Chapter 14

Intergraph

Introduction

Of the "big five" CAD vendors in 1980, Applicon, Auto-trol Technology, Calma, Computervision and M&S Computing, only the last of these, now known as Intergraph, is still a viable thriving business although it has also had its share of highs and lows.

The history of Intergraph from the mid-1980s on cannot be completely separated from the history of Bentley Systems, the company that developed and currently markets MicroStation. This chapter will describe the MicroStation story from Intergraph's point of view, leaving it to a separate chapter on Bentley (Chapter 10) to describe in depth the breakup of this corporate partnership and how Bentley eventually went its own way.

Establishment of M&S Computing

Intergraph was started as M&S Computing in February 1969 by a group of engineers who were working for IBM's Federal Systems Division in Huntsville, Alabama developing guidance software for the Saturn rocket. The group consisted of Jim Meadlock, his wife Nancy, Terry Schansman (the S of M&S), Keith Schonrock, and Robert Thurber. James Taylor joined three months later as employee #6.

This was an extremely loyal group of founders with all of them except for Schansman sticking with the firm through the 1980s and much of the 1990s. In fact Taylor was the company's president and CEO when he retired for the second time in July 2003. Schansman left the company when it went from being a software contractor to marketing turnkey graphics systems. He wanted to stay in the software business. Unfortunately, he died from a heart attack a few years later.

M&S Computing was founded on the assumption that government agencies would begin to use digital computers for real-time missile guidance rather than the analog computers used up until then and that as a private company there would be business opportunities exploiting this change in technology. Some of the company's early work was with NASA and the US Army in developing systems that applied digital computing to real-time missile guidance issues. Like most start-ups, the company took on whatever work that would help pay the bills. Many of these assignments ended up using computer graphics to display data such as simulated missile trajectories.

An important early project was the development of an interactive graphics system for the design and layout of printed circuit boards. This NASA effort fundamentally launched the company into the computer graphics business. Later, the software was expanded to cover the design of integrated circuits. According to Meadlock, being able to perform computer graphics independent of a programmer was a novel concept at the time.[1] The initial minicomputer version of this software was implemented on Xerox (formerly Scientific Data Systems) Sigma 5 and Sigma 2 computers.[2]

---

[1] http://www.geoplace.com/gw/1999/1099/1099jim.asp

[2] *CAD/CAM Alert*, March 1982, Pg. 2

M&S Computing's name was changed to Intergraph (**Inter**active **graph**ics) in 1980 prior to the company initial public offering in 1981. For simplicity, the company will simply be referred to as Intergraph throughout the remainder of this chapter.

Jim Meadlock dominates company

No story about Intergraph can be complete without a detailed discussion about Jim Meadlock and his influence on the company for nearly 30 years. Meadlock received a degree in electrical engineering from North Carolina State University in 1956 and worked on the Apollo space program at IBM for 12 years before founding Intergraph. The work mostly involved the development of software used to guide, control and check out the Saturn Launch Vehicle. Meadlock's electrical engineering background was particularly influential on many business and product decision he would make while CEO of the company.

To describe Meadlock as a controlling individual would be an understatement. Other than an interest in being a gentleman vintner, his entire life as well as that of his wife Nancy revolved around the company even to the point of building a home virtually on the company's industrial campus just west of Huntsville. Between them, the Meadlocks controlled expenses as if each dollar came out of their own pockets. One programmer once told me that that he needed Nancy's personal approval to obtain a programming manual for a computer system he was working on. There were contradictions however. Meadlock frowned on employees flying first class even if they were doing so on a free upgrade. On the other hand, Intergraph was the only CAD company that had its own corporate jet.

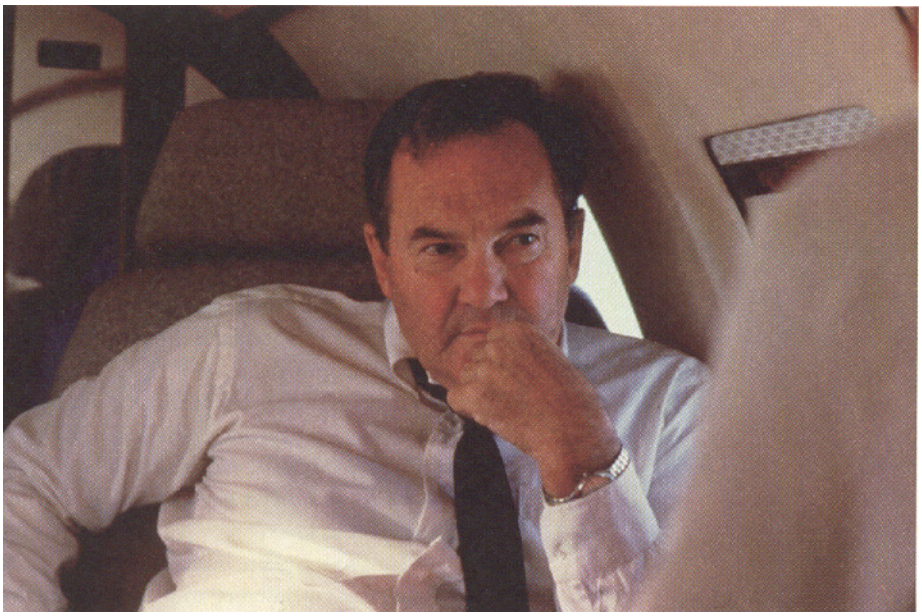

Figure 14.1
Jim Meadlock on Intergraph's Corporate Jet

Like many other engineering entrepreneurs Meadlock did not have much use for traditional sales and marketing. His attitude was if you built a good product the customers

would come. In the late 1970s, the company had just a handful of sales people and promotional literature consisted mainly of black and white product data sheets. The primary sales technique was to bring the prospect to Huntsville where Meadlock would lay on his considerable charm.

As described below, Meadlock was brilliant product strategist. Each major product decision the company made seemed to lead to the next significant development. Throughout the latter part of the 1970s and the 1980s there was very little wasted motion within the company's product development activity. In particular, Meadlock had an excellent feel for the relationship between software and hardware, particularly at a time when the CAD industry was dominated by hardware-oriented turnkey systems. But he was stubborn and this stubbornness led to both difficulties and successes at Intergraph. The company probably stuck with manufacturing its own workstations and PCs far too long but when it switched platforms, it never looked back.

Probably the ultimate example of Meadlock's stubbornness, however, involved Intergraph's protracted legal dispute with Intel over microprocessor patents. At a time when most industry observers felt that Meadlock was tilting at windmills, he was determined to see the issue through, mainly because he absolutely believed his company was right. As described later in this chapter, he was proven to be correct, to the tune of many hundred million dollars.

Meadlock received numerous awards during his career including being one of 15 individuals to receive a 1985 Congressional High Technology Award. He was also given an Ed Forrest award for contributions to the CAD industry at the 1994 A/E/C SYSTEMS Conference in Washington, D.C.

