# Chapter 17

## Structural Dynamics Research Corporation

Structural Dynamics Research Corporation (SDRC) was founded in 1967 by Dr. Jason (Jack) Lemon, Albert Peter, Robert Farell, Jim Sherlock and several others. Lemon and his partners had previously held teaching and research positions in the University of Cincinnati's Mechanical Engineering Department. Initially, this was a mechanical engineering consulting company that over the years made the transition to being a full-fledged mechanical design software company. One of the company's early consulting assignments was for U. S. Steel and it was so impressed by the work SDRC did that it decided to invest in the company and for a time held about a 40 percent ownership position.

The relationship with U.S. Steel was far more than simply a financial investment. SDRC's engineers worked closely with U. S. Steel's sales and marketing people to create new markets for steel. One example was the machine tool industry which had traditionally used castings for the base of their machine tools. U.S. Steel wanted to sell these companies plate steel that could be welded into the shapes needed. SDRC's engineers developed the analytical techniques that proved to these prospective customers that the steel plate bases were an acceptable alternative. This relationship generated numerous leads for SDRC's seminars on advanced engineering design and analysis technologies. U.S. Steel also had two people on the company's board of directors during this period.

Dr. Russ Henke, who was also a University of Cincinnati graduate, joined SDRC in 1969 as director of computer operations, at a time when the company had about 20 employees. His early responsibility was to develop the company's Computer-Aided Engineering (CAE) software business and its Educational Seminar Activity. As the company developed its consulting practice, it became increasingly involved in applying computer-based analysis to the problems it encountered. There was very little engineering software available at the time and SDRC found itself developing programs needed to support its consulting work. Henke became president and chief operating officer in 1972, a position he held until he left in 1982.

One of the other early employees was Dr. Albert Klosterman who joined SDRC in 1970. For many years Klosterman was the driving force behind the company's software development activities including modal analysis software, solids modeling, surface modeling using NURBS and variational modeling as described below. Although his title changed over the years, for the most part he was SDRC's chief technical officer and managed the company's software development activities as a senior vice president. Another key employee was Jack Martz who headed the company's consulting activities for a number of years.

SDRC's primary focus was on vibration analysis. The intent of this work was to determine the natural frequencies of a vehicle or piece of equipment to determine when it would vibrate at an unacceptable level and to determine how to dampen these vibrations. Technically, this is often referred to as "modal analysis." To facilitate the work, SDRC established working relationships with both academic institutions such as the University

of Cincinnati and commercial companies such as GenRad. The latter company was a key partner in that it provided the systems used to physically measure equipment and vehicle vibrations. Like most manufacturers of test equipment in the late 1960s, GenRad needed software for Modal Analysis, making the relationship mutually beneficial.

The company's early headquarters was in the town of Mariemont, Ohio, a Cincinnati suburb. The offices and laboratories were in a collection of old historic buildings. SDRC was starting to develop an educational aspect to its consulting practice and these classes were held in a classroom on the second floor of a former restaurant. The first floor was the ex-restaurant's räthskeller to which the students retired after class for beer and conversation.

In the early 1970s the company began to get more involved with the use of computers for engineering analysis, both to support its consulting work and as a means of generating revenue. Finite Element Analysis (FEA) was beginning to became an accepted engineering analysis tool about this time. FEA had evolved during the 1960s as an aerospace technology with major support from NASA. Two of the first companies to offer software in this area were Swanson Analysis Systems (ANSYS) and McNeal-Schwendler Corporation (NASTRAN) (See Chapter 22). Prior to products from these two companies being available, SDRC used FEA code it had developed internally as well as a public domain version of NASTRAN available from NASA referred to as COSMIC NASTRAN.

Lemon felt strongly that timesharing systems were the wave of the future and that SDRC should focus on providing software on these systems rather than license its software for a one-time fee. Initially, the company sold ANSYS and NASTRAN on a timesharing basis using computers operated by U. S. Steel. This was followed by resale agreements with Control Data's Cybernet timesharing operation and Tymshare, a west coast company that offered timesharing services on Scientific Data Systems 940 computers and Digital PDP-10s. Around the same time, SDRC productized its own FEA software, Superb, and began offering a modeling package called Supertab.

Early FEA programs analyzed models that had a few hundred to a few thousand individual elements. Input data was prepared by laying out a grid of elements on a drawing of the part and then carefully measuring the coordinates of each node. These values were entered on to coding forms which were then manually keypunched into 80-column punch cards. It was a laborious process and one very susceptible to errors.

SUPERTAB was one of the first programs that automated the process. It became available to SDRC analysts and clients around 1975. The initial version of the software simply enabled a user to digitize the two ends of a line and would then evenly space intermediate nodes along the line. The nodes could then be connected to form individual elements. While the primary objective was to provide a means for creating input to the company's own Superb program, SDRC soon added the capability to generate both ANSYS and NASTRAN input. SUPERTAB used Tektronix storage tube terminals as its primary input device. Initially it ran on the various timesharing services the company used.

In 1978, SDRC moved into a new 75,000 square foot office facility in Milford Ohio, about six miles from the Mariemont location. In addition to typical office space for its engineering and software staff, it included a large laboratory area where equipment supplied by clients could be tested. One of the major areas of consulting activity

 

continued to be noise and vibration tests for automobile manufacturers. The teaching experience of Lemon and many of his associates was reflected in a large lecture hall and other training facilities incorporated into the new office complex.[1] A important aspect of the company's business consisted of classes for clients in how to use FEA and other emerging technologies as design tools.

While the training classes in Milford and at its other offices generated a moderate amount of revenue for SDRC, they were far more important in that the classes created a growing demand for the company's consulting and software services. The entire notion of FEA or mechanical simulation as some referred to it, was a foreign concept to most engineers at the time. Few of them had come across these tools during their college years or in their earlier engineering practice. Literally thousands of engineers received their first exposure to this new technology via SDRC's training programs.

**SDRC enters software market**

By the mid-1970s there was pressure within SDRC to begin selling the company's software on a packaged basis as well as on timesharing systems. Lemon in particular was reluctant to do so in that he believed that there was more money to be made by charging for the software on a usage basis. While some companies had expense budgets for this type of work, other companies preferred to make a capital investment in hardware and software. Around 1977, the company began selling a licensed version of SUPERTAB for use on customer owned computer systems such as Digital PDP-11s.[2]

By 1978, in addition to its Milford, Ohio headquarters, SDRC had offices in Detroit, Chicago, Boston, and San Diego as well as in England and France. In addition to its mechanical testing and education services, SDRC by this time was beginning to sell its software products more aggressively. The software was provided in three different ways; customers could license the software for use on their own computers, they could access it via time-sharing over telephone lines or they could bring their data to SDRC and have the analysis work done either by themselves or SDRC engineers on SDRC equipment. Applications supported by the company included static and dynamic FEA, elastic-plastic stress and deformation analysis, heat transfer and fluid flow studies. SDRC used a combination of its own software and software licensed from other developers to support this work. The predominate analysis software being used at the time was NASTRAN and ANSYS.

The most significant internally developed software package continued to be Supertab. By 1978 Version 2.0 was being used by the company and its customers. Primary competition for the timesharing version of SUPERTAB came from McDonnell Douglas Automation Company (MCAUTO) which offered a modeling package called Fastdraw. MCAUTO, which eventually became the parent company of Unigraphics, was probably the country's largest vendor of technical timesharing services with a library of dozens of engineering design and analysis programs. (See Chapter 19). In March 1977

[1] SDRC maintained the informal atmosphere of Mariemont at its new facility in Milford. Outside the cafeteria used by the students, the company installed a bar with a beer tap that initially was available to employees and students at all times. Eventually, the company's management realized that some of its employees were engaged in potentially dangerous testing activities and reduced the time the bar was open to after working hours. Friday afternoon "beer blasts" were not unique to Silicon Valley.

[2] Interview with Richard Miller, March 9, 2004

CDC introduced UNISTRUC (Unified Structural Design System) for use on the company's Cybernet timesharing system.

As far as software that could be run on internal systems, there were two competitors. Around this time, PDA Engineering began offering PATRAN, a modeling and postprocessor. In the fall of 1977, Tektronix introduced its FEM181 system that ran on the company's 4081 stand-alone graphics system. None of the traditional turnkey CAD vendors were supporting FEM or FEA software to any significant extent nor did they provide translators that could automatically transfer design data to analysis programs. The packaged version of SUPERTAB sold for $10,000 or $20,000 if the customer wanted a copy of the program's source code. A typical hardware configuration cost from $70,000 to $130,000. A timesharing user needed to spend $12,000 to $20,000 for a graphics terminal as well as incur hourly timesharing charges that typically ran from $50 to $300 per hour. Once a company began using a timesharing system for FEM more than 500 hours per year, the capital expenditure to install the software internally started to become increasingly attractive.

At this point the company was growing fairly rapidly. By mid-1977 employment was up to about 220 people, of which more than 85 percent worked in Milford. With rapidly growing sales, the company was becoming quite profitable as shown in the following table:

SDRC Revenue and Profits[3]
(Amounts in Millions)

| Fiscal year Ending in March | Consulting Service | Networks and Software | Education | Total Revenue | Profits after Taxes |
|---|---|---|---|---|---|
| | | | | | |
| 1974 | $2.4 | $0.6 | $0.2 | $3.2 | $0.1 |
| 1975 | $2.9 | $0.8 | $0.2 | $3.8 | $0.0 |
| 1976 | $3.7 | $1.0 | $0.2 | $4.9 | $0.3 |
| 1977 | $4.9 | $1.3 | $0.3 | $6.5 | $0.5 |

Although the company's total revenues were low compared to CAD system vendors such as Applicon and Computervision, SDRC's customer base read like a who's who of the automotive and heavy equipment industries: Allis Chalmers, Borg Warner, Carrier, J.I. Case, Chrysler, Clark Equipment, John Deere, Eaton, FMC, Ford, General Electric, General Motors, etc.

