation Report,* March 1998, Pg. 13

[41] *Engineering Automation Report*, February 1998, Pg. 5

PTC executives felt that over the next several years the company's business could split one-third CAD and two-thirds information management. Walske repeatedly stated that the mechanical CAD business was becoming a lower-growth industry and that the future was in managing design information, not just in creating it. One example of the new emphasis the company placed on this area was the setting up of a separate sales force to promote information management software products and services. Initially, it had about 30 dedicated sales representatives with 60 to 75 planned by the end of mid-1998. Several months later, at the Kalthoff International User Forum in San Diego, PTC marketing personnel were talking in the context that the ERP market was 30 times the size of the PDM market and more than four times the size of the entire CAD industry.[42]

During the conference call mentioned above, Walske was asked what would happen with Computervision's new DesignWave mid-range package which had been introduced the same day the acquisition was announced. Walske reiterated his previously stated concern that he was not convinced that there was a substantial mid-range market.[43] In spite of this concern, Walske planned to provide increased funding for the development and marketing of DesignWave and give the team responsible for it an opportunity to prove him wrong.[44]

In the first quarter of calendar 1998, PTC reported revenues of $264 million, up just 6 percent from the prior year's $250 million. Earlier results were restated to include Computervision's numbers. It was immediately obvious that although PTC was seeing a jump in revenues due to the acquisition, Computervision's business was continuing to decline, offsetting gains in the sale of Pro/ENGINEER.[45] In spite of this, PTC was now the first billion dollar CAD software firm.[46]

The future looks bright -temporarily

Release 19 marked a significant change in Pro/ENGINEER development strategy. Previously, PTC promoted the fact that it was able to grind out a new release of software every six months. This pace slowed down with Release 19 and the company switched to a ten month upgrade cycle with beta test sites receiving new software about six months prior to its general release. While this was less frequent than before, it was still better than what most competitors were able to do. Much of the user interface change originally scheduled for Release 19, however, were postponed to Release 20.

One area where PTC was moving slowly was incorporating Pro/DESIGNER into the Pro/ENGINEER product suite. Three years after acquiring CDRS from E&S, this software was still being sold as a separate product with its own icon-oriented menu structure and separate database. While surface geometry could easily move from Pro/DESIGNER to Pro/ENGINEER, if a surface geometry change needed to be made, that had to be done in Pro/DESIGNER and the data translation repeated. Workable but awkward.

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[42] *Engineering Automation Report*, April 1998, Pg. 9
[43] To some extent this sounded similar to statements attributed to Ken Olsen, CEO of Digital Equipment Corporation, who described the PC as a passing fad.
[44] *Engineering Automation Report*, February 1998, Pg. 5
[45] *Engineering Automation Report*, May 1998, Pg. 15
[46] Intergraph was also a billion dollar company but a significant portion of its revenue was from the sale of computer hardware.

By mid-1998, PTC seemed to be doing all the right things necessary to take the company to the next level of technical and business accomplishment. In general, the integration of Computervision into PTC's operations was going well with a number of senior Computervision employees taking on comparable rolls at the combined company. Fairly quickly, PTC decided not to run the Computervision operation as a separate business entity but to combine it all into a single integrated organization.

John Stuart, PTC's senior vice president of marketing stressed to *Engineering Automation Report* that former Computervision products such as Medusa and CADDS 5 would continued to be actively supported and enhanced. The plan was good but the details were in its execution and as described below, things did not always work out as the company expected. PTC was on target to do about $1.16 billion during fiscal 1998. That made PTC the largest company in the CAD industry and the fifth largest independent software firm in the world in terms of revenue. The company now had over 4,700 employees.

PTC was far from finished making acquisitions. The next business entity the company was interested in turned out to be the ICEM Technology division of Control Data Systems which it purchased for $40.6 million in cash. This Frankfurt Germany-based operation developed and marketed some excellent surface geometry and reverse engineering software (ICEM Surf) used extensively in the automotive industry at accounts such as Audi, BMW, Ford and General Motors.

The challenge for PTC was to take the best of the surface geometry capabilities in Pro/ENGINEER, Pro/DESIGNER (ex-CDRS), CADDS 5 and ICEM and blend them together. ICEM never seemed to fit into the company's MCAD business model and in mid 2002 the business, which was still doing a little over $11 million annually, was sold to its management for $10.6 million or one times revenue.

Windchill was where most of the excitement was in mid-1998. To put this interest in perspective one needs to realize that most of the early commercial PDM and ERP solutions had been implemented on mainframes or minicomputers. This was followed by a switch to client/server computing where a great deal of effort went into providing software that would run on a variety of client and server platforms: PCs, UNIX, Macintosh, etc. Most of these systems were difficult to implement due in part to customers constantly changing the platforms they wanted supported, especially client (desktop) machines. Many users ended up spending more on implementation services than on the software itself. One result was that numerous companies never got out of the pilot stage and those who did, found their systems difficult to adapt to changing business requirements.

One indication of the extent to which PTC's management was getting carried away with Windchill in mid-1998 was a statement by Walske that in three years (i.e. 2001) the PDM area would generate two-thirds of PTC's revenue.[47] It turned out to be more like 23 percent, a number that has only increased in the succeeding years to about 35 percent.