Intergraph enters the commercial graphics market

In the early 1970s, Intergraph was still basically a consulting company. The market for turnkey graphics systems was taking off very slowly, mostly for the design of printed circuit boards and integrated circuits. There was one consistency in this technology and that was the concept of data layers. Designs consisted of two-dimensional representations of data elements and these layers were stacked one on top of another.

Meanwhile, nearby in Nashville, Tennessee a young Ph.D. mathematician, Dr. Joel Orr, had been hired by the city to direct the development and deployment of LAMP, metropolitan Nashville's Location And Mapping Program. The need for a municipal mapping system had its origin in a request from the Tennessee governor in 1972 for municipal support of a traffic accident reporting and analysis system. As the system manager responsible for establishing a geocoding methodology for the Nashville Metro Area (it was a combined city and county government), Orr looked at alternatives to handle widely varying requirements. While engineering needed precise data, the planning department could work with more generalized data.

A $300,000 budget was established in 1973 to procure a system for digitizing and managing geospatial data. Orr set out to see what other cities such as Houston, Atlanta and Eugene, Oregon were doing to establish digital map databases. Based on his findings a Request For Proposal was prepared and distributed to potential bidders. Nashville received 40 responses including proposals from Synercom and Calma which were both more established in this market than was Intergraph.

Although Intergraph did not have a mapping system per se, it proposed to convert the software the company had developed for integrated circuit design to manage geospatial data. (Nobody referred to it as "geospatial" at the time.) Intergraph agreed with Orr that digitized maps could be viewed on a CRT screen, edited interactively and a wide range of reports could be generated for municipal organizations such as school districts and fire and police departments.

According to Orr, one of the major reasons Intergraph won the contract for this system was that it was willing to interface the interactive mapping system to Nashville's IBM 370/145 mainframe computer. That computer had a huge amount of disk storage for the time, ten removable disk drives, each with the capacity of 300MB. Orr realized that the mapping system would generate a tremendous volume of data, far more than could be stored on the minicomputers then available.

The system proposed by Intergraph consisted of a Digital PDP-11 computer with a 24K 16-bit word memory and a 5MB disk drive, four Tektronix 4014 terminals, Summagraphics digitizers and an early version of what eventually became the company's primary graphics software package, IGDS (Interactive Graphics Design System). This particular version of the software was called IGDS3. The memory was soon increased to 48K words. One problem discovered soon after the system was installed was that it could only process straight lines and circular arcs. Since Nashville ran along side a river, irregular curves were needed. When this was pointed out to him, Keith Schonrock returned to Huntsville and added the ability to handle spline curves to IGDS in short order.[3]

Nashville started digitizing the municipal maps in-house but soon realized that it had undertaken a bigger task than it could handle. After an aborted contract with an engineering firm in Atlanta, Intergraph accepted a contract to digitize the municipality's maps for the huge sum of $32,000. According to Meadlock, it ended up costing the company $200,000 to complete the work. In the process of fulfilling this obligation, the company developed important software for aligning and scaling individual map sheets.

From this one project evolved a major portion of Intergraph's subsequent business. Over the next 30 years the company probably installed several billion dollars worth of mapping systems throughout the world. It also led to a lucrative market in developing specialized mapping systems for government agencies – much of which remains classified to this day. About the same time Intergraph delivered an IGDS3 system to Fluor Corporation in Los Angeles.

Orr, of course, went on to become a leading consultant, writer and speaker in the computer graphics industry as well as a personal business associate and someone I consider a close friend.

Moving from consulting contracts to commercial systems

By 1975, Intergraph had honed IGDS to the point where it was a fairly respectable mapping and general drafting solution. While the company's graphics systems were still based on Tektronix storage tube graphics, it took a rather novel approach to using this technology. As mentioned elsewhere, a major drawback of storage tubes was that when a change was made to the display, such as moving or deleting an graphical element, the entire image had to be regenerated. This was particularly time

[3] Interview with Dr. Joel Orr, October 22, 2004

consuming if the user was viewing a small section of a drawing and wanted to view the entire drawing so as to zoom in on some other area.

Intergraph solved this problem by using two storage tube displays as components of a user station or terminal. One CRT typically displayed an overall view of the drawing or map being worked on while the second CRT displayed a smaller working area. At other times, one unit was used for alphanumeric data while the other displayed graphic information. The typical terminal had these two CRTs mounted above a large digitizer table that was the operator's primary communication device. Each workstation contained a DEC LSI-11/2 computer to control local operations. See Figure 14.2.

Need illustration of early dual screen terminal

Figure 14.2
Intergraph Model ????? Terminal with Dual Storage Tube Displays

Intergraph in the late 1970s

From less than $2 million in 1973, Intergraph's revenue grew to over $20 million in 1978. Although the company still did some contract programming work, especially for federal government agencies, the bulk of Intergraph's business involved interactive graphics systems, most of which incorporated the IDGS software. While the company had grown to about 200 employees by 1978, the key executives were still the original founders.

Most customers utilized their Intergraph systems for either mapping or engineering drafting applications. Major users included Commonwealth Edison, Detroit Edison, Sargent & Lundy, Bechtel, U.S. Steel, Fluor, Michigan Highway Department and Texas Highway Department. The IGDS system delivered to Texas included some of Intergraph's first photogrammetric software. Over time, this would become one of the company's technical strengths.

The company was well respected for the human factors aspects of its system design. The software was strong in mapping, drafting and database management. Although they had some manufacturing companies as customers, mechanical design and drafting was not a targeted market at this time.

Managing explosive growth

In the six years from 1978 to 1984 Intergraph's revenue grew by a factor of 20 to over $400 million. By 1980, the Intergraph system architecture that would dominate the

engineering design and mapping markets throughout the decade and well beyond in some cases was rapidly taking shape. As mentioned earlier, there was little wasted motion in Intergraph's product development activity. Each step along the way led logically to the next. A good example was the management of attribute data for engineering drawings and maps.

Once it had established itself as the leading vendor of mapping system, Intergraph took dead aim at the AEC market and systematically began to push aside Auto-trol Technology which had been the early leader in this market, particularly for process plant engineering. Creating a instrumentation drawing for a process plant by itself is not a complex undertaking. Symbols are retrieved from a library of symbols, text is added at predefined locations on or adjacent to the symbol and inter-connecting lines are forced to snap points on the symbols. The problem is that the user ends up with a pretty picture of lines, arcs and alphanumeric text. There is no meaningful context to this data – no way to find all the 8-inch gate valves on lines carrying a specific product. This is what system implementers call "attribute" data.