**Developing a working relationship with Tektronix**

One of the most difficult business issues facing SDRC was how to develop a sales and distribution channel, both internally and with business partners. This was particularly difficult for an organization whose management was made up of academically-oriented engineers. The initial sales organization was set up as SDRC Systems under Sid Barton. This is the group that eventually evolved into the CAE International organization

[3] Authors personal papers

described below. The company was eager to establish marketing relationships with other companies that could help it sell SDRC software packages.

In the late 1970s, Tektronix (see Chapter 22) dominated the computer graphics market as much as Microsoft dominates the PC operating system market 25 years later. Its 4014 storage tube terminal was used extensively with both timesharing and stand-alone systems for engineering design and analysis. The 4014 was packaged with an Interdata minicomputer and sold as the 4081. This, in turn, was used as the platform for a finite element modeling system, the FEM181. It was slow to gain market momentum but Tektronix was committed to expanding its presence in the mechanical engineering market. In August 1978, Tektronix established a new organization, the Mechanical Engineering Graphics Business Unit (usually referred to simply as MEG) under the management of Claude Tucker.[4]

To jump start its activities in the mechanical systems market Tektronix took two steps. It licensed AD-2000 from Manufacturing and Consulting Services (see Chapter 15) and it signed an agreement with SDRC to resell that company's SUPERTAB software. Tektronix had taken its 4014 terminal and repackaged it in a more user friendly console called the MEG121. It then added a Digital PDP-11/34 minicomputer to the MEG121 and called this stand-alone version that was capable of running SUPERTAB the MEG131. Tektronix wanted a resale agreement with SDRC since it realized that the 4081-based FEM181 system was not appealing to many prospects since its Interdata computer had little third-party engineering software available.

In general the FEM181 software and SUPERTAB were roughly comparable. SUPERTAB had somewhat better geometry features while FEM181 might have been easier to use. In particular, FEM181 had an excellent "shrink" feature that facilitated the detection of model errors and it also had an excellent mesh generator option. The two software packages sold for about the same amount.

Tektronix subsequently began selling SUPERTAB running on the MEG131 as well as copies of SUPERTAB to run on customer provided Digital minicomputers. The first MEG131 with SUPERTAB was sold to Whirlpool Corporation in December 1978. About the same time, Tucker was replaced as head of the Tektronix MEG business unit by Jon Reed who decided to focus on the AD-2000 portion of the company's product line.

A new agreement was worked out with SDRC in early 1979 under which SDRC took on the responsibility for sales and support of both the FEM181 and SUPERTAB software while Tektronix sold the graphics hardware and in some cases MEG131 computer systems. This relationship lasted until late 1979 when Tektronix suddenly decided to get out of the mechanical software business, leaving SDRC to proceed on its own.

**Getting in bed with General Electric**

In addition to Tektronix, SDRC also had a co-operative development and marketing agreement with Applicon under which the two companies worked to integrate Applicon's design software with SDRC's finite element modeling and analysis software.

[4] I was working for Tektronix at the time as the district sales manager in Denver, Colorado and was promoted to national MEG program coordinator when MEG was established. In this role I was involved in most of Tektronix's relationship with SDRC for the next 18 months.

 

In mid-1980, General Electric, which owned 22 percent of Applicon, made an offer to acquire the remainder of the company just before that Applicon went public, an offer that was rejected. Later that year, GE acquired Calma from United Telecommunications for $170 million. Throughout this period, numerous GE operations were SDRC clients either for the company's consulting services or its software.

As part of the agreement between Applicon and SDRC, Applicon was reselling SUPERTAB while SDRC had set up half a dozen automated design service centers using Applicon CAD systems. (See Chapter 7). One reason for the close working relationship between the two companies was that they both used Digital computer systems making it easy for customers to install their software and exchange data between packages. By early 1982 the relationship between the two companies deteriorated and a number of SDRC people including Dick Miller, Rex Smith and Paul Vollbracht left to join Applicon. They were followed a few months later by Russ Henke.

Meanwhile SDRC had established a subsidiary, CAE International, in 1977 as the company's sales and support arm. Lemon and Farrell believed that establishing separate corporate entities with their own stock would provide senior managers with financial incentive to run their own businesses. In addition to CAE International, two other divisions of the company were established; SDRC Systems and SDRC (the consulting part of the business). The people assigned to CAE International and SDRC Systems were still SDRC employees and worked in the same facility.

There were two reasons for SDRC joining forces with GE. On one hand, Lemon was a strong believer in the future of timesharing even though its impact on technical computing was starting to slip with the growth of minicomputers and GE was a major factor in that industry through General Electric Information Services Company (GEISCO). The second reason in Lemon's mind was that GE had hundreds of sales people who could be turned loose to sell SDRC software. Unfortunately, most of these people knew little about the engineering software market. According to Dick Miller, "Floyd Soulé (a salesman in Detroit) could outsell the whole GE sales force."[5]

As part of CAE International, SDRC began reselling NC software that had been developed under the direction of Joe Frazier. In July 1981, Frazier was named president of this subsidiary. Then in November 1981, GE announced a joint venture with SDRC under which the two companies planned to open five "productivity" centers equipped with Calma CAD/CAM systems, GE robotics equipment and GE NC controllers. Combined with SDRC's analysis software, these centers would enable clients to take projects from conceptual design through prototype manufacturing. The work could be done either by the clients' own personnel or SDRC would do it on a consulting basis.

The productivity centers fit in with GE's concept of the "factory of the future." (See Chapter 11). In December 1981 the two companies announced that GE had acquired a 49 percent interest in CAE International and it subsequently became known as GE-CAE International. Basically, GE-CAE International was a sales operation. The development of SDRC's software and actually ownership of the technology remained with SDRC itself.

The GE involvement in SDRC did not sit well with many of the company's employees. The company had been consistently profitable during the 1970s and the expectation among its people had been that the company would go public around this

[5] Interview with Richard Miller, March 9, 2004

 

time. When it did not, stock options employees had counted on suddenly became of questionable value. It would be several more years before the company finally went public and employees could cash out their options. In addition, GE's style of management just did not sit well with this bunch of engineers. Henke, for example, thought that the U.S. Steel relationship was a better deal for the company.[6]

In early 1984 Brad Morley became manager of product marketing at GE-CAE International while Gerald Knobeloch was made manager of North American operations, James Sherlock was manager of international operations and Martin Meads was manager of European operations. In May 1985 Knobeloch became general manager of this organization.

**The transition from CAE to CAD**

Chapter 11 describes how Calma, now owned by GE, resold SDRC software packages as components of its broad CAD/CAM product line. For the sake of brevity, that material is not repeated in this chapter. The fact that GE owned Calma outright and held a 49 percent interest in GE-CAE International undoubtedly influenced SDRC's efforts to broaden its product line. For the most part, SDRC concentrated in areas such as solids modeling as well as its legacy analysis software and consulting rather than competing directly with Calma. Some of the people at SDRC had a rather casual attitude concerning Calma, considering that company to simply be a distributor of GEOMOD.[7]

Starting in 1980, SDRC's overall product nomenclature for the company's integrated design and analysis software was called I-DEAS which stood for Integrated Design Engineering Analysis Software (the – was due to the fact that another company was already using the IDEAS name). This software suite covered conceptual design using both wireframe and solids modeling, drafting, finite element modeling pre- and post-processing and a variety of analysis modules as well NC part programming.

Not all these capabilities were included when I-DEAS was launched in the early 1980s but were added as time passed. The intent was to use a common database and a consistent user interface. The company also began development of a faceted solids modeler around this time which eventually evolved into GEOMOD described below.

It took some time for SDRC to be recognized as a viable CAD software vendor, probably because the company was not particularly interested in the drafting portion of the design cycle and other vendors such as Computervision and Applicon were heavily engaged in that task. Daratech's *1983 Survey and Buyers' Guide* covered 91 CAD/CAM software vendors without mentioning SDRC. From 1983 through 1985, I managed competitive analysis for Auto-trol Technology. Part of my responsibilities included maintaining a competitive notebook for the company's sales force. Here also, SDRC was conspicuous by its absence. It would take several more years before the company would be considered more than a vendor of mechanical engineering analysis software and consulting services.

**SDRC adds solids modeling**

GEOMOD, which was introduced in 1983 (beta test versions had been installed at GE the prior year), added a NURBS (Non-Uniform Rational B-Spline) boundary

[6] Interview with Russ Henke, March 22, 2004
[7] Personal notes from NCGA-84 Conference

representation capability to the earlier faceted modeler. Curved surfaces were represented using planar faceted surfaces with user control over the size of these facets. This improved software performance but at the cost of some lost precision. The software synchronized these two representation of geometry. In addition, the user could record a design session in a manner that created the equivalent of a Constructive Solid Geometry (CSG) data representation.[8]

There were three basic means of creating geometry in GEOMOD:

- Boolean operations such as join and subtract using primitives including blocks, cones, spheres, tubes cylinders and hexahedrons.
- Extrude and revolve two-dimensional boundaries defined by lines, arcs and B-spline segments. These boundaries could be swept along a spline.
- Skinned surfaces could be lofted across a series of arbitrary two-dimension sections. This surface could then be used to define a solid object.

Mass properties of models created using these techniques could be calculated directly by the GEOMOD software.