When the Internet and the World Wide Web became important technologies, most of the vendors of existing PDM and ERP systems adapted their products to the new environment with varying degrees of success. What set Windchill apart from nearly all its competitors at the time was that this software had been implemented from the start on the

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[47] Kempfer, Lisa, *Computer-Aided Engineering*, June 1998, Pg. 28

basis that it would take advantage of the new generation of Web-based software tools and concepts. PTC promoted the idea that this approach was far more effective than trying to add these new concepts to legacy information management solutions. The difference was that Windchill was Web-centric, not simply Web-enabled.

The overall Windchill concept used a three-tier architecture where the user communicated with the system through a standard Web browser such as Internet Explorer or Netscape Navigator. This led to an application layer which typically consisted of a standard Web server such as Microsoft Internet Information Server or Netscape Enterprise Server. The application layer fed HTML pages to the user's Web browser or downloaded Java applets to accomplish predefined functions such filling in a form or routing a document to another team member. The third tier consisted of the data itself which was stored in an object-enabled relational database such as Oracle 8.

The original NetFactor software module evolved into a product PTC called Windchill Foundation. It could best be described as the object-oriented glue that tied the three-tier architecture together and provided the starting point for either PTC or user developed applications. An enterprise license for Windchill Foundation was $250,000. The second building block was the Windchill Information Modeler, a $10,000 program that provided an application development environment. PTC also offered two applications, Windchill Document Manager priced at $800 per named user and Windchill Configuration Manager priced at $900 per named user. PTC claimed at the time that it had closed million dollar deals with Airbus and Sun Microsystems and had over 20 prospects for similar size deals.

It still was not clear how aggressively PTC planned to pursue the ERP market. Less than six months after first promoting that idea, the company seemed to be backing off its initial stance. I was still enthusiastic about the idea and wrote:

> "PTC comes to the ERP marketplace with an engineering design and product manufacturing mindset. The company appreciates that a bill-of-material for a design engineer looks a lot different than what it does to manufacturing or purchasing. A design-centric ERP solution will provide customers with a choice that they really do not have today. It might not be for everyone, but PTC's strategy will create a broader range of choices for the user community."[48]

Meanwhile, DesignWave remained in the company's product line and appeared to be getting more development and marketing support than it probably would have received under Computervision. PTC set up a separate business unit for mid-range systems with Jon Stevenson, who was the driving force behind DesignWave, as the senior vice president for this group, reporting directly to Dick Harrison. This business unit was also given marketing responsibility for the existing PT/MODELER package, over 15,000 copies of which had been sold by mid-1998. DesignWave was priced at $3,495 as compared to $2,995 for PT/MODELER.

Meanwhile, PTC had not forgotten Pro/ENGINEER. Release 20 went into pre-production testing in mid-1998 with a substantially new user interface that utilized a new

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[48] *Engineering Automation Report*, July 1998, Pg. 6

menu bar and other features users had become familiar with through their use of Microsoft's various Windows operating systems. Previously, PTC had developed UNIX
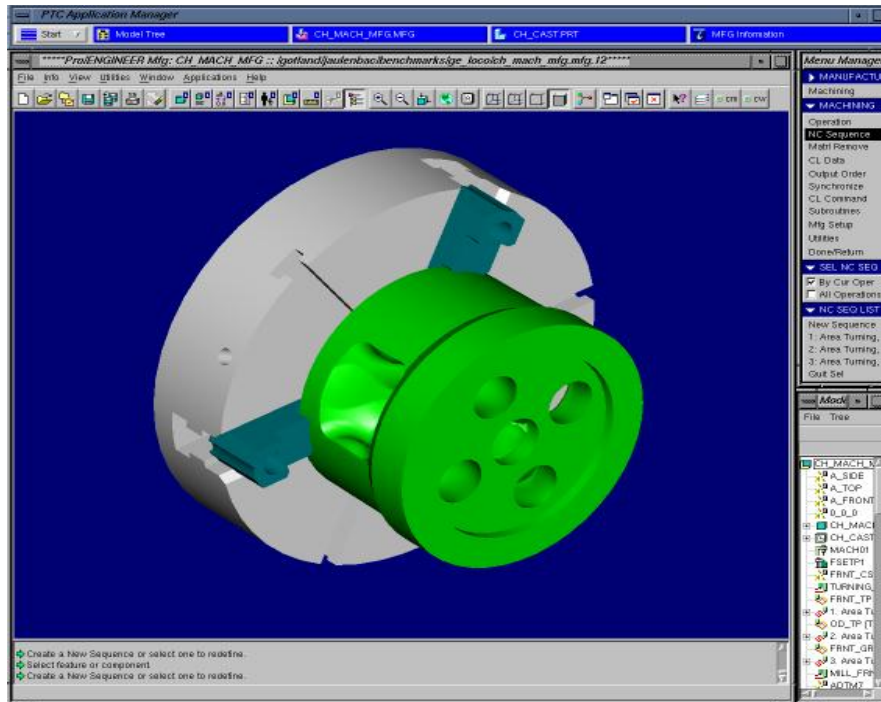

Figure 16.6
Pro/ENGINEER Release 20 with new user interface and updated sketching capability

versions of its software that were then ported to Windows but still looked like UNIX programs. With Release 20, this methodology switched and now Pro/ENGINEER looked more like a Windows program and that version was implemented on the UNIX workstations the company still supported.