There are fundamentally three ways to manage the combination of graphic and attribute data – each with its own benefits and detriments. The attribute data can be added to the graphic information in a single integrated system. This is a straightforward approach and one followed by a number of companies. On the downside, drawing files become very large and it is often difficult to keep the attribute data synchronized with the graphical elements. A second approach is to store everything in a database and extract drawing images from the database. While this eventually became an accepted technique, in the 1980 time frame computers were simply too slow to do this effectively and database software technology was still fairly immature.

The third approach was to create two parallel universes, one for graphics and one for related attribute information. This is fundamentally what Intergraph did and it worked very well for over a decade. The graphic system was the previously mentioned IGDS software which by 1980 was in its eighth incarnation. The data management function was handled by a new program, DMRS (Database Management and Retrieval System). It was a hierarchical database management system which was the preferred technology at the time. It would be a few more years before relational database technology was considered ready for prime time.

To speed up the process of finding specific information in the DMRS database, Intergraph developed a hardware device called the "File Processor" (often referred to simply as a disk scanner) that retrieved records based upon search parameters generated by application programs. The File Processor could retrieve data records based upon requests that included logical operations such as AND, OR, LESS THAN, etc. Fundamentally, it was a hardware solution to a software problem.

Eventually, software developments and faster computer hardware would negate the need for the File Processor, but for a number of years it provided Intergraph with a performance advantage over the company's competitors. A further indication of how the company looked ahead in its product development activity was that by the late 1970s it was obvious to Meadlock and his crew that a transition was underway from 16-bit computer architecture to 32-bit systems. Well before Intergraph was ready to replace the 16-bit PDP-11 computers it was then using with Digital's new, but more expensive, 32-bit VAX computers, Intergraph began converting its software to work with 32-bit data

files. As a consequence, when the company did make the switch to the VAX it was able to do so with much less effort than most of its competitors experienced.

By 1980 approximately 60 percent of the company's systems business was in process plant design and heavy engineering with most of the balance mapping related. Bob Thurber headed the plant design business activity in Huntsville where all the hardware work was also done. Jim Howell handled basic mapping and land use applications, also in Huntsville, while public utility and municipal mapping was managed in Denver by Jim Hargis and Keith McDaniel. The operations side of the business was headed by Keith Schonrock with Ed Eva as the national sales manager reporting to him. Between 1978 and 1980 the company's revenue took off like a rocket growing from $20 million to over $56 million. By mid-1981, the company had installed 270 systems.

Intergraph becomes a major player in CAD industry

In 1981, Intergraph's product development activity seemed to switch into a higher gear. Although it was not the first CAD vendor to jump on the raster graphics bandwagon, when it do so, Intergraph did it well. The first product was a 1280 by 1024 resolution monochromatic raster display that was packaged in the company's dual-screen terminal much like the storage tube units had been earlier. It is interesting that although the dual-screen configuration had originally been implemented to overcome shortcomings of the storage tube, Intergraph continued to use this setup for many years after the company switched to raster displays. The IGDS software supported the display of eight independent views of a drawing on the two screens. The monochromatic display was followed soon afterwards by a color unit with similar resolution.

Equally significant was the company's addition of Digital's 32-bit VAX 11/780 computers to its product line in 1981. Although the VAX had been introduced in 1978, it took Intergraph some time to recompile the software to run in native mode on the VAX. PDP-11 software could run on the VAX in emulation mode but that performance left something to be desired. Moving PDP-11 software to the VAX in native mode required some coding changes and recompilation as well as a lot of testing. The switch was somewhat complicated by the fact that the original IGDS software was written about 50 percent in FORTRAN and 50 percent in PDP-11 assembly language. Likewise, high-speed interfaces for terminals had to be redesigned for maximum effectiveness.

The first Intergraph VAX systems was installed at Phillips Petroleum in Bartlesville, Oklahoma in the fall of 1981. This was part of a large order for eight VAX-based systems. An important aspect of Intergraph's introduction of VAX-based systems was that the company used a standard version of the Digital VMS operating system. This meant that third party software packages could run without modification. Of course, if the developers of these packages wanted to use Intergraph's dual-screen graphics terminals, that required some customization work. This led to cooperative relationships with third party software vendors who offered software that Intergraph did not such as structural analysis.[4]

The switch to VAX-based systems was done over some period of time. In fact, Intergraph continued to introduce new PDP-11 systems even after it began shipping VAX systems. This was especially true for lower-cost systems since the prices for VAX 11/780 computers alone started in the $200,000 range. As mentioned earlier, Intergraph had

[4] *A-E-C Automation Newsletter*, October 1981, Pg. 3

already switched to a 32-bit data format for IGDS and DMRS. As a result, the company's PDP-11 and VAX systems could easily share data, making the transition from 16-bit to 32-bit systems much less painful than it was for users of competitive systems.

One such low-end system was what the company called The Starter System. It consisted of a DEC PDP-11/23 minicomputer with Digital's RSX-11M operating system, an 84MB disk, a terminal with dual 19-inch monochromatic raster displays, a 36-inch by 48-inch digitizer and Intergraph's IGDS software along with several architectural space planning and drafting packages. All this for just $85,000.[5] A Hewlett-Packard 7580 pen plotter added $20,000 while substituting color displays for the monochromatic units added an additional $22,000. A mechanical design and drafting version of The Starter System was shown at AUTOFACT III in Detroit in November 1981. The company introduced color shading software around this same time that took several minutes to produce an image.

Intergraph was one of the first CAD vendors to appreciate the need to support distributed operations. The communications system it began selling in the early 1980s consisted of data concentrators that connected to the Digital UNIBUS and transferred data at rates up to 2 Mbps at distances up to 6,000 feet. The company actually called the product "Internet" well before the term came into common use.

In late 1981, 48 percent of the company's business was in mapping and land management systems and 42 percent was in AEC systems. The balance was primarily custom programming work for Federal government agencies. Intergraph was planning on entering the electronic circuit board design market with manual placement and routing software. In particular, the company planned to target prospects that used Multiwire technology for their circuit boards.

Multiwire was a technique where a machine laid overlapping insulated wires on a circuit board instead of etching traces as was done with traditional printed circuit boards. Corrections could be made to Multiwire boards with a soldering gun and jumper wires more easily than PCBs could be modified. Intergraph itself was a major user of this technology having installed $5 million of specialized equipment in 1980 and 1981 for producing Multiwire boards. While Intergraph purchased computer equipment from Digital, it produced custom circuit boards for its dual-screen workstations, the disk scanner and a vector to raster converter for driving electrostatic plotters.[6] In fact, Intergraph was beginning to become a fairly significant electronics manufacturing company at this point.

Intergraph also began the serious development of mechanical design software in the 1981 time frame. At AUTOFACT 4 held in November 1982 in Philadelphia, Intergraph demonstrated new mechanical design and manufacturing software including 5-axis machining. A new 64-bit graphics processor enabled the software to do hidden line removal operations, perform image rotation and produce shaded images very quickly. This unit also supported raster to vector conversion for scanning applications.