Not only could individual parts be modeled with GEOMOD, but assemblies of parts could also be defined. The software's user interface depended somewhat upon which computer and terminal configuration was being used. SDRC supported Digital VAX computers with a wide variety of storage tube and raster refresh terminals, IBM mainframes and Apollo workstations. Typically, commands were entered either using the terminal or workstation's keyboard or selecting screen menu items using a tablet and cursor. The initial version of GEOMOD was written almost entirely in FORTRAN.

A key aspect of GEOMOD was its ability to interface with other I-DEAS modules. Kinematic analysis was performed with a Mechanism Design module while SUPERTAB was used to prepare model data for finite element analysis using either SDRC software such as SUPERB, FRAME, SYSTAN, FATIGUE and MODAL-PLUS or third party packages including ANSYS and NASTRAN. By this point in time SUPERTAB had been complemented by an automatic mesh generation program called TRIQMESH.

Drawing production was handled by exporting GEOMOD data to GEODRAW, a package the company licensed from Computer Aided Systems for Engineering (CASE) or other third-party drafting programs. Data was transferred either as a wireframe model or as view-dependent surface boundary descriptions with hidden lines removed. In the 1985 timeframe, changes to the GEOMOD model did not result in changes being made directly to the GEODRAW drawings nor did changes to the drawings affect the model. That technology would come later. GEODRAW could be used to define two-dimensional profiles that could then be imported into GEOMOD and used for extrusions and revolves.

By early 1985, SDRC had installed nearly 300 copies of GEOMOD at over 100 customer locations. GE-CAE International typically sold I-DEAS software on a per-installation basis. As of October 1985 basic GEOMOD sold for $35,000, the system assembly option for $20,000, Mechanism Design for $5,000 and GEODRAW for $25,000. Workstations versions of the software were priced lower plus the company offered substantial quantity discounts. In addition to buying I-DEAS software from GE-

[8] *The Anderson Report*, September 1985, Pg. 4

CAE International, customers could purchase complete turkey systems from Calma, IBM and GenRad. The latter, of course, was focused primarily on vibration testing systems.

About 65 percent of the company software revenue came from the GE-CAE International sales force while the balance came from its turnkey partners.
Robert Johnson, the industry's leading analyst of solids modeling solutions at the time was duly impressed by the software's modeling capabilities, especially GEMOD's ability to distort objects by bending and twisting and its ability to interface to analysis programs. He was concerned, on the other hand, that all curved surfaces were approximated with planar facets.[9] A major drawback of GEOMOD in this timeframe was that the interface with Calma's DDM software and SDRC's own GEODRAW was via an IGES translator.

SDRC's sales force emphasized a consultative sales approach where the objective was to understand the prospects engineering process and then try to match SDRC's software products to that process. The company was very amenable to trial installations of its software as long as the prospect paid for and attended a training course. Over 90 percent of such trial accounts ended up purchasing the software. As of the fall of 1985, over 50 percent of the company's software installations were on Digital VAX computers, another 25 percent were on Digital PDP-11 computers while the balance was split between IBM mainframes and Apollo workstations.[10] The defense, aerospace and automotive industries made up slightly less than 50 percent of the company's software business.

The September 1985 issue of *The Anderson Report* contained summaries of interviews with three SDRC users. Hughes Electro Optical and Data Systems Group had 48 workstations operating on Digital VAX 11/785 and Apollo computers running I-DEAS software. About 75 percent of this usage was with GEOMOD. According to Bill Marks, a senior staff engineer with Hughes, the company was using MODAL-PLUS to compare computer simulation data to physical test data. One of his more interesting comments was that Hughes was going through design iterations without relying on paper drawings. They were, however, using GEODRAW for other applications and Marks referred to it as "a diamond in the rough." Overall this division of Hughes was very pleased with SDRC software and planned to add 300 to 400 workstations over the next two years, mostly using Digital MicroVAX computers. Marks was particular high on SDRC as a vendor, "SDRC engineers understand my problems and are almost like consultants compared to the used car salesman approach of some companies." The other organizations interviewed, NASA, Langley and Honeywell, Commercial Avionics Division, were comparably enthusiastic about I-DEAS and GEOMOD.[11]

Overall, by the end of 1985 SDRC was well respected by the engineering design community, not only as a vendor of CAE technology but increasingly as a vendor of a broader range of design solutions.

**Continuing the transition to becoming a CAD vendor**

Over the next several years, SDRC continued its transition away from being considered a mechanical engineering consulting firm to being more of a traditional

---

[9] Johnson, Robert H., *Solid Modeling: A State-Of-The-Art Report, Second Edition*, October 1985 Management Roundtable
[10] *The Anderson Report*, September 1985, Pg. 4
[11] *The Anderson Report*, September 1985, Pg. 4

software organization. It should be noted that throughout this transition, there did not appear to be any intent on the part of the company to turn itself into a turnkey systems vendor. Since GE owned 49 percent of GE-CAE International and all of Calma, it is fairly clear that Calma was the designated systems house while SDRC was encouraged to focus on the software and consulting aspects of the market.

In April 1986, SDRC introduced I-DEAS software that could be used to optimize part designs by minimizing the mass of these parts. This was several years before Rasna began offering comparable software. The SDRC software enabled users to work with multiple load cases in order to ensure the integrity of the design.

SDRC, which had primarily been supporting Digital, IBM and Apollo computer hardware, ported the I-DEAS suite of programs to Hewlett-Packard's HP-9000 Model 320 workstations in early 1986. The arrangement between the two companies had SDRC assisting in pre-sales activities, HP actually selling the hardware and software and SDRC providing post-sales software support. Software prices started at $18,000 per seat.

GEODRAW was enhanced in May 1987 with an icon-based user interface, more dimensioning capabilities, intelligent line fonts and a macro language. The price was reduced to $6,500 with quantity discounts available. SDRC also implemented a floating license that resulted in customers paying for the maximum number of simultaneous users rather than the number of workstations on which the software could run. In other words, if a customer had 20 workstations but only 10 would be running GEODRAW at any one time, then it only had to pay for 10 licenses. In addition to Digital and Apollo workstations, the software was also available for Sun systems but apparently not HP workstations.[12]

In a rather interesting development that September, SDRC announced an enhanced interface between I-DEAS and Computervision's CADDS 4X software. A GEOMOD design could be transferred to CADDS 4X for drafting and NC tape preparation. Conversely, a CADDS 4X design could be transferred to I-DEAS for structural and thermal analysis. The transfer mechanism was an enhanced or "flavored" version of IGES. At this point in time, I-DEAS was available on Sun workstations so the SDRC software could run in a network with Computervision's Sun-based CADDStations.[13]

**SDRC finally goes public**

Ron Friedsam, a 17-year veteran of Burroughs, was hired as CEO in 1986. Prior to his being hired, the company had been lumbering along earning just $1.5 million on annual sales of $39 million. Friedsam injected SDRC with a "big-company" management and discipline style it had not previously known. After his arrival, the company's revenues and earnings picked up sharply. While Friedsam energized the company, his people management skills could have been better as evidenced by the legal problems the company ran into a few years later.

This led, in August 1987, to the filing of a preliminary stock prospectus with the Securities and Exchange Commission to sell three million shares of stock at $14 to $17 per share. The plan was for the company to sell half these shares to raise operating capital

[12] *The Anderson Report*, May 1987, Pg. 7
[13] *The Anderson Report*, September 1987, Pg. 7

and for several stockholders to sell the other half. As part of the arrangement for going public, General Electric sold its interest in the company to a group of outside investors.

It is interesting to note that *CAD/CIM Alert*, in describing the pending offering, described SDRC as a traditional CAD/CAM company rather than as a MCAE company as it was typically being portrayed. The offering was unwritten by Morgan Stanley & Company of New York and Robertson, Coleman & Stephens of San Francisco.[14] The company closed on this offering later that year at $12.50 per share, somewhat less than what was originally expected. A month after SDRC's public offering, the stock market crashed in October 1987.

**Life as a public company**

One aspect of SDRC's software distribution strategy that has not been previously mentioned was the company's relationship with IBM. SDRC arranged to have IBM sell a version of I-DEAS implemented to run on IBM computer systems. Called CAEDS for Computer Aided Engineering Design System, it initially ran on IBM mainframes using that company's 5080 graphic display terminals. At the same time, IBM was marketing Lockheed's CADAM software which was predominately drafting oriented (See Chapter 13) as well as CATIA. In late 1987 SDRC ported I-DEAS to IBM's RT/PC workstation running the AIX version of UNIX. This latter version included a new FEA package, Integrated Finite Element Solver, which handled linear static, dynamic and potential flow problems and sold for $7,200. A new drafting module, CAEDS Dimensioning, sold for $9,800.

In 1987 SDRC had total revenues of $61.2 million of which 60 percent represented software sales and services while the other 40 percent represented the company's traditional consulting business. Net earnings were $3.6 million. About 40 percent of the software business was international. SDRC was basically organized into two divisions, CAE International and Engineering Services. If a prospect was particularly analysis oriented, SDRC typically had a good shot at the business. If the application was more production design and drafting or manufacturing oriented. SDRC sales personnel had an uphill fight.

At this point in time the company's software was being licensed on Digital, Apollo, IBM, HP and Sun Microsystems workstations, minicomputers and mainframes. SDRC probably was supporting more different platforms than any other CAD/CAM vendor and had over 5,500 software licenses installed at 1,900 customer sites. IBM was the company's largest reseller of software products handling about 15 percent of SDRC's total software sales in spite of the fact that it was also marketing CADAM and CATIA.