Release 20 also incorporated a new sketcher called Intent Manager which facilitated the definition of constrained geometry. As the user sketched a 2D profile, the software automatically determined constraints and dimensions and displayed these on the profile. Another new capability was the ability to append notes to 3D models of parts and assemblies. When the user scaled or rotated the model, these notes retained their original orientation and were always visible to the user.[49]

A bump in the night

On July 1, 1998, PTC announced preliminary results for its third fiscal quarter ending June 30th that severely disappointed stockholders. For the first time in the company's history, quarterly revenues actually decreased compared to the prior year, from $249 million in 1997 to $245 million in 1998.[50] The company claimed that much of the shortfall was due to the delay in receiving a number of very large orders it had expected. A number of these did come in shortly after the quarter closed including

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[49] *Engineering Automation Report*, July 1998, Pg. 6
[50] These results included Computervision's revenue prior to the acquisition.

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several from long-time Computervision customers including Rolls-Royce Aero Engine which ordered $2.7 million of Pro/ENGINEER and Windchill software.

The next day, PTC's stock dropped 35 percent in value and before the month was over, it was down nearly 60 percent to $14.19 per share. This was the start of a long painful part of PTC's history, a phase it is still recovering from.

There were a number of factors impacting the CAD industry and PTC in particular in mid-1998:

- Mid-range systems had developed a level of geometric modeling and drawing productivity in just a few years that had taken PTC a decade to achieve. Many potential customers were satisfied with the capabilities these lower cost systems offered.

- Windows NT was becoming the technical operating system of choice. Over 50 percent of Pro/ENGINEER shipments were now for this version of its software. When someone paid just $4,000 to $6,000 for a high-end PC with excellent graphics, they were reluctant to shell out nearly $20,000 for software.

- Several years earlier, competitive products such as CATIA, Unigraphics and I-DEAS could not do what Pro/ENGINEER could. By mid-1998, these other packages had improved significantly and in some cases had progressed farther than Pro/ENGINEER. PTC had probably kept a lid on its R&D investment for far to long. The company's software was beginning to look somewhat out of date, especially in regards to its Windows based systems which had a UNIX look-and-feel until Release 20.

- Companies were increasingly focused on information management, not just design creation. IT solutions were a harder sell that took much longer to consummate. Unfortunately, Windchill was still a collection of technologies that required far too much effort on the part of customers to install and make part of the mainstream of their operations.

It was no surprise when PTC announced that it was restructuring its 900-person sales force. After acquiring Computervision, it became apparent to PTC that its historical "one size fits all" sales management model would no longer work, particularly for large strategic accounts. As a result, the company switched to a four tier sales structure, each with its own management organization.

Major Accounts – A separate sales organization with about 100 account managers was set up to pursue business with the company's 300 largest accounts and potential prospects. The Major Accounts sales people were responsible for all PTC products at these accounts.

Primary Accounts – The bulk of the sales force continued to be assigned territory responsibility for selling Pro/ENGINEER and related software products and services. Explicitly excluded, however, was the Windchill product line.

Windchill – PTC continued to focus on building a sales and support staff specifically chartered to go after Windchill PLM business, both within the existing Pro/ENGINEER user base and at accounts that were using competitive design systems. A typical Pro/ENGINEER user had to deal with two sales people, one handling Pro/ENGINEER and the other Windchill.

Small Accounts – When PTC first started, a high percentage of its sales was through various types of resellers. By 1996, this had dropped to 10% of the company's revenue and, as noted earlier, PTC changed its reseller agreements such that these companies were no longer able to sell Pro/ENGINEER but were limited to PT/Modeler. The one exception was Rand Technologies which continued selling Pro/ENGINEER to its existing customers. In a major move, PTC and Rand signed a multi-year agreement under which Rand became the master distributor for all PTC products except Windchill in North America and Europe for all companies with less than $10 million in revenues.

Engineering Automation Report commented:

> "… the agreement with Rand is significant in that a single monolithic sales organization typically has problems selling individual copies of different software products to small companies while at the same time trying to develop meaningful long-term relationships with large global enterprises. Rand, itself, will use an additional tier of resellers or 'business partners' as they refer to these smaller vendors. PTC sales personnel who had been targeting smaller accounts will be reassigned to the other three organizations while we expect that Rand will undertake a substantial staff expansion in coming months. In addition, the 100 or so independent resellers who have been selling PT/Modeler and DesignWave will continue to do so, but it is still unclear as to how much effort PTC will put into expanding this group."[51]

One result of the restructuring was that PTC laid off over 300 people from its sales and marketing organization during the first half of fiscal 1999. On the other hand, the company began expanding its professional services organization (PSO). By the end of fiscal 1999 the company had nearly 5,000 employees.

This was far from the last time PTC would reorganize its sales organization as it strove to find the combination that would get it back on a growth track. The agreement with Rand was changed several times. First, the limit was increased to $50 million, then the exclusivity was removed and Rand was authorized to sell to all businesses except PTC's 200 largest accounts. The relationship between the two companies continued to be rocky and by 2003, Rand was just about out of the business of reselling Pro/ENGINEER and was becoming an affiliate of Dassault Systemes reselling CATIA.