At the same conference Intergraph introduce a low-cost VAX 11-730 system that sold for $145,000 with one workstation and mechanical design and drafting software. The

[5] *A-E-C Automation Newsletter*, October 1981, Pg. 1
[6] *Anderson Report*, October 1981, Pg. 3

company also previewed a new InterAct workstation powered by a Motorola 68000 microprocessor.[7]

There were two versions of this new InterAct workstation. The DSP041 used two monochromatic raster displays while the DSP042 had one monochromatic display and one 256-color display. The 68000-based display processor with its 68KB memory handled functions such as pan, zoom and rotate locally once the graphic image was transferred from the VAX memory. View transformations of fairly complex images typically took less than two seconds. The company was also working on an array processor than would be able to produce images of complex three-dimensional models with hidden lines removed ten to twenty times faster than could be done in software on a VAX 11/780.

Bechtel validates system productivity

The company went public in April 1981. Intergraph's revenues grew to $91 million in 1981 and $156 million the following year. With VAX systems selling for over $100,000 per seat, the company's growth was being powered by sales to large engineering organizations.

Typical was Bechtel's Los Angeles Power Division (LAPD). By May 1983, this organization had 14 Intergraph systems at five different sites with a total of 84 workstations committed to power plant design applications. By 1983 Intergraph had replaced Auto-trol Technology as Bechtel's primary CAD vendor.

Bechtel was seeing significant productivity improvements using these systems. Pipe hanger design went from four hours to 15 minutes while, at least in one case, a 30-hour structural frame design was done in 30 minutes. Much of this performance was accomplished through the use of specialized IGDS add-ons developed by Bechtel. One example was BISEPS (Bechtel Interactive System for Engineering of Pipe Supports).[8]

Establishing strong position in the mapping market

Many entrepreneurial organizations fail because the founders attempt to keep these companies within their original comfort zone rather than adapt to the needs of the marketplace. Intergraph's founders had backgrounds predominately in space related technology such as NASA's Apollo program. That did stop them, however, from taking Intergraph into new markets they saw as emerging opportunities. The market that probably did more to define Intergraph than any other was what can generally be described as mapping. or geographic information systems (GIS).

GIS does not refer to a single application. Rather it is a broad spectrum of applications that have one thing in common – managing large volumes of spatially related data. One aspect of this market that Intergraph came to dominate was the production of topographic maps, predominately for military and non-military government agencies. Another market segment was the data collection and preparation of maps for utilities containing detailed information relating to physical assets. The latter area soon became known as Automated Mapping/Facility Management (AM/FM). These maps were far different from those used for planning purposes where the information being recorded and displayed referred more to types of land use such as zoning data or

[7] *CAD/CAM Alert*, December 1982, Pg. 2
[8] *A-E-C Automation Newsletter*, May 1983, Pg. 1

population densities. This latter area is referred to as thematic mapping and is a market segment that never was a particularly high priority at Intergraph.

One of Intergraph's first significant mapping customers was Southern Bell.[9] Working with AT&T and Bell Labs, Intergraph implemented a continuous facilities model using the company's DMRS and IGDS products. This software was used to model Southern Bell's outside plant – that portion of the telephone network not inside its switching centers. It was basically a database management solution driven by graphics although inquiries could be made from alphanumeric terminals. Changes to the telephone network entered via these alphanumeric terminals were immediately reflected in the graphic views of the data.

Another pressing need for mapping software in the early 1980s was in the oil and gas industry for managing exploration and production data. Just a few years earlier, the United States had experienced a severe oil shortage that resulted in long lines at the local gas station. Intergraph recognized the need for new technology to help in this area and plunged in to provide solutions to the industry. It turned out that many of the application modules developed to support energy companies were also useful for other mapping customers. These packages included software to:

- Digitize paper maps and photographic images to produce a spatial database.
- Covert data from one coordinate system to another.
- Adjust digitized data to compensate for paper shrinkage and to match one map sheet to another.
- Produce digital contour maps from grids of data points (this was commonly called digital terrain modeling).
- Select data based upon proximity to linear or area features.
- Digitize and process specialized data such as oil well logs and seismic results.

Product development activities at Intergraph during the preceding ten years had positioned Intergraph very well to pursue this market. The separation of graphics and data management functions into two separate programs, IGDS and DMRS, proved to be an effective way to manage the mass of data these applications involved while the company's proprietary disk scanner resulted in fast interactive response times. The use of industry standard Digital VAX computers made it relatively easy for oil and gas companies to integrate their Intergraph systems with other data processing resources. Finally, the dual-screen terminals, especially the color raster versions, facilitated the viewing of these large data files.[10]

Although Calma, Computervision, Auto-trol Technology and even Applicon offered mapping applications, none of these competitors focused on the market to the extent that Intergraph did. Probably the company's most serious competition was a Houston based company, Synercom. The latter company had good technology but never was able to achieve the market recognition that Intergraph did. In the planning area, the major competition would eventually turn out to be Environmental Systems Research Institute, Inc. (ESRI), but in the early 1980s, it had yet to achieve critical mass.

---

[9] Southern bell eventually became BellSouth and then in 2006, merged with AT&T.
[10] *A-E-C Automation Newsletter*, November 1981, Pg. 6

Exploration and production mapping systems also provided Intergraph with an opportunity to expand its international presence, especially in the Middle East. This would eventually turn out to be a major source of revenue for the company. As we will see later, by 2004, Spatial Information Management as Intergraph now calls it, generated directly or indirectly 75 percent of the company's revenue.

New generation plant design software

As part of the company's plan to develop a new process plant design system, Intergraph teamed up with a Houston company, Zydex Engineering, Inc. in late 1981, to develop a new plant design system. Zydex was run by Eduardo (Ed) Zorrilla. This joint development project led to what eventually became known as Intergraph's Plant Design System (PDS). The software was intended to provide an comprehensive interactive three-dimensional capability for complex process plants including design, drafting, material take-off, and visualization. Zydex developed the specifications for PDS while Intergraph personnel did the actual software implementation.

The first public demonstration of PDS was at the Petro Expo '85 show in Houston in March 1985. The first modules mostly involved two-dimensional drafting applications such as P&IDs and Instrumentation Loop Diagrams. I saw a demonstration of the software in April 1985 at NCGA-85 in Dallas. My observations at the time were:

- The new software involved more keyboard activity than Intergraph's earlier plant design software.
- Performance using a VAX 11/750 and an InterAct dual screen workstation was not particularly impressive except for generating shaded images of the plant model. The latter task was facilitated by the use of Intergraph's Graphics Processor described earlier.
- Fittings were inserted by first routing the pipe and then inserted specification defined fittings in a batch operation. During the demo, it took three minutes to insert eight fittings. Inserting fittings on a vessel took just a few seconds, however.
- The system did not appear easy to use. During the demonstration I watched, the application engineer lost his orientation in the model and had to stop, log off, reload the model and then continue. His last few operations were lost when he logged off.[11]

By mid-1986 Intergraph had invested over $8 million in developing the complete application suite.[12] PDS represented a new approach to engineering design, one in which the management of design data was treated as important as if not more so than the graphical design of the physical plant. Descriptive information was stored in a manner that facilitated multiple applications sharing the same data.