Release 4.0 of I-DEAS was announced in April 1988. SDRC was continuing to put substantial resources into the development of GEOMOD which was fast becoming the company's flagship product. The company referred to GEOMOD as I-DEAS Solid Modeling and GEODRAW as I-DEAS Drafting. As mentioned earlier, GEOMOD combined a faceted modeler for speed with a boundary representation (B-Rep) modeling capability for precision.

Release 4.0 greatly enhanced the user's ability to select and modify individual geometric elements in the model. After all the desired changes were made, the model could be converted into a B-Rep data file in a single operation. One negative aspect of

[14] *CAD/CIM Alert*, August 1987, pg. 3

 

this method was that I-DEAS models tended to be larger than those of competitors and took longer to open. SDRC recognized that performance was an issue and Release 4.0 speeded up many operations on Digital and Apollo hardware by 40 percent and by 100 per cent on IBM systems due to some special performance enhancement work by the company's programmers. This release also implemented the ability to update drawings based upon changes made to solid models but changes to drawings did not automatically change the solid model.

Supertab was now known as I-DEAS Engineering Analysis. Release 4.0 added an adaptive meshing capability to the software. This version of I-DEAS created a finite element model at an arbitrary mesh density and then analyzed the model. Based upon the results, the software automatically re-meshed the model with finer meshes in high stress areas and repeated the analysis step until the designer was satisfied with the results.

In a May 1988 article, *The Anderson Report* was optimistic about the companies future.

> "Two trends enhance SDRC's opportunity for continued growth. First is the incredible price/performance gains in technical computing. MCAE applications need lots of MIPS and MFLOPS which continue to decrease in price. Second is the evolution of success stories from companies that are currently using MCAE to improve their competitive edge. These 'early adaptors' have set an example of how MCAE technology can be successful, thus building the confidence level for a broad range of companies to utilize these tools. We continue to be very optimistic about the future of SDRC."[15]

In spite of this optimism for SDRC, *The Anderson Report* did not mention the company again for nearly two years.

**SDRC's business and product offerings mature**

By 1990 Parametric Technology was beginning to have a significant impact on the mechanical CAD market with the parametric design capabilities of its Pro/ENGINEER software. SDRC countered in early 1990 with I-DEAS Release V which incorporated the company's first implementation of an alternative design technology called variational geometry. While parametric design uses a sequential equation solver for predefined geometry, a variational system uses a simultaneous equation solver and accepts less structured input. The proponents of variational geometry technology believed that it was more flexible than parametric design and enabled users to make changes more easily.[16] The debate between the two techniques would go on for the next decade.

I-DEAS' initial implementation of variational design was basically limited to two-dimensional geometry. It would be several more years before it would be a full-fledged three-dimensional design capability. The 1990 version of I-DEAS also included feature-based modeling with the ability for the user to add custom features to the standard library of holes, ribs and bosses. Dimensions could now be displayed on solid models. SDRC began to see some national attention with a two-page article in the June 25, 1990 issue of

[15] *The Anderson Report*, May 1988, Pg. 3
[16] *The Anderson Report*, February 1990, Pg. 1

*Forbes Magazine.* Unfortunately, the *Forbes* article gave the impression that SDRC was the only significant company in the mechanical CAD industry.[17]

*The Anderson Report* had a follow-up profile on SDRC in its August 1990 issue. Brad Morley was now the senior vice president of the company's software division. SDRC's revenues were growing nicely from $75 million in 1988 to $94 million in 1989 and an expected $116 to $120 million in 1990. The user base had exploded to 23,600 licenses at 4,300 customer sites. The company's president was quoted in the *Forbes* article as saying "More and more, people are buying our I-DEAS software to be used all the way from initial design to manufacturing, a full soup-to-nuts offering, rather than just installing our solids modeling or analysis products as a front end to traditional CAD systems."[18] While the company had no overt intention to get out of the consulting business, the fact was that software now constituted 75 percent of SDRC's overall revenues.

As the I-DEAS software continued to evolve, the integration between design and analysis was strengthened with each release. The company also put substantial effort in to improving the software's user interface, adopting standards such as the X.11 graphics specification. It also broadened the types of analysis that could be handled incorporating plastic mold filling and cooling simulation.

Once again the nomenclature was changed. The main modules were now called I-DEAS Part Design (solids modeling), I-DEAS Assembly Design (included interference detection), I-DEAS Mechanism Design (complex motion simulation), I-DEAS Drawing Layout (organize drawing views and prepare preliminary drawings), I-DEAS Drafting (formerly GEODRAW), I-DEAS Finite Element Modeling (mesh generation and interfaces to third party analysis software), I-DEAS Model Solution (SDRC's own analysis software) and I-DEAS Optimization (knowledge-based tool for design refinement). The NC software was the Graphic Numerical Control package developed by England's CADCenter and adapted to work with I-DEAS. SDRC's implementation was called I-DEAS GNC.

In the early 1980s SDRC acquired database technology that had been developed internally at General Motors and initiated the development of its Data Management and Control System (DMCS). This work was funded by General Electric. The software was structured so that it could be customized for widely different applications. DMCS was tested by multiple divisions of GE and by the U.S. Air Force for a number of years. By early 1991, there were over 40 installations of this software and SDRC began aggressively expanding its software product mix to encompass a broad range of data management functions. DMCS handled functions such as managing metadata (data about data) as well as inheritance and ownership issues.

Although developed to work with I-DEAS, SDRC was adamant that DMCS was insensitive to which design system was being used. It was built on top of the Oracle relational database management system although the company was considering enhancing its capabilities by replacing Oracle with an object-oriented database system within the next two years.[19] As far as I can tell, this never happened. DMCS would eventually morph into Metaphase as described below.

---

[17] Wiegner, Kathleen K., *Forbes Magazine*, June 25, 1990, Pg. 131
[18] *The Anderson Report*, August 1990, Pg. 5
[19] *CAD/CIM Alert*, March 1991, Pg. 1

In addition to DMCS, SDRC also offered I-DEAS Data Manager (IDM) which provided data management capabilities to small groups of I-DEAS users. IDM was intended to primarily be used by I-DEAS users and worked with the same MOTIF user interface as did I-DEAS. It particularly helped designers manage product data as it moved through various stages of the design and manufacturing process. Prior to the release of IDM, SDRC users were limited to maintaining model and drawing files using the basic file management capabilities provided by the operating system of the computer they were using. DMCS was fairly expensive software. Its base price was $45,000 for the first five users. Additional users cost $1,500 to $4,500 depending upon the functions implemented and the number of users. IDM cost $1,500 per user.

SDRC changed the way it designated new I-DEAS software releases in early 1991. Its latest version was now called I-DEAS Level VI. It incorporated expanded variational design capabilities to include equations in the relationship definitions. Level VI also included new sheet metal and tolerance analysis modules. Perhaps the most significant enhancement was the addition of a graphical tool called the Dynamic Navigator to the I-DEAS Drafting software. When the user pointed a cursor at a graphical element, the software highlighted end points, mid points, intersections and tangencies to existing geometry. This was very similar to a technique implemented by Ashlar in its Vellum product and would eventually lead to a lawsuit against SDRC by Ashlar. I-DEAS' user interface was also enhanced to include menus that displayed just the commonly used commands, much like Windows does today.

As mentioned elsewhere in this chapter, SDRC's product suite was not particularly strong in regards to drafting software. I-DEAS Drafting was a third party product that accepted data from I-DEAS' design software in IGES format. This meant that other products could be used equally well for drafting, including AutoCAD. SDRC and Autodesk established a joint marketing relationship under which the concept of using AutoCAD to document I-DEAS designs was promoted. The two companies jointly developed an interface package called I-DEAS SOLID Link.

About this point in time, SDRC hired Bob Fischer as a senior vice president. He had been running the Computervision Division of Prime Computer until November 1990. SDRC closed out 1991 with announced revenues of over $146 million prior to a later restatement described below. Consulting services now represented just 20 percent of the total, but an important 20 percent.

The company's stock was being heavily pushed by the investment community in the fall of 1991. With its stock selling for $21 to $23 per share, Prudential Securities, Morgan Stanley and Robertson, Stephens & Company all had buy recommendations. Apparently based upon company guidance, they all saw SDRC generating over $180 million in revenue in 1992. It didn't happen – the company initially reported revenues of $163 million which were later restated to $149 million. By late 1992, the company's stock would be selling for just over $10.

**Shifting into high gear**

When I launched *Engineering Automation Report* in March 1992, the feature article in the inaugural issue was on SDRC. I summed up the company's position as follows:

 

> "SDRC has a strong product line that is built around their own solids modeling technology. They approach the needs of the user with a focus on design and analysis. This differs from most traditional CAD/CAM vendors who have approached it from a design, production drawing and manufacturing point of view. As these vendors moved more towards supporting analysis needs, SDRC extended its product line into the drafting and manufacturing realm."[20]

The article discussed a number of strengths SDRC brought to the table, especially the ability to tightly link its analysis software with I-DEAS' solids modeling capability. In addition, the fact that SDRC continued to perform mechanical engineering consulting assignments was seen as providing a degree of practicality to the company's software development efforts that competitors lacked. Another positive was the broad range of platforms the company supported including Digital, IBM, HP, Sun and SGI machines.

On the other hand, feedback from users indicated that I-DEAS solids modeling software created excessively large data files (this was at a time when memory was still fairly expensive and high-end workstations typically had 64MB or less of main memory) and slower performance, particularly for loading models, compared to competitive packages such as Pro/ENGINEER. The fact that both the NC and detailed drafting software came from third parties and had limited interoperability with I-DEAS solids modeling was also seen as a detriment. In fact, a number of SDRC customers used other packages for meeting their drafting and manufacturing needs.