Getting back on track

One of the first steps PTC took to regain its earlier growth momentum was to drop the PT/Products software including PT/Modeler and to replace them with a product called Pro/ENGINEER-Foundation. For just $5,995, a customer received full-function Pro/ENGINEER software capable of part and assembly design, drawing production, bill-of-material generation, photorealistic visualization and data translation. Unlike PT/Products, customers could upgrade the Foundation package with any of PTC's other application programs. Existing PT/Products users were allowed to upgrade to Foundation or DesignWave at no cost.[52]

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[51] *Engineering Automation Report*, August 1998, Pg. 1
[52] *Engineering Automation Report*, September 1998, Pg. 10

No sooner had the dust settled on the Foundation announcement then PTC launched Pro/DESKTOP, built on DesignWave but with an internal model topology similar to Pro/ENGINEER. This was intended to enable better data movement between the two packages. The vehicle for doing this was called the Associative Technology Bus (ATB). It enabled the two packages to share geometry and topology without having to translate models from one database to another. Pro/DESKTOP, priced at $3,495 per license, could open Pro/ENGINEER files directly and use these models as if they were created in Pro/DESKTOP. The plan was that in early 1999 Pro/ENGINEER users would be able to do the same thing with Pro/DESKTOP and CADDS 5 models. DesignWave as such, ceased to be product.[53]

In early 1999, PTC's Windchill strategy was becoming somewhat clearer. The company was beginning to appreciate the extent to which Windchill customers needed technical and business management support in order to use Windchill effectively. PTC had inherited a substantial consulting services organization when it acquired Computervision, but this group was insufficient to meet the total demand for such services. The company began working with outside management consulting firms to provide these services, initially Computer Sciences Corporation, Price-Waterhouse and Anderson Consulting (Subsequently renamed Accenture) .

PTC's Windchill group recognized three principals that influenced the company's broad concept of PDM:

- First was the concept that within a large organization, a single data structure or schema could not meet the requirements of all the individual groups in the enterprise.
- The second principal was that an enterprise-wide information system could best be implemented using Internet and Web standards.
- The third principal was that most companies did not want to replace their existing data management solutions. Instead they wanted to implement Windchill as an umbrella technology, install enterprise-wide applications, and then link existing commercial and custom applications to the Windchill infrastructure.

This was a complex message that PTC had a hard time communicating to potential customers, partially because it was an enterprise-wide IT message and most of PTC's sales personnel were more comfortable talking about product design to engineering management. In spite of this, by late 1998 there were already 50 pilot Windchill projects. One major problem was getting companies to move from the pilot stage to full enterprise-wide rollout. A subtle change was going on in the development associated with Windchill in that an increasing amount of resource was being applied to the development of specific applications such as product configuration, manufacturing process planning and supplier management. Also, the company was talking less about pursuing the ERP market and more about interfacing to leading ERP packages.[54]

Acquisition pace continues

PTC was not finished making acquisitions. In October 1998 the company acquired InPart Design, the developer of DesignSuite, a web-based information service

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[53] *Engineering Automation Report*, December 1998, Pg. 10
[54] *Engineering Automation Report*, January 1999, Pg. 6

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intended to be a repository of three-dimensional mechanical part data. InPart created its library of component data using Pro/ENGINEER and distributed this information in Pro/ENGINEER, IGES, STEP and AutoCAD DXF formats. Customers used a proprietary client program to retrieve component outlines that could be incorporated into CAD assembly designs. PTC paid for InPart with 600,000 shares of stock worth about $38 million at the time.

On January 21, 1999 the company announced plans to acquire the Division Group, a vendor of visualization, simulation and integration tools for approximately $48 million in stock and cash. This was about 4.5 times Division's then current revenues. Based in Bristol UK, Division originally developed and marketed toolkits that facilitated the implementation of virtual reality-like visualization software. In the two years prior to the acquisition, the company changed its focus and began selling actual applications such as dV/MockUp, a virtual prototype and visualization package.

In September 1998, Division had announced the planned acquisition of ObjectLogic, a small software firm in San Diego. This deal closed in March 1999. PTC subsequently offered that company's primary application as dV/ProductView. This latter package enabled users to view, markup, and circulate product data generated on a wide range of CAD systems with conventional Web browsers.

The press release sent out by PTC mentioned the future opportunities the company saw in integrating Division's applications with PTC's Windchill technology. *Engineering Automation Report* commented:

> "We also see an interesting opportunity that was not mentioned. That is the integration of dV/MockUp and dV/ObjectLogic with the Concurrent Assembly and MockUp (CAMU) software PTC obtained through its acquisition of Computervision early last year. We have not heard much about CAMU from PTC recently, but it was one of CV's best jewels. Between the Division software, Windchill, and CAMU, PTC has the basic building blocks to offer customers an integrated assembly management solution that is independent of the CAD system used to create individual part models."

This never happened the way I expected.[55]

The third acquisition was auxilium, a vendor of Web-based information management development tools used to integrate legacy databases and application programs. The price for this deal which was also completed in March 1999 was nearly $102 million.

Windchill and Pro/ENGINEER continue to evolve

By the spring of 1999 PTC claimed to have 200 Windchill installations of which 10 to 15 were considered production sites. Later that year the company began comparing Windchill revenue during the first four quarters it was on the market to Pro/ENGINEER revenues during its first four underlined years. During its fourth year Pro/ENGINEER generated $45 million in sales while Windchill generated $40 million in its fourth quarter.

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[55] *Engineering Automation Report*, February 1999, Pg. 5

PTC changed its naming of Pro/ENGINEER releases with what was expected to be Release 21. Instead the company decided to switch to a year nomenclature and the software became Pro/ENGINEER 2000i where the "i" stood for "interoperable." The most significant aspect of 2000i was a new technology called "behavior modeling." Sold as the Behavioral Modeler Extension it was priced at $4,995.