The underlying concept was that once a data element was defined, perhaps in a P&ID (Process and Instrumentation Diagram), that information could be used to produce other drawings such as instrument loop diagrams or to verify that process elements were not left out of the actual piping design. This held whether the application involved two-dimensional schematic data or three-dimensional models of the plant. Prior systems

[11] Author's personal notes
[12] *Anderson Report*, August 1986, Pg. 4

tended to treat each application's data separately and transferring information from one task to another was a "hit or miss" affair.

As implemented, PDS actually stored information in three interrelated databases.

- Reference Database – contained information relative to industry design codes, vendors' catalog data, job specifications, symbol libraries, etc.
- Task Database – used to store working data associated with active design tasks prior to that aspect of the design being "approved."
- Master Database – repository for approved project data. Once a portion of the plant design was stored in the Mater Database, special procedures were required before that data could be changed.

Specific programs implemented in PDS handled the following tasks:

- Process and Instrumentation Diagrams (Included a library of 1,000 symbols)
- Instrument Diagrams
- Instrument Loop Drawings
- Equipment Design
- Plant Layout
- Structural Modeling (analysis handled by Intergraph-Rand Micas or third party programs)
- Piping (Included a library of 75,000 components)
- Electrical Raceway Design
- HVAC

The basic user interface to PDS was done with IGDS which by mid-1986 encompassed over 800 man-years of development effort. The software was implemented on the Digital VAX computer using the VMS operating system. Orthographic piping drawings were produced by selecting portions of the plant model, eliminating hidden lines and then using IGDS to put the finishing touches on the drawings.[13]

While one group of Intergraph programmers was preparing PDS for formal release as a VAX-based system in mid-1986, other Intergraph software groups were hard at work preparing a new generation of applications for the company's UNIX workstations then under development. PDS would remain a VAX-based application longer than any other comparable program sold by Intergraph and it would not be until the early 1990s before it would be ported to UNIX.

In August 1995, Intergraph filed a legal action seeking to dissolve its business arrangement with Zydex. Intergraph wanted to be able to continue selling PDS without having to pay Zydex on-going royalties which supposedly were in the range of 30 percent of the software's sales price. Zydex filed a counterclaim several months later alleging wrongful dissolution of the business relationship, seeking both sole ownership of PDS and significant compensatory and punitive damages. Needless to say, this would have effectively put Intergraph out of the plant design business if the court had sided with Zydex.

After nearly two years of litigation, the companies agreed to settle the dispute in 1997, but failed to agree on certain terms of the settlement. In September 1997, the court issued an order resolving the disputed issues and dismissed the case. The settlement

[13] *A-E-C Automation Newsletter*, June/July 1986, Pg. 14

involved Intergraph acquiring Zydex for $24.8 million. The closing under these terms never took place and finally in November a hearing was held during which the judge ordered both parties to sign the closing documents.

The documents were finally executed by both parties, but Zydex still wanted to take one more shot at Intergraph and indicated they might appeal the judge's order.[14] In order to put this dispute behind it, Intergraph agreed to increase the payment to $26.3 million and the deal was finally consummated in January 1998. PDS software sales in 1997 amounted to about $45 million.[15]

Intergraph in the mid-1980s

The 1980s were the go-go years for Intergraph. The company was starting to pursue nearly every aspect of automated design and drafting. This even included architectural applications, an market segment the company would pull out of in the late 1990s with Meadlock complaining that it was impossible to make a profit selling to architectural firms. Typical applications included Structural Steel Detailing and Reinforced Concrete Detailing which sold for $10,000 each. Remember, Intergraph's software prices were on a per system basis and at this point in time, the company was claiming that a VAX 11/785 could support up to 20 terminals.

In the early 1980s, Intergraph started getting carried away with executive titles. Jim Meadlock was, of course, president and CEO. Below him were eight executive vice presidents: Keith Schonrock, Jim Taylor, Nancy Meadlock, John Thorington, Roland Brown, Allan Wilson and Willam Zarecor.[16] Nancy Meadlock was taking on increased responsibilities at Intergraph as executive vice president of administration and was clearly a power behind the throne. About the same time, Rick Lussier became vice president of sales. He held this job until early 1985 when he left the company and was replaced by Howard Fisher. Both had earlier worked with me at Tektronix.

Intergraph eliminated most 16-bit Digital PDP-11 systems from its product line by mid-1983 and focused on the 32-bit VAX machines. By the fall of 1983, Digital had shipped over 500 VAX systems to Intergraph.[17] One exception was the low cost Innovator II which was targeted for use in architectural applications that used a Digital PDP-11/23 computer.

Architectural software product management was under the direction of Al Kemper who reported to George Stienke[18], vice president of product marketing. Kemper was a well respected author[19] on the subject of architectural design and had worked at Ralph M. Parsons as well as Tricad, a Calma spinoff. Kemper's master plan envisioned the use of Intergraph software for everything from the preparation of massing studies to CAD-generated perspective site views, walkthroughs and what would eventually come to be called "urban simulation." Kemper also saw the need for using the computer to

---

[14] *A-E-C Automation Newsletter*, December 1997, Pg. 4
[15] Intergraph 2000 Annual Report, Pg. 60
[16] *Anderson Report*, January 1983, Pg. 8
[17] *Anderson Report*, September 1983, Pg. 2
[18] Steinke left Intergraph in March 1985 to become vice president of sales and marketing at Cognition, a company founded by Philippe Villars who had also been one of the founders of Computervision.
[19] *Architectural Handbook – Environmental Analysis, Architectural Programming, Design and Technology, and Construction,* Wiley Interscience, 1980

manage project workflow, an area that would attract tremendous focus in the late 1990s as the use of the Internet took off.[20]

In the mechanical area, a key development was an agreement signed with Xerox Corporation in January 1984 under which the two companies planned to work together in the development of surface and solids modeling, kinematics analysis, robotics and enhanced numerical control.[21] This was followed by the introduction of a mechanism modeling package two months later that produced data that could be used by third-party analysis programs.

By mid-1984, Intergraph was firing on all cylinders. It had increased its market share in 1983 to 14.7 percent on $252 million in sales. Only Computervision and IBM had larger sales in this industry. Intergraph participated in every segment of the CAD industry with sales broken down as follows:

AEC	43 percent
Mapping	31 percent
Mechanical	13 percent
Electronics	2 percent
Technical Publications	2 Percent

MicroStation comes on the scene

(As previously mentioned, the detailed story of the Bentley brothers, Bentley Systems Incorporated (BSI) and MicroStation is contained in Chapter 10 although some of it is repeated here.)