After nearly six years of increased earnings, SDRC stumbled in the third quarter of 1992. On September 8th the company announced that earnings for the quarter would be $0.10 to $0.14 per share, significantly less than the $0.17 analysts had expected. Wall Street was brutal, knocking its stock price down $4.67 in one day to $10.50 even though revenues were still expected to be up 10 to 15 percent. This compared to a 12-month high of $30.

When the results were finally posted, revenue was up just two percent, mostly as a result of slower international sales. When the year was over, sales were up 12 percent to $163 million while earnings decreased 19 percent to $14.5 million except these numbers would eventually be restated downward dramatically. Rapidly growing PTC was obviously starting to have an impact on the company. This was the beginning of a period of strained relationships between SDRC and the investment community.

Probably the most significant product-related announcement in 1992 was the establishment of a joint venture with Control Data Systems, Inc. known as Metaphase Technology, Inc. Metaphase planned to develop a new generation of Product Data Management software using SDRC's DMCS and CDSI's EDL (Engineering Data Library) products as the starting point. At the time this new organization was established there were about 2,000 licenses of DMCS in use at 100 customers while there were 5,000 licenses of EDL in use at 500 sites.

The intent was that both SDRC and CDSI would sell the PDM solutions created by Metaphase. In addition, the new company planned to look for other distribution channels including companies that would incorporate Metaphase solutions into their product lines. Robert Nierman was appointed president of Metaphase Technology and

[20] *Engineering Automation Report*, March 1992, Pg. 6

Jim Hepplemann, who had been with CDSI, was the new joint venture's chief technology officer. For the next four years they led the development of the Metaphase product line which basically used a client/server architecture. As 1992 transitioned in 1993, customers were starting to wonder when I-DEAS Level VII would finally show up.

**A new generation of software**

In March 1993 SDRC introduced a major overhaul of the company's software product line. Called I-DEAS Master Series rather than simply I-DEAS Level VII, the software implemented new modeling capabilities, a new user interface, the concept of a "master model" and a team approach to large projects. The heart of the system was the I-DEAS Master Modeler which combined wireframe, surface and solids modeling within a single database. It incorporated feature-based dimension-driven design techniques along with a fully-integrated variational geometry constraint system. A particularly attractive feature was the ability to define where two surfaces were tangent to each other and to maintain this relationship as surface geometry was changed. *EAReport* described it as the "equivalent of electronic modeling clay."[21]

The new software extended the previously introduced two-dimensional Dynamic Navigator to handle three-dimension data. The I-DEAS Master Series user interface was predominately icon oriented. Command palettes dynamically reconfigured themselves based upon the context of the current work being performed. SDRC claimed that this reduced the number of keystrokes required to accomplish most tasks by 70 percent. I-DEAS Master Series also introduced Team Data Manager, a department-level model and drawing management system that facilitated project-level concurrent engineering. Enterprise-wide data management was handled by DMCS (the new Metaphase software was still off in the future).

Other developments included SDRC's own NC software to complement the GNC package the company had been marketing. Called I-DEAS Generative Machining, it worked off of the I-DEAS master model. When the model was modified, tool paths were supposed to be updated to reflect these changes. In addition, I-DEAS Drafting was now bi-directionally associative with the model database. Analysis software was enhanced to incorporate a Simulation Advisor that helped step users through the finite element modeling and analysis process.

Overall, the software incorporated numerous capabilities that were on the front edge of CAD/CAM/CAE technology. There were some rough edges but overall this was a significant step forward for SDRC and was expected to enhance the company's ability to compete with PTC. It also clearly showed that SDRC planned to be considered a broad range software supplier and not simply a vendor of design and analysis software.

SDRC began shipping I-DEAS Master Series in late June 1993 but soon ran into some problems. Prospects were having problems completing benchmarks with the new software and it took some time to work all the bugs out of the software. This had an adverse impact on SDRC's sales for 1993 and once again the company's stock took a hit. After recovering to about $19 per share, the sales shortfall knocked the stock down 28 percent to $13.75 in one day before it began recovering again.

With the introduction of Master Series, IBM dropped the CAEDS nomenclature for the SDRC software it was reselling and decided to market it as I-DEAS Master Series.

---

[21] *Engineering Automation Report*, April 1993, Pg. 3

At AUTOFACT '93 in Chicago, IBM demonstrated the software running on the PowerPC-based POWERstation 250.

SDRC was also starting to gain some traction selling PDM software. Towards the end of 1993 it closed a $2.3 million order for DMCS software and related services with European-based Groupe Schneider. The interesting aspect of this order was that Groupe Schneider used non-SDRC software, particularly PTC's Pro/ENGINEER, for its design work. This was one of the first installations of heterogeneous design and engineering information management software, a trend that would take on increasing importance for SDRC in the future. Overall, SDRC ending 1993 with revenues of $186 million for the year. As with the 1991 and 1992, these figures would soon be restated.

**Cooking the books**

As 1994 began to unfold, SDRC's revenues began improving modestly as the company closed several large orders in the Far East. Meanwhile the company closed an initial $8 million deal with Boeing for Metaphase PDM software. This was the calm before the storm. In September 1994 the company announced that it would be restating its revenues and earning for 1992 through the first half of 1994 to include a $30 million charge relating to sales discrepancies in its Asian operations. The company claimed that it first realized that there was a problem in August 1994 when a shortfall in cash collections resulted in the substantial write off of outstanding accounts receivable. It seems that the company's Far Eastern Operation had been booking orders that were not, in fact, valid sales.

The company immediately terminated Tony Tolani, a vice president and general manager of SDRC's Far Eastern Operations. He had been with the company for 21 years and headed this sales activity since 1988. SDRC announced that it would change how business in the region would be handled in the future. Retroactive to the beginning of 1994, the company would recognize revenue when a distributor sold a product to an end user, not when the product was shipped to the distributor. SDRC was not the first high tech company tripped up by this issue nor would it be the last.

Once again the company's stock was hammered, dropping 36% to $4.875 on 11 million shares trading in one day. This was the equivalent to nearly one third of the company's outstanding shares. A stockholder lawsuit was filed within 24 hours. The company had gotten a similar lawsuit filed earlier dismissed by the courts. The attitude seemed to be that the problem was not limited to Tolani. The lawyer bringing the latest lawsuit, William Flynn, was quoted as saying: "It begs the question to say that this is a management problem. This doesn't go on for 2½ years without it permeating all levels of management."[22] This time SDRC would not be as lucky in court nor would Tolani be the last of the company's management to go because of this problem.[23] Within a few months those exiting included Ron Friedsam, the company's CEO and Ronald Hoffman, the company's CFO.

Meanwhile the company's software kept moving forward. In late September 1994 SDRC announced Metaphase Series 2, the latest PDM software developed by Metaphase Technology. It included workflow management, product structure definition, application encapsulation, configuration management and component imaging.

---

[22] *The Cincinnati Enquirer*, September 16, 1994

[23] *Engineering Automation Report*, October 1994, Pg. 3

As if the financial problems weren't enough, towards the end of 1994 SDRC was sued by Ashlar over the technology used in the company's Dynamic Navigator software. Ashlar claimed that SDRC's use of these techniques violated patents based on work done by Dr. Martin Newall, Ashlar's chairman and chief technology officer. The courts eventually ruled in SDRC's favor in September 1997 based upon the fact that Ashlar had demonstrated its technology more than a year before it filed its patent application, making the patent invalid.

**Getting the train back on the tracks**

In early 1995, SDRC released I-DEAS Master Series 2 with improved modeling capabilities, an improved user interface with more extensive use of the Dynamic Navigator in spite of the pending lawsuit with Ashlar and improved performance, particularly for viewing complex hidden-line images and part editing. At about the same time, the company announced restated revenues and earnings for 1991 through mid-1994. The changes were much more extensive than had originally been contemplated.

| Period | Original Reported Revenue (millions) | Restated Revenue (Millions) | Original Reported Net Earnings (Millions) | Restated Net Earnings (Million) |
|---|---|---|---|---|
| 1991 | $146 | $130 | $17.9 | $9.3 |
| 1992 | $163 | $149 | $14.5 | $9.5 |
| 1993 | $186 | $148 | $14.3 | ($11.7) |
| 1994 Q1 and Q2 | $101 | $80 | $6.4 | ($6.6) |

Overall, SDRC wiped $89 million in revenue off its books and reduced previously reported earnings by $31.4 million.

The company obviously needed some adult supervision and the board of directors asked one of the company's founders, Al Peter, to come back from retirement to take over the CEO position and get the train back on the tracks. Within a relatively few months, Peter had the company focused on improving I-DEAS Master Series' quality and functionality, improving its sales momentum and refocused on its analysis roots. In March 1995 I visited SDRC and spent some time with Peter, a low key engineering-centric individual who seemed somewhat out of place running a major software company. He was the complete opposite from the highly polished Ron Friedsam. But that was what the company needed in order to recover from its financial missteps.

I-DEAS Master Series 2 was a significant improvement over the company's initial release of this software. Specifically, SDRC worked closely with its user base to ensure that the software was stable before it was released. When Master Series was launched in mid-1993, individual software modules were tested fairly thoroughly but the testing of a fully integrated system working on complex designs did not receive adequate attention. The focus was to ship the software since revenue growth depended upon sales of the new product. With a conservative engineer running the show this time, SDRC was not about to make the same mistake twice.