As an example of behavioral modeling, if the user wanted a part to have a set volume and needed to minimize its surface area, the user would define which parameters (dimensions) could be changed, the range that they could be changed in, and the number of iterations permitted. The system would then iteratively change the model to meet the criteria that were to be minimized or maximized. Although this might have taken several hours on a 1999-era workstation, manual trial and error could have taken days.[56]

Other 2000i enhancements included an expanded version of the Associated Topology Bus or ATB. As initially developed, it enable Pro/ENGINEER users to import geometry from older legacy systems such as CADDS 5 and CATIA V4. This software imported the basic geometry into Pro/ENGINEER but not feature definitions and constraints. The geometry could subsequently be incorporated into Pro/ENGINEER models and manipulated as if that software had created it. If the part was subsequently changed in the originating systems, those changes would flow through to the new Pro/ENGINEER model.

Pro/ENGINEER 2000i was followed up a few months later with Pro/MECHANICA 2000i. Since being acquired by PTC, the Pro/MECHANICA software was associative with Pro/ENGINEER models but the new 2000i version operated directly on Pro/ENGINEER models instead of converting them into its own format. This was accomplished using PTC's ATB which was also used to communicate with other PTC i-series programs.[57]

One change in 2000i that caused other software firms substantial grief was the change from ASCII coded data in Pro/ENGINEER files to binary coded data. This reduced the size of most Pro/ENGINEER files by about 50 percent but made it much more difficult for other software packages to read the data unless they used PTC supported application programming interfaces. One problem with the latter approach was that it required an active Pro/ENGINEER license in order to use the software.[58]

About this point in time, one had to wonder if PTC simply had too many products on its plate as the result of all the acquisitions it had made during the prior several years. On top of that issue, Windchill activity was changing the nature of the company. By mid-1999, PTC had over 800 people dedicated to Windchill, nearly 300 of whom were developers. This is not to say that PTC was ignoring other products. The ICEM Technologies subsidiary, which PTC had acquired in 1998, was now responsible for the CDRS and 3D PAINT packages also. In August 1999 new versions of the ICEM, CDRS and 3D PAINT software were released that had improved capabilities for transferring surface data to and from Pro/ENGINEER 2000i. One reason for operating ICEM Technologies as a separate business was that there were many users of this software who used CAD tools from vendors other than PTC and this level of independence was necessary in order to maintain that revenue flow.

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[56] *Engineering Automation Report*, April 1999, Pg. 4
[57] *Engineering Automation Report*, June 1999, Pg. 9
[58] *Computer Aided Design Report*, October 1999, Pg. 9

The new ICEM Technologies software releases also used the 2000i nomenclature as did new software from Division. This included new versions of DIVISION Product View and DIVISION MockUp (previously called dv/Reality). It appeared as if PTC was planning on competing with Engineering Animation Incorporated for the high end visualization business in the CAD market. Towards the end of 1999, PTC repositioned Pro/DESKTOP once again, this time as a conceptual design front-end to Pro/ENGINEER. Priced at $3,495, PTC claimed to be selling several thousand units per quarter.

By the last quarter of fiscal 1999, PTC seemed to be getting its growth back on track. Revenue was up 12 percent compared to the prior year to $280 million with earnings of over $50 million before consideration of special charges associated with the company's acquisition spree. This would turn out to be the company's high water mark. During the last quarter of calendar 1999, PTC's overall revenues slipped once again, down 4 percent compared to the prior year to $239 million. Windchill-related revenue was over $38 million compared to just $5 million for the same quarter a year earlier. This meant that revenue for Pro/ENGINEER and other design-related packages was just $200 million compared to about $245 million the year before.

There were probably several reasons why PTC was struggling with the MCAD portion of its business:

- Competitive mid-range solutions such as SolidWorks and Solid Edge could now handle much of the work that previously required heavy duty software such as Pro/ENGINEER.
- The company's constant reorganizing of its field sales force had adversely impacted PTC's ability to close business. The size of the company's direct sales force was about 10% below where management wanted it to be at the end of 1999.
- Sales to smaller customers through Rand Technologies meant that PTC received less revenue per sale.
- Finally, the company's focus on Windchill may have taken management's eye off the CAD market.[59]

The problems with the MCAD market did not seem to really bother PTC's management as it focused much of its resources on its Windchill activity. As clearly stated in the company's 1999 10-K Report:

"We are incurring expenses that would support revenues in excess of current levels in order to implement our strategic initiatives, particularly as they relate to our Windchill solutions. Although these expense levels have adversely affected net income, we continue to believe that these initiatives will provide a foundation for future growth."[60]

The 21st century - A changing business environment

In early 2000, PTC stopped referring to itself as Parametric Technology Corporation and began simply calling itself PTC, although legally it was and still is

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[59] *Engineering Automation Report*, January 2000, Pg. 15
[60] PTC 1999 10-K Report, Pg. 10

Parametric Technology Corporation. Marketing material also starting referring to PTC as the "Product Development Company."[61] For the next several years, the company produced a series of Pro/ENGINEER releases that made product design easier and more flexible and speeded up assembly modeling as well as a continuous stream of new Windchill software modules.