Intergraph's pricing model until it began selling its own Clipper-based workstations, was to license the IGDS and DMRS software on a per CPU basis. When a company purchased a VAX 11/780 system, it could attach as many terminals as the computer could physically support. The limit really was based on what was the acceptable level of performance for the type of work the customer was doing. There was just one catch. The software only worked with Intergraph manufacturer terminals and these were fairly expensive. Like many other turnkey CAD vendors at the time, the bulk of Intergraph's revenue came from selling hardware and software was seen as the means that enabled the company to sell hardware.

One of Intergraph's major customers in the early 1980s was DuPont in Wilmington, Delaware. Keith Bentley had gone to work at DuPont after receiving an MS degree in electrical engineering from University of Florida. DuPont was using its Intergraph systems for producing process plant electrical diagrams. Usage, however, was limited by the high per seat cost of adding more capacity. Bentley believed that there was a lower cost alternative and set out on his own time to develop a package called PseudoStation. It enabled someone to use Intergraph's CAD software from a low-cost Digital VT-100 terminal equipped with a graphics card or a Tektronix storage tube terminal such as a 4014. PseudoStation proved to be particularly cost effective when DuPont designers simply wanted to make changes to existing drawings such as revising some text on a drawing.

In 1983, Keith Bentley left DuPont to work with his brother Barry in California at a company called Dynamic Solutions. Before leaving Dupont, Bentley negotiated an

[20] *A-E-C Automation Newsletter*, May 1984, Pg. 3
[21] *CAD/CAM Alert*, January 1984, Pg. 7

agreement with Dupont under which he received marketing rights to the software in return for which he would provide technical support to the company's PseudoStation users. On the way to California, he stopped in Huntsville and offered the software to Intergraph. According to Bentley, "I would have sold [PseudoStation] to Intergraph for $5,000, and that would have been that. [That I didn't] is one of a series of lucky coincidences….."[22]

Los Angeles had a large number of Intergraph installations and soon Keith and Barry Bentley found a receptive audience for PseudoStation. Keith founded Bentley Systems Inc. and arranged to have Dynamic Solutions market the software in exchange for work he did on that company's software. Soon Keith and Barry sold their interest in Dynamic Solutions and relocated to the Philadelphia area where they were joined by brother Scott and Ray. Within a short time they sold over 350 copies of the terminal-based PseudoStation software.

After relocating to Philadelphia, Keith became convinced that what Intergraph was doing on a VAX, he could do on a IBM PC/AT. This new version of the software was soon known as MicroStation. In January 1987 Intergraph purchased a 50 percent interest in Bentley Systems for $3 million and announced that MicroStation would be marketed by Intergraph on both UNIX and PC platforms.

Micro IGDS – an alternative to MicroStation

Bentley Systems was not the first PC CAD software company Intergraph acquired an interest in. CNR Research was started by two former employees of Bechtel Power Corporation in Ann Arbor, Michigan, Antonio Robinson and Erdwing Coronado. Robinson had been a system engineer for Bechtel while Coronado was a senior programmer-analyst. When Bechtel announced plans to shut down its Ann Arbor office in 1984, the two decided to start their own software company, CNR Research, with Robinson as president and Coronado as vice president of R&D.

Initially, the two focused on providing CAD/CAM consulting based on their knowledge of Intergraph systems and Digital hardware. In April, 1985, the two decided to create a two-dimensional drafting package compatible with Intergraph's IGDS. Called C-CADD, it ran under both MS-DOS and UNIX and implemented the equivalent of about 30 to 40 percent of the commands in IGDS. According to *A-E-C Automation Newsletter*, this represented over 90 percent of the functionality in IGDS. The software sold for $3,000 per copy, a little more expensive than AutoCAD.

C-CADD was written in C, a fairly new programming language at the time and its files were compatible with Intergraph's IGDS file structure so no translation was necessary. Competitors, including VersaCAD and Autodesk, were promoting the fact that they had software available for translating Intergraph drawing files. In May 1986, Intergraph acquired a 50 percent equity interest in CNR Research. Under the new relationship, CNR continued to market the PC version of C-CADD through its existing reseller channel (eight companies at the time) while Intergraph marketed the UNIX version, now known as MicroIGDS, through it sales organization.[23] Once Intergraph

[22] Solomon, R. E., "Those fabulous Bentley Brothers, MicroStation's building blocks," *MicroStation Manager*, June 1992, Pg. 76
[23] *A-E-C Automation Newsletter*, June/July 1986, Pg. 28

acquired an interest in Bentley, it lost interest in marketing the UNIX version of MicroGDS and CNR Research and C-CADD simply faded away.

Intergraph software in the mid-1980s

As mentioned earlier, Intergraph's primary graphics software package was IGDS. Data was maintained in either a two-dimensional or three-dimensional format with some difficulty in moving it from one state to the other. One of the major limitations was that an active drawing could only have 63 layers of data. This was far less than competitive systems which typically could store 256 or more layers and in some cases an unlimited number of layers. In addition, up to three reference drawings each with its own 63 layers could be overlaid with the base drawing. Another shortcoming was the fact that IGDS used a 32-bit fixed point format at a time when other vendors had switched or were in the process of switching to 32-bit and 64-bit floating point data. It was a trade-off between performance and precision.

IGDS was particularly efficient when being used for two-dimensional drafting. One reason for this was that the drawing data did not carry with it three-dimensional data that was not needed as did some competing system. The software generated up to eight independent views of a drawing and displayed up to four on each screen of a double-screen workstation. A macro language called User Command enabled users to combine a series of tasks in a single command. The primary user interface was a hard copy menu on a large digitizer located in front of the terminal's display(s). For a user to change the layout of the menu or to add new commands required the knowledge of FORTRAN programming. By mid-1985, the interface was in the process of being changed to more on-screen menus and "fill in the blank" dialog boxes.

Most CAD packages then on the market stored attribute data as part of the drawing file. Intergraph took a different approach and stored this data in a separate file which was managed by the previously mentioned DMRS (Data Management Retrieval System)software. DMRS primarily used a CODASYL compliant hierarchical data structure although by mid-1985, Intergraph was incorporating some relational technology into the package.

DMRS was not required to do straight-forward CAD tasks such as drafting and many customers opted not to use it because of the time required to learn the software. One shortcoming was that a user could not back up the data associated with a single drawing file but had to back up the entire DMRS database. This might have worked well for a utility mapping customer but it really was awkward for the typical architecture or engineering organization to use.

Although DMRS could be used without Intergraph's File Processor, that hardware greatly improved performance when it was part of a VAX configuration. The linkage between DMRS and IGDS was managed by a software module called Attribute Services. The price of the data management software as well as IGDS was bundled in with the cost of the VAX computer at the heart of all Intergraph systems at this time.