While the software's geometric modeling capabilities were improved it was the package's user interface that really impressed me. Icon menus typically were only two

 

levels deep compared to five and six levels in other systems, the Dynamic Navigator had been enhanced, users could define geometry working with shaded images of models, and commands such as DIMENSION worked based upon the context of the geometry selected (radial dimensions if it was a circle or arc). I wrote in the April 1995 issue of *EAReport:* "I-DEAS has the best interactive user interface available today for mechanical design and analysis."[24]

I-DEAS Master Series consisted of over 90 different modules that could be purchased either individually or as part of 28 different I-DEAS configurations. Prices typically ran from $16,000 to $35,000 per configuration with substantial quantity discounts. I-DEAS was supported on UNIX workstations from Digital, Sun, Hewlett-Packard, IBM and SGI while Metaphase was supported on the same mix of platforms except for the Digital workstations and servers. While the Metaphase client software was also supported on Windows 3.1 PCs, SDRC was quiet about its plans concerning porting I-DEAS software to either Windows 95 or Windows NT.

The company also seemed to be making progress with the Metaphase product. In addition to being sold by SDRC and CDSI, Metaphase was also being incorporated into solutions sold by Alpherel, FORMTEK and Intergraph. SDRC management believed that the joint venture was investing three times the resources in software development than SDRC would have been able to do by itself. Another interesting aspect of the Metaphase story was that SDRC was not necessarily targeting just its own customers but was instead was attempting to sell this PDM solution to companies using other CAD systems. To avoid the appearance of a conflict of interest, SDRC had established a separate sales force to sell Metaphase.

*EAReport* concluded its review of SDRC with a fairly upbeat assessment of the company. "The new management is committed to running SDRC with greater focus on the needs of the user community and with less concern about the investment community."[25]

**Making progress**

With its new management firmly in place, SDRC started focusing on rebuilding its sales momentum. A $12 million contract was negotiated with Nissan for I-DEAS Master Series software and services over a three year period. Perhaps equally significant was an $800,000 contract with MEM, Ltd., a division of Delta Circuit Protection and Controls to replace installed seats of PTC's Pro/ENGINEER software. This company was quoted in the press release distributed by SDRC that it was easier to make changes using SDRC's variational geometry than it was using PTC's parametric technology.[26] Thompson Multimedia signed up for $3.7 million of I-DEAS over five years and Boeing committed to an additional $7 million of Metaphase 2 software and services.

By the fall of 1995, word within the CAD industry was that SDRC had won a heavily contested competition at Ford Motor to become that company's primary vendor of CAD/CAM technology. This was a $200 million contract when it finally closed in December. The good news was that this would mean significant revenue from Ford and its suppliers in coming year while the bad news was that Ford would put tremendous

[24] *Engineering Automation Report*, April 1995, Pg. 6
[25] *Engineering Automation Report*, April 1995, Pg. 9
[26] *Engineering Automation Report*, May 1995, Pg. 12

pressure on SDRC to provide software specifically tailored to its needs. By March 1998, SDRC had over 160 people supporting the Ford contract.[27] This made many other users of I-DEAS software feel like second class citizens.

The lawsuits filed in mid-1994 over SDRC's need to restate its financial results were settled in late 1995 for $27.6 million, of which the company's insurance carriers paid $5 million.[28] On the positive side, growing sales of I-DEAS and Metaphase software was starting to impact the bottom line. For the last quarter of 1995, the company had revenues of $62.8 million and an operating profit of $8.3 million before special charges including the lawsuit settlement.

**Strengthening the product line**

In early 1996, SDRC moved to strengthen the NC portion of its I-DEAS product line by acquiring CAMAX Manufacturing Technologies for $30 million. CAMAX had previously acquired Point Control and that company's SmartCAM software product line. CAMAX's flagship product was called Camand and it was used extensively to machine stamping dies for the automotive industry. Both packages were surface geometry and wireframe oriented with the major difference being that Camand was targeted at UNIX users working on complex parts while SmartCAM was a PC product that was used by smaller firms on less complex parts. NC had been a weak aspect of SDRC's software product line for some time and the integration of CAMAX software was viewed as a good move.[29]

In April 1996, the company released I-DEAS Master Series 3 with improved modeling capabilities such the ability to handle intersecting fillets, new techniques for viewing and managing design history, improved capabilities for importing geometry from other systems and healing geometric discrepancies, better NC functionality and new visualization software based on a relationship previously established with Engineering Animation, Inc. Then, just six months later, SDRC released I-DEAS Master Series 4 with additional geometric modeling enhancements, direct export of I-DEAS data to the Camand NC software it had recently acquired and bi-directional sharing of model data with the Alias styling software sold by the Alias|Wavefront Division of SGI. The latter feature was probably driven by Ford Motor.

In late 1996 the company announced that it was looking for a new president and COO with the expectation that Al Peter would remain as chairman and CEO although several months later they revised this to say that the new person would also become the company's CEO.

On the negative side, the relationship between SDRC and Control Data System over the management of Metaphase was starting to show some strains. Since SDRC was responsible for two-thirds of Metaphase sales, the company felt that it should have a bigger say in both product development and marketing. The two companies were unsuccessful in establishing a single PDM sales and support organization and for the time being decided to proceed on their own.

Within a month the Metaphase situation change rather dramatically when SDRC announced that it was acquiring CDSI's 50 percent interest in Metaphase for $31 million.

---

[27] SDRC Press Release dated March 26, 1998
[28] SDRC 1997 Annual Report, Pg. 30
[29] *Engineering Automation Report*, February 1996, Pg. 14

That gave SDRC complete control over the 130-person Metaphase operation including both product development and marketing and in the long run proved to be a beneficial move.

**SDRC enters the mid-range fray**

By early 1997 it was becoming increasingly apparent that the new category of mid-range CAD software products such as SolidWorks, Solid Edge and Mechanical Desktop presented a competitive threat to the traditional CAD software product sold by vendors such as SDRC. In February SDRC announced I-DEAS Artisan Series, its first Windows NT product.

Artisan Series included most of the basic functionality contained in I-DEAS Master Series except for some of the latter's more advanced surface geometry capabilities. The basic software suite was called Artisan Series Modeler and it included solid modeling, assembly modeling, tolerance and mechanism analysis, drafting and a number of data translators, all for just $4,995. The industry's initial reaction was that this was a lot of software for a fairly reasonable price.

SDRC's plan was to attack the same market the other mid-range vendors were going after – the existing AutoCAD user base which was predominately drafting oriented at the time. Within this overall market, SDRC was particularly interested in the automotive sector which was then producing over a third of the company's revenues, up from just 10% two or three years earlier. Much of this was due to the company winning the major deal at Ford Motor. Artisan Series was expected to be particularly attractive to many of Ford's suppliers.

*EAReport* considered Artisan Series to be the most complete initial offering to date among the mid-range CAD products it had reviewed. Artisan Series Modeler incorporated the same Dynamic Navigator and lean menu structure (only two levels deep) that had impressed *EAReport* when it earlier reported on I-DEAS Master Series. Windows NT was the only operating system supported and there were no plans to provide this software on UNIX workstations or running under Windows 95. For the sake of compatibility, SDRC elected to stick with the traditional I-DEAS user interface rather than move to the Windows paradigm. According to Jeffrey Rowe, "While some users will find this Windows noncompliance somewhat bothersome, most will get over it quickly and get on with real work."[30]

The major problem any vendor of high-end solutions has when introducing a lower-priced product is how to maintain sales of the more expensive product. Clayton Christensen explores this problem in depth in his excellent book, *The Innovator's Dilemma*. Most companies try to establish artificial barriers around the lower-priced product and SDRC was no different in this situation. The company attempted to minimize conflict between the two product lines by marketing Artisan Series as an individual productivity tool while Master Series had built-in data sharing tools that facilitated concurrent engineering. This is similar to the strategy that Dassault Systemes eventually took with SolidWorks and UGS took with Solid Edge after these companies acquired those mid-range products.

In addition, while SDRC provided bi-directional transfer of geometric data, when going from Master Series to Artisan Series the model's history tree was not transferred. It

[30] Rowe, Jeffrey, *Computer Graphics World*, June 1997, Pg. 97

was, however, transferred when going in the other direction. Licensing for the two product lines also differed significantly. Artisan Series was licensed for a specific computer system – what is usually referred to as "node locking." Master Series customers could procure floating licenses so that they needed to only install the maximum number of copies that would be in use at any one time rather than a copy for every potential user. Prices for Artisan Series software were not discountable while SDRC offered volume discounts for its other software. According to Bill Carrelli, SDRC's then vice president of field operations, "At some point, it actually becomes more economical to purchase Master Series. Typically , this will occur when there are 15 to 20 people in the design team." [31]

Artisan Series was intended to be sold exclusively through value-added resellers (VARs). SDRC claimed that it wanted to make it easy for an Artisan Series customer to upgrade to Master Series and offered a full trade-in on money spent of Artisan Series when a customer upgraded.

In early 1997, SDRC was doing well business-wise with revenues quickly approaching an annual rate of over $250 million.

**SDRC becomes a mature company**

Throughout the 1990s CAD software developers struggled to make it easier for a design engineer to edit a part or assembly model, particularly one which the engineer did not create himself. Far too often, using contemporary parametric design software was an exercise in frustration. Geometric elements needed to be related to each other in a very precise manner or changes could not be correctly executed. Designing a complex part was analogous to writing a computer program with the parameters taking the place of the program variables and the part's history tree taking the place of the software logic.

As part of its launch of I-DEAS Master Series 5 in mid-1997, SDRC introduced a new modeling technique it called VGX (extended variational technology). VGX was intended to bring to three-dimensional solids modeling what variational geometry had provided in the two-dimensional realm. It would eventually enable a user to change geometric entities without concern over the sequence in which they were initially created or subsequently modified.

According to Dr. Marc Halpern who was with D.H. Brown Associates at the time, "..VGX enables dramatic performance improvements in the ease of editing parametric feature-based solids because it removes the requirement of understanding and employing object history to make model changes."[32] Another way of putting it is that VGX made the model editing process much more natural. One of the advantages of variational geometry over pure parametric geometry is the ability to work with under-constrained models. Constraints can be added later, increasing the flexibility of the design process.