Eleven months after Pro/ENGINEER 2000i was released, PTC launched 2000i^2 with a new Windows-compatible user interface. Rather than making its Windows software look like the UNIX version of Pro/ENGINEER, PTC made its UNIX-based software look similar to the Windows implementation, a fairly strong statement regarding what the company expected the majority of its customers to be using in the future. PTC also change the sequence in how operations were executed.
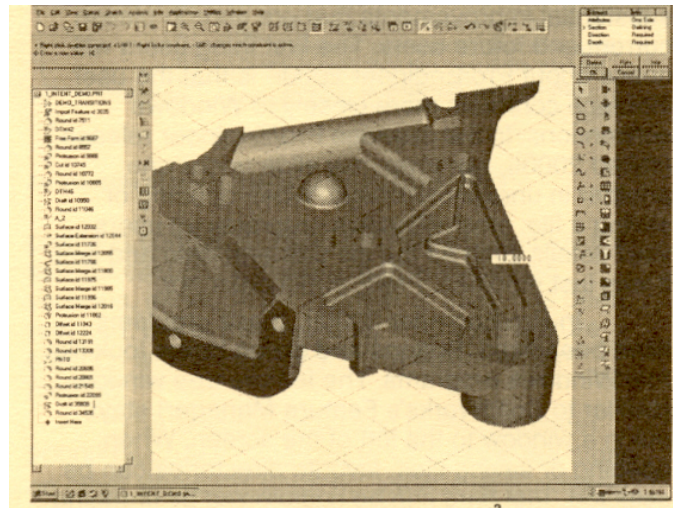

Figure 16.7
Pro/Engineer 2000i^2 with Windows-like User Interface

With previous versions of Pro/ENGINEER users selected an operation and then selected the geometry on which that operation would be executed. Starting with 2000 i^2, the sequence was reversed. Geometry was selected and then the operations to be applied to that geometry were initiated, much like other Windows applications. This release also incorporated substantial improvements in how sequences of features were regenerated as well as how geometry was created and edited. The *Computer Aided Design Report* was impressed with this release but felt that many of the improvements it contained should have been done earlier.

"It's unfortunate for PTC and Pro/E users that the train didn't leave sooner. Had Pro/Engineer's developers started working in 1994 on the kinds of improvements made to Pro/Engineer 2000i^2, its share of the CAD market would not now be declining and companies such as SolidWorks and Unigraphics Solutions would not be winning as much business at

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[61] In 2002 the new marketing term was "Product First." The theme was that "great products make great companies."

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PTC's expense. Moreover, 11 months between releases is too long in a world where competitors are turning out lists of improvements every six months."[62]

In the first quarter of the new decade, PTC's revenues slid 14 percent to $227 million and earnings on an operating basis were just about nonexistent. Other companies were not having similar problems. Autodesk's quarterly revenues grew by 14 percent during roughly the same period to $223 million. The stock market did not treat PTC's financial results kindly. During April 2000 the company's stock which had climbed back to $25.46 per share dropped to just $8.25. This coincided with the start of the massive decline in high tech stocks as the NASDAQ index slid from over 5100 in March 2000 to a low of 1100 in October 2002.

In June 2000, I wrote a front page article in *Engineering Automation Report* titled "PTC Faces the Biggest Challenges in its History." In addition to the issues mentioned above, I pointed out several other problems the company was facing.

- Large enterprises often considered Pro/ENGINEER to be under-powered for their needs when compared to CATIA or Unigraphics. This kept the company from gaining a more significant presence in large global companies.
- The acquisition of Computervision, Division, CDRS and other companies left PTC with a boatload of product integration issues. Resolving these problems probably took resources away from addressing some mainstream product and marketing issues.
- Although Pro/ENGINEER was credited by many with revolutionizing mechanical design twelve years earlier, some observers considered it to be old technology by 2000. In particular, the lack of surface defined modeling, what is typically called hybrid modeling, was seen as a weakness by automotive and aircraft manufacturers.[63]

The company soon took several steps to get things turned around. Dick Harrison replaced Steve Walske as CEO in April 2000 although Walske stayed on as chairman and "chief business strategist." This didn't last very long and Walske severed all management connections with PTC in June and was replaced as chairman by Noel Pasternak, a partner in a Boston law firm who has been associated with the company since its start. The company was restructured into three business units:

- Windchill and Web-based collaborative solutions under Jim Baum who previously was responsible for product development
- MCAD products and flexible engineering solutions under Jon Stevenson who had joined PTC with the Computervision acquisition
- Netmarkets, a new dot com initiative headed up jointly by Jim Heppelmann and Stacy Lawson. Lawson had joined PTC when it acquired the company she had founded, InPart.

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[62] *Computer Aided Design Report*, April 2000, Pg. 5
[63] *Engineering Automation Report*, June 2000, Pg. 1

At this point in early 2000, nearly everyone was still enamored with the Internet and the company was fond of quoting market research statistics that claimed Business-to-Business Internet activity would be as much as $1.8 trillion by 2003.[64]

In the June 2000 article I asked:

"The final question is whether Pro/ENGINEER still a competitive product. Ray Kurland, the president of TechniCom and a well respected industry analyst recently took a hard look at Pro/ENGINEER 2000i^2. His comments were that PTC had significantly improved ease of use, top-down design and sketching which now has good auto-constraint capabilities. Kurland particular liked the fact that the software's Behavioral Modeling function could now handle multiple objectives. It also can output data directly to an Excel spreadsheet when used on a Windows system. Engineers who understand how to work with Excel equations can perform some interesting tasks with the combination of the two programs.