Like all other CAD vendors, Intergraph was also becoming interested in solids modeling. Its implementation of solids technology, Solids Modeler, was tightly coupled to IGDS. Wire frame and surface defined geometry could be used to create solids. The Graphics Processor was required in order to utilize this software.

Intergraph had perhaps the largest array of applications software of any vendor in the industry at this time. These application fell in several broad categories.

- Process plant design.
- Engineering design.
- Architecture.
- Mapping.
- Petroleum exploration and production.
- Mechanical engineering.
- Electrical engineering.
- Technical illustration.

Although the open architecture of the company's VAX systems enabled outside parties to develop software to run on Intergraph systems, there were few such packages. Part of this was due to the fact that the company did not particularly encourage third-party developers and part was due to fact that these developers would have had to purchase a VAX system from Intergraph in order to do any development work. Complicating the development of third-party software was the fact that Intergraph fine tuned the VAX VMS operating system to give high priority to the company's workstations. Outside developers had to understand what had been done and adapt their software to these modifications or their software would not operate effectively.

Typical prices

Some of the typical Intergraph prices as of mid-1985 were:

• VAX 11/750 CPU with a floating-point accelerator, 2MB of memory, an 84MB disk[24], tape drive, File Processor, console and IGDS and DMRS software	$195,000
• INF096 Graphics Processor	40,000
• Additional VAX memory in 0.5MB increments	5,000
• InterPro 32 (monochromatic)	20,000
• InterAct color workstation	48,000
• Architectural drafting software	10,000
• Base map digitizing	2,000
• Drawing management	4,000
• Finite element modeling	10,000
• Mechanical design and drafting	10,000
• Solids modeling	20,000
• Numerical control	10,000

While some of these software prices seem high, it should be remembered that these were the cost per VAX system. If a VAX 11/785 had a ten workstations doing mechanical design then the cost of the application software per user was only $1,000.

A new generation of workstations

In 1983 Intergraph began demonstrating new single screen InterPro and dual screen InterAct terminals that utilized Motorola's 68000 microprocessor. Initially, the

[24] A single 86MB disk drive left very little room for drawing files since the VMS operating system and the IGDS and DMRS software required nearly 80MB by itself.

InterPro was just available as a monochromatic unit. The first InterPro unit was the Model DSP046 with a price of $25,000.[25] A color InterPro was introduced in mid-1984 for $42,000. The DSP052 InterAct had dual monochromatic screens while the DSP055 had one monochromatic screen and one color. All these units had 1280 by 1024 resolution. The InterAct used a structural foam type of construction and provided substantial operator control over the height and angle of the displays and the digitizer table.

By 1984 it was fairly clear to most executives in the CAD industry that the future was with networked workstations rather than minicomputer-based systems. While competitors such as Auto-trol Technology, Calma, and SDRC were making the transition to commercially available workstations from Apollo and Sun Microsystems, Intergraph had started down the path of building its own workstations and, in effect, becoming a vendor of commercial workstations as well as CAD systems. It was clear that Intergraph saw networked workstations as the wave of the future. It just took the company longer to get there than it would have liked. In November 1982, Jim Meadlock had been quoted as saying "If I were starting a new company today, I would build a standalone workstation operating in a network."[26]

In September 1984 Intergraph announced the single screen InterPro 32 workstation which was intended to use the National Semiconductor 32032 microprocessor as well as an Intel 80186 microprocessor. It was designed to run UNIX on the 32032 and MS/DOS on the 80186 although not both at the same time. Initially, the company said that deliveries would start in the first quarter of 1985. The InterPro 32 was intended to function as a stand-alone UNIX workstation, as a terminal for Intergraph's existing VAX-based systems, as a terminal emulator for devices such as the Tektronix 4014 or as a IBM-compatible PC.

The price for the hardware was set at $20,000 which, given the intended capabilities, appeared to be very competitive.[27] There was a major misconception at the time, however. Although Intergraph did not claim that the InterPro 32 would be able to directly execute IGDS software, the impression among many potential prospects was that it would do so. The initial InterPro 32 had a 15-inch color monitor with 1184 by 884 resolution. It displayed 64 colors from a palette of 4,096. It had a base memory of 1.75MB upgradable to 4MB. It also had as 26MB hard disk and a floppy disk as well as a 64-bit floating point processor.

Numerous other workstation manufacturers with names we have long since forgotten such as Syte, Saber and Mosaic, planned to introduce workstations in this time period using the 32032 microprocessor. The 32032 nomenclature referred to the 32-bit instruction size and 32-bit data bus architecture. National Semiconductor had not yet produced deliverable 32032 chips and was providing its OEM customers the 32016 with a 16-bit data architecture as an interim microprocessor. The InterPro 32 based on the 32016 was slow compared to competitive products from Apollo and Sun. National was never able to produce 32032s in quantity and eventually most of the workstations vendors developing product lines dependent on this chip went out of business.

---

[25] Author's personal notes

[26] Author's personal notes.

[27] *Anderson Report*, October 1984, Pg. 1

At the same time that Intergraph announced the InterPro 32, it also announced support for Digital's MicroVAX II which would support up to four workstations. The basic computer was priced from $40,000 to $60,000 with workstations extra. Packaged by Intergraph as the Model 250 it was also referred to as the Micro II. Deliveries were scheduled for the second quarter of 1985. One problem with the MicroVAX was that Digital replaced the UNIBUS used on prior VAX system with a slower Q-BUS. Intergraph, in turn, replaced the Q-BUS with a data bus of its own design called the INTERBUS which had a capacity of 13.3 Mbps. The InterPro 32 connected to VAX systems via an Ethernet link. In what was perhaps a strategic mistake, Intergraph chose to use Xerox's XNS Ethernet protocol rather than the TCP/IP Ethernet protocol that most other computer manufacturers were using. Perhaps this was done because Xerox was emerging as a major Intergraph customer.

At the AUTOFACT-6 Conference in Anaheim, California in October 1984 the units on display were unable to execute IGDS software on a VAX computer. A complete one-station system consisting of a MicroVAX II and an InterPro 32 with IGDS, DMRS and architectural drafting software was eventually launched in June 1985 at a somewhat expensive $94,000.[28] A dual MicroVAX II system called the 252 was introduced in August 1986. The MicroVAX system did not support either Intergraph's File Processor or Graphics Processor.

Intergraph began shipping InterPro 32 units based on the 32016 in early 1985 with the commitment that they would be upgraded to the 32032 as soon as that microprocessor was available.[29] The company also said it would provide IGDS software on the InterPro 32 along with applications such as schematic drafting. This never occurred as the company shifted its focus to MicroStation for UNIX platforms. Some stand-alone UNIX-based applications were available including the FEA software Intergraph had obtained when it acquired the Rand Group.