To some extent, this was more of a technology announcement than a fully functional capability. SDRC used Master Series 5 to launch the basic three-dimensional variational technology with plans for detailed capabilities to follow in future releases. The first version only worked with a limited set of extruded features. Master Series 5 had a number of other enhancements that made it an attractive design, analysis and manufacturing tool for complex parts and assemblies. Performance was once again

[31] *Engineering Automation Report*, March 1997, Pg. 1
[32] *Engineering Automation Report*, June 1997, Pg. 5

improved, on-line help, on-line tutorials and computer-based training made the package easier to lean and use, Web browsers could be used to view I-DEAS models, Metaphase was more tightly integrated with I-DEAS, the company placed renewed emphasis on analysis modules and the first steps were being taken to integrate the CAMAX software with I-DEAS.

*EAReport* concluded its review of I-DEAS Master Series 5 with:

> "We are impressed by the speed with which SDRC is improving its product line. The only thing preventing the company from giving Parametric Technology a run for its money is the lack of an aggressive sales force comparable in numbers and focus to what PTC brings to the table. SDRC is looking for a new CEO and if that person is capable of lighting a fire under this organization, the result could be impressive."[33]

SDRC solved its search for a new CEO in June 1997 when Al Peter retired once again and Bill Weyand took over as president and CEO. (He became chairman in February 1998.) Weyand had been executive vice president at Measurex, a company that provides control systems for the paper and process industries. Although he did not come from a CAD-related company, Weyand had a strong technical background associated with working for a computer-oriented vendor selling to industrial customers.

In late 1997 SDRC announced plans to acquire two privately held companies which did business together as Computer Aided Systems for Engineering (CASE) for 1.5 million shares of the company's stock then valued at $25 million. CASE had been responsible for developing several I-DEAS modules including Drafting, View and Markup and CADAM Translator with SDRC being the sole distributor of this software. The relationship had started in 1984 with the development of GEODRAW. From a financial point of view, this acquisition had no impact on SDRC's revenues but it improved the company profits since SDRC no longer had to pay royalties to CASE.[34]

**Expanding the product line**

Product enhancements at SDRC were starting to come fast and furious with significant I-DEAS releases approximately every six to nine months. In March 1998 SDRC announced I-DEAS Master Series 6 with enhancements focused on four areas - assembly modeling, analysis, manufacturing and collaborative design. Master Series 6 also extended the VGX technology described above to encompass assemblies as well as individual parts, making assembly design a logical extension of part design. As the user moved parts together, graphical feedback showed if the parts were parallel, tangent, perpendicular, etc. Built in mechanism animation eliminated the need for third party kinematics software.

Two significant analysis problems were addressed in Master Series 6 - suppressing small details that do not have to be considered by the analysis software and cleaning up surface geometry elements that could distort results. Previously, individual details were suppressed on a case by case basis, a rather time-consuming process. The

[33] *Engineering Automation Report*, June 1997, Pg. 9
[34] *Engineering Automation Report*, January 1998, Pg. 15

new software enabled the user to suppress all small details in a general area in a single operation.

Contemporary modeling techniques created extremely complex surfaces on solid objects which could result in small slivers of geometry. Finite element modeling software typically created nodes along each edge of a surface which might not have accurately represented the model for the purposes of analysis. Master Series 6 treated these surfaces in a more holistic manner, resulting in smaller FEA models and, according to the company, more accurate results.

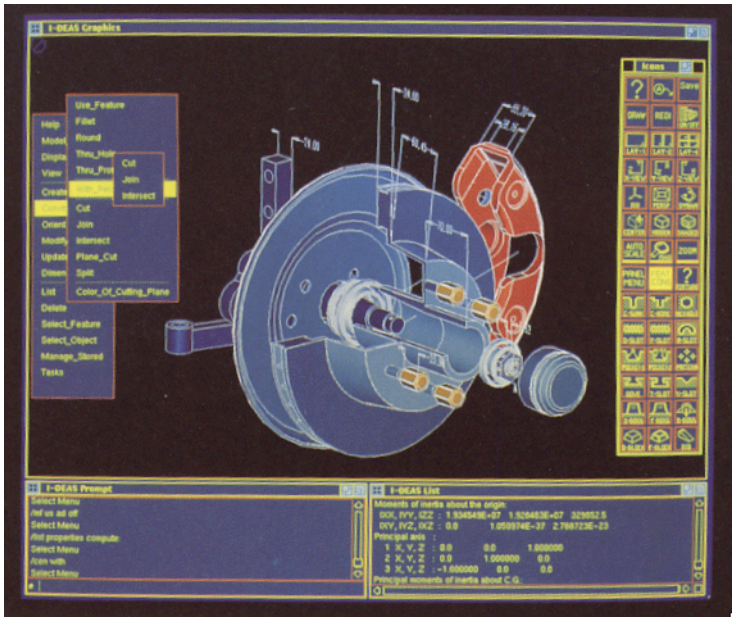

Figure 17.1
Typical I-DEAS Screen Image

In May 1998, *EAReport* carried an in-depth review of SDRC. In the process of preparing this article I once again visited Cincinnati and spent a fair amount of time with both Weyand and Carrelli. Weyand clearly saw the company's primary objective being the need to accelerate its growth. We discussed a number of inter-related steps being taken to accomplish this:

- The first step was to clearly define the company's market position. According to Carrelli, the company's then vice president of marketing, "We want to be the partner of choice for industry leading companies driven by time-to-market."
- It takes people to sell complex design and data management solutions. SDRC increased its field sales organization by 50 percent in 1997 and planed another 50 percent increase in 1998. Weyand expected this expanded team to start having a positive impact on sales by mid-1998.
- The company was committed to a 50/50 split between direct sales and resellers. They had taken steps to ensure that the company did not compete with

its own VARs. Basically, the SDRC people were responsible for specific designated accounts and the VARs were responsible for all other opportunities.

- During the prior three years SDRC's automotive business had gone from 15% of total revenues to over 40%. The company planed to exploit the position it had with Ford, Mazda, Nissan, and Renault and others by aggressively going after these companies' first and second tier suppliers. Other major markets were aerospace (19 percent) and consumer products (23 percent). The company's business was fairly evenly split between the United States (49 percent) and international (30 percent in Europe and 21 percent in Asia).
- SDRC's management recognized that there was a lot of confusion over the company's product nomenclature, Master Series, Artisan Series, etc.
- Finally, both Weyand and Carrelli discussed SDRC's need for greater visibility in the marketplace. Both felt that the company was winning a large portion of the deals where they were considered, but that SDRC was not always considered. To counter the lack of awareness, the company had launched a new marketing campaign targeted at top management with full page ads in the *Wall Street Journal* and several other leading business and trade publications that emphasized a new logo and the I-DEAS brand.

**Expanding its penetration of the automotive industry**

Many people in the CAD industry were surprised when Ford selected SDRC as its corporate standard for design and PDM software. SDRC was clearly the dark horse candidate when this procurement was underway. The resulting $200 million deal, however, seemed to be working well for both firms. As of the beginning of April 1998, Ford had installed 3,000 seats of I-DEAS and 2,600 seats of Metaphase Enterprise software. In addition, the company had shipped over 2,000 copies of I-DEAS to Ford suppliers. The contract with Ford included the requirement that SDRC sell copies of the I-DEAS software to these suppliers at a substantially discounted price. By the spring of 1998 Ford was using SDRC software to support over a dozen vehicle programs, a far faster ramp-up of the technology than what had been originally envisioned.

At this point in time, Ford was generating about 13% of SDRC's revenues. *EAReport's* observation was that this was a significant portion of the company's business, but not so large that other customers needed to be concerned that their needs were not being heard. It went on to say: "The bottom line is that SDRC cannot prosper by focusing just on Ford, but rather needs to use this as the prototype for additional major deals."[35]

Ford was in the midst of a major re-engineering initiative at the time called "Ford 2000" with multiple goals of reducing costs, enhancing product quality and reducing the time it took to develop a new vehicle from 42 months to just 20 months. SDRC had a project office at Ford staffed with 170 professionals whose aim was to help Ford accomplish these objectives. SDRC used the Ford project as the prototype of how it wanted to work with other large global manufacturers, particularly in the automotive sector.

[35] *Engineering Automation Report*, May 1998

A good example was the company's growing relationship with Nissan. In March 1995, Nissan and SDRC signed an agreement under which Nissan implemented I-DEAS Master Series for mechanical component design. In January 1998, the two companies expanded the relationship with a new $100 million multi-year agreement which extended the use of I-DEAS throughout the full design process, from concept and body in white to vehicle simulation and prototype production. Like Ford, Nissan used Metaphase Enterprise to manage product information.

In another deal, SDRC signed a contract for I-DEAS Master Series and Metaphase Enterprise with Renault in February that was expected to be worth more than $35 million over five years. This contract required SDRC to work closely with Matra Datavision which Renault had selected earlier to provide body design and manufacturing software.

**Improving Artisan interoperability**

By the fall of 1998 the battle for the mid-range CAD market was heating up considerably. SDRC had not made much of an impact in this area having sold just 2000 copies of I-DEAS Artisan Series in the 16 months since it was introduced. Its primary weakness appeared to be the lack of complete bi-directional compatibility with the company's high-end Master Series product. Master Series users were able to download models (including history tree information, feature definitions, constraints and parametric relationships) to Artisan but if changes were made to the model, only the basic geometry created in Artisan could be exported back to Master Series. This was an unacceptable limitation for large organizations that wanted the two software products to co-exist and work together.