"PTC is planning to incorporate the CDRS surface modeling software directly in the next release of Pro/ENGINEER. This will resolve perhaps the most serious problem facing PTC in pursuing automotive accounts. Overall, Kurland feels that Pro/ENGINEER is a very competitive product today and that the company just needs to get its sales act together."[65]

As mentioned earlier, one of the major reasons PTC acquired Computervision was to gain access to its customer base of large companies. On June 1, 2000, PTC announced one of the largest contracts it ever received, a $22 million order from Airbus for both mechanical design and Windchill software and services. Airbus had long been a key Computervision customer. In fact Computervision at one time had nearly 200 people in its Paris office, many of them assigned to support Airbus.[66]

By mid-2000, PTC had nearly 400 Windchill customers, of which 80 percent were either Pro/ENGINEER or CADDS 5 users. For fiscal 2000, PTC reported revenues of about $928 million, nearly $130 or 12 percent less than the prior year and the company had a loss of $4 million for the year compared to profits of nearly $120 million the year before.

The new three part organization structure announced earlier in the year didn't last until the end of the year. By November, PTC had combined the basic Windchill operation with the Netmarkets initiative into a single division with Jim Heppelmann in charge. Barry Cohen, who like Jon Stevenson had come to PTC as a result of the Computervision acquisition, became an executive vice president responsible for marketing.

In March 2001, PTC announce Granite One[67], a toolkit that provided third party software firms and customers access to the Pro/ENGINEER database. When initially announced, the perception was that Granite One was a geometric modeling kernel similar to Parasolid and ACIS. In reality, its primary use has been to extract data from the

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[64] PTC Fiscal 2000 Annual Report, Pg. 4
[65] *Engineering Automation Report*, June 2000, Pg. 1
[66] *Engineering Automation Report*, July 2000, Pg. 15
[67] For the most part, it is simply referred to as Granite today.

Pro/ENGINEER database for translation to other systems, for viewing or for analysis. Few applications have been developed that use Granite One for actually creating geometry.

Granite One had one specific advantage compared to industry standard translation tools such as IGES and STEP in that it provides the third-party software with accurate feature and associativity information. When this latter capability is turned on, a change in the Pro/ENGINEER model can flow through to an external program in the same manner that PTC's own applications exhibit bi-directional associativity.

Granite One was also used as the basic geometric building block for Pro/ENGINEER 2001 released in mid-2001. It incorporated an enhanced geometry creation and editing capability called "Direct Modeling" which enabled users to double click on a model element and then edit the dimension of that element directly in the graphics window. This release also provided the ability to compare two models in order to detect differences using the ModelCHECK software the company had earlier acquired from Rand.

Users could also create a derived model from a parent model. As an example, the casting an engine block is machined from differs from the final product in that it contains excess material that will subsequently be removed and does not include features machined into the block during manufacturing. Changes to the parent model are subsequently reflected in the derived model although the reverse does not occur.

Probably the most significant enhancement in 2001 was the incorporation of advanced surface geometry capabilities directly in Pro/ENGINEER as an option called Interactive Surface Design Extension (ISDX). No longer did CDRS users have to use one program to create sophisticated geometry and then import that geometry into Pro/ENGINEER. This integration of CDRS technology took much longer than originally planned, but once done, proved to be an effective design tool.

The major problem with Pro/ENGINEER was not its technical capabilities but how it was being positioned against products such as SolidWorks and Autodesk's Inventor. Although Pro/ENGINEER-Foundation was priced competitively at $4,995, to add the newest surface geometry capability cost $3,995 for ISDX plus PTC's Advanced Surface Design Extension which cost another $4,995. For all practical purposes, a typical seat of Pro/ENGINEER still cost nearly $15,000. PTC simply was not doing an adequate job of explaining to customers and prospects why its software was worth this type of premium.

The product strengthens but business continues to slide

In the July 2001 issue of *Engineering Automation Report*, David Cohn[68] wrote an excellent in-depth review of PTC. Some of the issues surrounding PTC at the time included:

- While the Windchill business had increased from $13 million in fiscal 1998 to $175 million in fiscal 2000, PTC's MCAD business had decreased from $1,018 million to $754 million during the same period.

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[68] David Cohn became Editor-in-Chief of *Engineering Automation Report* when Cyon Research purchased the newsletter in August 2000.

- The company had 250,000 seats of advanced design software installed at 30,000 customers. The top 30 accounts had more than 1,300 seats each but there were also 17,000 accounts that only had one or two seats.
- Two-thirds of PTC's revenue was now coming from service business including software maintenance as compared to less than 40 percent two years earlier.
- PTC had earlier been criticized for not spending enough on research and development. By fiscal 2000 it was spending 16 percent of gross revenues on R&D, up from just 9 percent two years earlier.
- Of the company's 4,700 employees, 2,800 were assigned to the MCAD products and 1,500 to Windchill. Likewise, of 600 sales people, 300 were devoted to MCAD, 200 to both MCAD and Windchill and 100 to just Windchill.
- PTC repackaged Windchill into more easily installable modules including Windchill ProjectLink (formerly Windchill Netmarkets) for collaborative project management and Windchill PDMLink for document management. ProjectLink was initially targeted at three specific groups of Internet-centric customers: manufacturers offering collaborative project portals, manufacturers offering private exchanges for design chain collaboration, and business-to-business public exchanges serving the manufacturing industry.

The article went on to describe PTC's extensive product line for product design, analysis, manufacturing, visualization, collaboration and data management.[69] As comprehensive as this product line was, the stock market was taking a dim view of PTC and the company's stock fell to a low of $3.97 during 2001. Things did not get any better the following year as PTC's stock fell to of $1.64 in 2002. In general, the companies revenues continued to spiral downward as shown in the following table (all numbers in millions) before finally turning up in fiscal 2005.