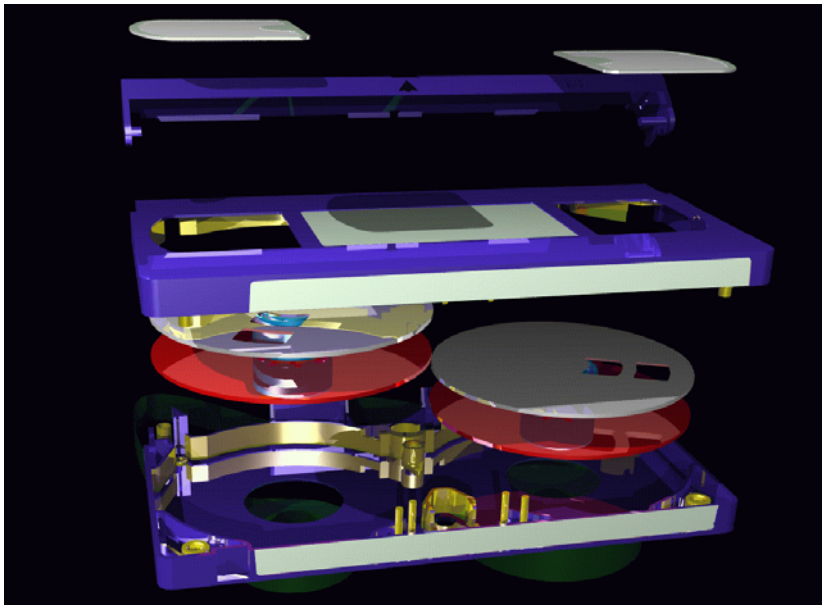

Figure 17.2
Exploded assembly model of a VHS videocassette created by Brian Slick of Purdue University using I-DEAS

When SDRC's customers made this point clear, the company responded with full bi-directional compatibility between Artisan and Master Series. There were still some functional differences between the two packages. Artisan Series 3 did not include some of the advanced surface geometry capabilities such as variational sweeps that were included in Master Series. Besides bi-directional compatibility, Artisan Series 3 also provided a complete drafting capability similar to that available with Master Series.

The prior versions had enough drafting to document Artisan designs but not enough to function effectively as a stand-alone drafting package. SDRC's sales strategy for Artisan changed somewhat since it had first been introduced. The company became increasingly focused on selling Artisan to existing large accounts and their primary suppliers in order to convert these two-dimensional drafting users to I-DEAS.

Bill Weyand, the company's new CEO, seemed to be having an impact on the SDRC's financial results. By the end of 1998, the company's annual revenues were running at more than $450 million and it was nicely profitable. As 1999 progressed, revenue growth slowed however and the company's stock took a big hit in October when it announced that revenues in the prior quarter had increased just 7 percent and earnings had dropped 64 percent from the comparable quarter a year earlier. It is interesting to note that the SDRC's mechanical engineering consulting business had shrunk to the point where the company no longer reported it as a separate line item. It was simply lumped in with other service revenue.

In October 1998 SDRC acquired privately-held Imageware Corporation of Ann Arbor, Michigan, for approximately $31 million in cash. Imageware was a specialty software firm that provided free form surface modeling software used extensively by the automotive industry and other companies to design Class 1 surfaces. Its customers included Mercedes-Benz, Volkswagen, Toyota, Ford Motor Co., Boeing, Lockheed-Martin, Motorola and Sony. On-going sales, however, failed to live up to what SDRC expected when it made the acquisition. While it initially continued to market Imageware software, by early 2001 it no longer sold that software except as part of the I-DEAS product line.[36]

**Expanding SDRC's PDM presence**

Sherpa Systems was one of the pioneers in the area of engineering document management and product data management. The company struggled throughout the 1990s, especially after signing a very large contract with Hughes Aircraft that distracted the company's development staff from providing the software most potential customers wanted. In December 1998, Sherpa was acquired by Boston-based Inso Corporation, an electronic publisher, for $35 million.

In January 2000, SDRC announced that it was acquiring Sherpa Systems from Inso along with a software development group called Inso France Development. The latter organization was involved in XML technology and SDRC planned to utilize its expertise in making the company's Metaphase software more Internet friendly. This group also had expertise in developing lightweight user interfaces and Web publishing technology. SDRC paid about $9.7 million for Sherpa and Inso France Development.

The primary rationale behind the acquisition, however, was to gain access to Sherpa's customer base, a number of whom had 1,000 to 10,000 users. Sherpa's

[36] SDRC 2000 Annual Report, march 2001, Pg. 2

customers base of 90,000 users included Boeing, Thiokol, and Johnson Controls. The first two were also SDRC Metaphase customers. Since it was well known that Inso was interested in selling Sherpa, SDRC obviously did not want to see competitors such as MatrixOne, PTC or Unigraphics Solutions gain a foothold at these accounts.

Combining the Sherpa customers with the 250,000 seats of Metaphase SDRC already had installed, the company now had about a 40 percent share of the installed PDM market. While SDRC stated that it would continue to maintain the Sherpa software, it was obvious to all parties that the company planned to migrate these accounts to Metaphase as soon as feasible. In early 2001, SDRC made it official that it would no longer enhance the Sherpa software.[37]

One of the major user acceptance problems surrounding the PDM market was the difficulty companies were having installing complex software. While CAD/CAM packages could pretty much be used as delivered, PDM software typically required substantial customization. SDRC attempted to get around this problem by marketing Metaphase Express, a set of Metaphase software modules and pre-defined services at a set price. The company had developed industry-specific templates to facilitate this process.

Complementing its Metaphase product line, SDRC introduced an e-business software product called Accelis in March 2000 that enabled users to access data from different enterprise application systems and present this data to users throughout an organization. In effect, Accelis was a Web-centric integration framework for linking different data sources. Several Metaphase customers including Boeing and Alstrom Power were quick to add this new software to their PDM installations. While SDRC obviously wanted to see Accelis customers use this software with Metaphase, it was designed to work with PDM solutions from other vendors.

In July 1999 SDRC had acquired TD Technologies for $10.3 million in stock and stock options. TD had developed a product called Slate (System Level Automation Tool for Engineers) which SDRC planned to use to expand the PDM capabilities of Metaphase Enterprise. Sales of the Slate product, especially to the automotive industry, failed to live up to expectations, resulting in a $8.5 million write-down in 2000.[38] Also in 1999, the company acquired Enterprise Software Products Inc., the developer of FEMAP, a desktop FEM tool, for $15.5 million in cash.

**Close to the end**

As the world was acclimating itself to the new millennium, SDRC began shipping the latest version of its software, I-DEAS 8 in the spring of 2000. With this release the distinctions between Master Series and Artisan were blurred as Artisan users could now access the same applications as Master Series users. Artisan now supported floating licenses and both versions used Team Data Management for work-in-progress PDM.

I-DEAS 8 had enhancements in areas such as geometric modeling, assembly management, integrated Imageware surface modeling software, faster finite element modeling and analysis and improved NC functionality. A new totally integrated drafting module, I-DEAS Master Drafting replaced the older I-DEAS Drafting Detail package.

[37] SDRC 2000 Annual Report, march 2001, Pg. 2
[38] SDRC 2000 Annual Report, march 2001, Pg. 13

In May 2000, SDRC hired Glenn Wienkoop as president and chief operating officer, responsible for product development, marketing and acquisitions management. Prior to joining SDRC, Wienkoop had been executive vice president of Cognex Corporation. More significant, however, was that prior to Cognex, he had been a senior executive Measurex, the same company Bill Weyand worked for before he became SDRC's CEO.

Business wise, revenues in the second quarter of 2000 crept up by 6 percent to $118.1 million led by a 25 percent increase in Metaphase sales while earnings slipped by 24 percent to $8.2 million. The company landed several significant Metaphase orders during that quarter including Nissan ($4.3 million), Erickson ($3 million) and Renault. Although Metaphase sales were increasing (they made up 35 percent of the company's revenues in 2000), I-DEAS sales were starting to spiral downward.

Overall, the company did fairly well for the first few years after Weyand took over in 1997, but sales growth slowed significantly in 2000. Ford accounted for 14 percent of the company's revenue in 2000. The large loss for 2000 shown in the table below was primarily due to $47 million in special charges resulting from the acquisition of Sherpa, Imageware and TD Technologies. Without the restructuring charges, the company earned $18.6 million in 2000. Earnings in 1997 would have been $49 million except for a special charge related to the acquisition of the portion of Metaphase owned by CDSI.

| **Year** | **Revenue in Million $** | **Earnings in Million** $ |
|---|---|---|
| 1996 | $285 | $38 |
| 1997 | $351 | $30 |
| 1998 | $403 | $36 |
| 1999 | $442 | $28 |
| 2000 | $452 | ($28) |

**EDS Acquires SDRC**

SDRC's 2000 Annual Report, which was distributed to stockholder in March 2001, was fairly upbeat. It talked extensively about the company's collaborative product management initiative in which SDRC would bring together its mechanical CAD/CAM products, the Metaphase PDM software and new Internet-centric tools to address the entire product lifecycle management process. The report discussed a new collaborative product suite of software scheduled for introduction in June.

On May 23, 2001, EDS announced an agreement to purchase SDRC for approximately $950 million in cash, or $25 per share. Concurrent with that purchase, EDS also offered to buy the 14 percent of its UGS subsidiary that was publicly held. The two companies were combined under the UGS name and became EDS' fifth line of business. Rather than duplicate details here, see Chapter 19 for a detailed description of how the two companies were merged together under EDS and how I-DEAS was blended together with Unigraphics.