Fiscal Year	MCAD Revenue	Windchill Revenue	Total revenue	Earnings (Loss)
1997	$808	na	$808	$219
1998	$1,005	$13	$1,018	$106
1999	$976	$81	$1,058	$119
2000	$754	$175	$928	($15)
2001	$721	$214	$935[70]	($10)
2002	$547	$195	$742	($94)
2003	$484	$188	$672	($98)
2004	$482	$178	$660	$35
2005	$503	$218	$721	$84

During this period, PTC was being squeezed between the mid-range vendors such as SolidWorks and Autodesk and the high-end vendors such as IBM/Dassault and EDS

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[69] *Engineering Automation Report*, July 2001, Pg. 5

[70] In 2003, PTC was forced to restate its revenue for prior years which resulted in reducing previously reported revenue by $33 million. This was the result of incorrectly booking service revenue.

Unigraphics Solutions. The most serious competition was coming from the mid-range competitors who offered software packages that were easier to learn and use than Pro/ENGINEER although the latter offered a much broader range of optional modules.

PTC spent several years working on a new version of its software that would be easier to use. The result was Pro/ENGINEER Wildfire, released in early 2003. It incorporated an entirely new user interface paradigm that utilized an object/action methodology. Once an object was selected, the user was presented with a selected list of actions that could be applied to that object. PTC priced Wildfire to match the capabilities of mid-range competitors while allowing customers to add all the task-specific applications including Windchill that they might need. Within six months, over 25 percent of the Pro/ENGINEER installed base migrated to Wildfire.

According to Evan Yares in *Engineering Automation Report*:

> "PTC will be able to walk into any customer account and go head to head with its toughest competitors without having to hem and haw about the price. My guess is that we may start seeing a resurrection of some of the swagger that used to characterize PTC salespeople in days of old (although I'm thinking that the old days of unmitigated arrogance are thankfully gone.)"[71]

Although there were some bumps in the road, Wildfire did allow PTC to get its revenue growing once again. The company also changed its marketing pitch, emphasizing what it called the Product First Roadmap. First introduced in early 2002, its basic premise was that great manufacturing companies have great products and PTC was the software vendor that could help make this happen. Unfortunately, PTC's sales people had to run harder just to stay in place as the average sales price of a Pro/ENGINEER seat dropped to under $9,000 in early 2004 as compared to nearly $20,000 in 1997. Simply stated, they had to sell twice as many copies of software just to stay even. In this adverse environment, Toyota became the company's largest customer in fiscal 2003 in terms of license and service revenue.

Although PTC continually referred to Windchill as being the key to the company's future, the fact remained that at the end of fiscal 2003 only 2,100 of the company's 35,000 customers were using Windchill software. But that did not reduce the company's enthusiasm for PLM technology. It estimated that for every seat of design software, and there were over 300,000 Pro/ENGINEER users by then, there were 10 to 30 individuals who need access to that design data. At the extreme, that meant a potential market for nine million seats of Windchill software without taking into consideration organizations using non-PTC design software.[72] Perhaps part of the problem in expanding Windchill sales was an issue facing all PLM vendors. That was the fact that companies had not done a very good job of measuring the effectiveness of past product development processes and, as a consequence, had a hard time calculating the return on PLM investments.

Significant changes took place at PTC in 2003 and 2004. In 2003 the company set out to reduce its annual operating costs by $140 million. The direct sales force headcount

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[71] *Engineering Automation Report*, March 2003, Pg. 1
[72] PTC 2003 Annual Report, Pg. 12

was reduced while the number of resellers grew rapidly to about 270 with a total of nearly 1,000 sales representatives by the end of 2004. This reseller channel was responsible for $136 million of the company's total revenue and some were beginning to sell Windchill Link as well as Pro/ENGINEER. Overall PTC employment was just over 3,000 at the end of fiscal 2004, down from nearly 5,000 at the end of fiscal 1999. By the end of fiscal 2005, it appeared that the company was on track to slowly return to $1 billion plus in revenue, a level comparable with Autodesk, UGS and Dassault.

There are several other changes at PTC that probably need to be pointed out. During fiscal 2002 through 2004 the company was spending 16 percent to 19 percent of revenue on R&D. This was more in line with what other software companies spend on R&D and compares to the six percent or so that the company was spending in the mid-1990s. Also, the company now had as many people assigned to R&D as were employed in PTC's sales and marketing organization. A decade earlier there were twice as many people in sales and marketing.

Several years later a number of customers were still using CADDS software. For example, Ukrainian-based ANTONOV Aeronautical Scientific/Technical Complex (ANTONOV ASTC) launched its newest aircraft, the AN-148 regional jet using CADDS 5i along with Windchill and Pro/MECHANICA. Likewise, Wuchang Shipyard in China was using Windchill PDMlink, Windchill ProjectLink along with CADDS 5i.

July 2005 also mark the re-emergence of PTC efforts to expand through significant acquisitions. One major deal involved paying $190 million for privately held Arbortext of Ann Arbor, Michigan. This company, which had revenues of about $40 million at the time as well as 250 employees, developed advanced software solutions for technical publishing. A number of Arbortext's customers, including Boeing and Toyoda, were also existing PTC customers.

This was followed in April 2006 by the acquisition of Mathsoft, a developer of engineering calculation software called Mathcad, for $63 million. Mathsoft had revenues of about $20 million and over 250,000 users worldwide. In typical aggressive PTC fashion, Harrison began stating in 2005 that PTC would once again become a $1 billion dollar company by fiscal 2008 with earnings in the $200 million range.