It was still not clear as of April 1985 if Intergraph intended to completely replace its VAX systems with the new UNIX workstations.[30] By the SYSTEMS-85 conference in June 1985 in Anaheim, California Intergraph was able to demonstrate the InterPro 32 as a terminal running IGDS on both a VAX 11/750 and on a MicroVAX II. Intergraph's UNIX implementation supported multi-tasking with each task running in its own window. Separate tasks could be logged on to different VAX systems. As an example, a user could be running a complex analysis task on a VAX 11/785 while doing interactive drafting on a MicroVAX II.

Eventually, Intergraph got tired of waiting for National to deliver the 32032 and switched to Fairchild Semiconductor's Clipper microprocessor. This move would eventually radically change the fortunes of Intergraph but that is a story covered elsewhere in this chapter. In mid-1986, Intergraph introduced ten Clipper-based workstations and two servers including InterPro, InterAct, InterView and InterServe units.

---

[28] Author's personal notes

[29] Some analysts expected that the volume of InterPro 32s would take off during the second half of 1985. Jay Cooper of F. Eberstadt & Company wrote in a June 18, 1985 report that he expected Intergraph to ship 900 units during the third quarter and 2,400 units during the fourth quarter. He also projected that Intergraph would generate $314 million in mechanical systems revenue in 1986, a number the company never came close to.

[30] Author's personal notes

The difference between these workstations was that the InterPro was a desktop unit while the InterAct used Intergraph's traditional dual screen packaging. The InterView was a limited function version of the Interpro that was intended to be used for data entry and graphic viewing. There was also a limited production unit called the InterMap that was intended for use with photogrammetry equipment. These systems all ran Intergraph's implementation of UNIX called CLIX. The InterPro and InterAct workstations were priced from $29,000 to $72,000 while the InterServe servers were priced from $22,000 to $29,000.

The InterPro units were initially intended to be used as either a VAX terminal or as a stand-alone workstation while the InterActs were more expensive stand-alone units with high performance graphics. Intergraph used the Weitek floating point engine in these units with a display processor that could support 512 colors from a palette of 16 million and display 100,000 vectors per second. This was about as good as anything that workstation manufacturers such as Sun and Apollo could offer. The InterPro 32C, introduced in July 1986, offered five MIPS performance for just $25,000. At the time, this was a significant level of performance for a moderate price tag. Both 15-inch and 19-inch displays were available on the InterPro 32C.

The transition to UNIX

A significant problem that would plague Intergraph for several years was that customers, especially large government agencies, wanted industry-standard UNIX systems rather than proprietary systems such as Digital VAX computers. The UNIX version of MicroStation was the primary graphics system for the company's new workstations. The major problem the company faced was converting its vast array of applications that had been developed to work with IGDS and DMRS to now work with MicroStation. This was a substantial task and it was the late 1980s before the bulk of the work was completed.

While this transition was proceeding Intergraph had to install a mixture of VAX and UNIX systems at many customer locations since some applications were only available on the older machines. In other cases, the company was forced to provide customers with VAX systems which were subsequently swapped out for Clipper-based UNIX workstations.

One aspect of moving from VAX-based IGDS and DMRS to MicroStation on the new UNIX workstations was the need to replace the hardware functionality of the DSK062 File Processor with its software equivalent. To a lesser extent the same applied to converting tasks handled by the INF096 and INF103 Graphics Processors with either UNIX software or comparable functionality incorporated into the workstation's graphics hardware.

Pursuing the mechanical CAD market

By the early 1980s it was clear that the largest overall segment of the CAD industry going forward would be the mechanical sector. The first Intergraph systems were sold into this market in 1982. Intergraph's early software for this market was simply its IGDS software with mechanical drafting and manufacturing applications built on top. Starting out somewhat slowly in the mechanical market, Intergraph developed some fairly decent NC software by mid-1985. In particular, the company took advantage of its

ability to rapidly display color shaded surfaces to show NC tool paths on top of these shaded surfaces.

The software was mostly on-screen menu driven with extensive use of dialog boxes and icons. The company's three-dimension modeling software handled most types of mathematical surfaces including planes, cylinders, ruled surfaces, NURBS, and Bezier surfaces. Intergraph, however, was always playing catch-up in the mechanical software arena and never provided its mechanical R&D staff with sufficient resources to dominate this software arena like it did mapping and AEC. Customers used the company's mechanical software primarily for designing industrial machinery rather than stylized automotive or consumer products although Intergraph was always able to provide examples of the latter type of user for marketing purposes.

Trying to be all things to all people, Intergraph began developing robotics software with GMF Robotics Corporation in early 1984 and technical illustration software around the same time. The previously mentioned Xerox contract, worth $20 million over three years, was a good example that the company could be serious about this market when it wanted to be. Around the same time, Intergraph introduced the Mechanism Modeling System (MEMS) which interfaced to Mechanical Dynamics' ADAMS and DRAMS software.

Getting serious about electronic design

As mentioned earlier, Intergraph had begun offering software that facilitated the graphical layout of circuit boards several years earlier. Meanwhile, the electronics design industry was making the transition to more automated techniques for designing electronic circuits, a field that soon became known as Electronic Design Automation or EDA. This was a new generation of software, not simply CAD software adapted to the design of circuit boards and integrated circuits.

Intergraph's management recognized that EDA was a new specialty field and that new software would have to be developed by individuals who understood what was involved. Rather than setting up such as group in Huntsville, in September 1984 Intergraph provided seed funding for Tangent, a new EDA software company in California. It invested $2 million up front for a 50 percent interest in this new six-person firm and provided it with a $4 million line of credit.

In June 1985, Intergraph announced two EDA products. The first, which ran on the InterPro 32, supported logic capture, rules checking, timing analysis, as well as logic and fault simulation. According to the *Anderson* Report, the software sold for $5,000 per seat. The other package, TANCELL, handled the physical design of semi-custom integrated circuits. It ran on a VAX computer and sold for $75,000 per system.[31]

Eventually, Tangent was acquired by Cadence Design Systems in early 1989 with part of the deal envisioning Cadence porting its EDA software to Intergraph's Clipper workstations. To the best of my knowledge, this never happened.

In December 1990, Intergraph acquired Dazix, the company that was formed in May 1989 as a result of the merger of Daisy and CADnetix. Within months of being formed, Dazix was in deep financial trouble and filed for Chapter 11 bankruptcy. This was in spite of having $90 million in revenue in 1989.

[31] *Anderson Report*, July 1985, Pg. 1

On the surface, it looked as if Intergraph had gotten a bargain since it paid just $14 million for the company, $10 million in cash and $4 million in stock. One of the underlying reasons for Intergraph making this move was to be able to offer customers combined electronic and mechanical design solutions.

Dazix had recently ported its software to Sun workstations and Intergraph stated in early January, 1991 that it would do the same with its existing electronic design packages. The statement was made, however, that there were no plans to convert the company's mechanical software to the Sun platform. That generated concern among users and tended to decrease the attractiveness of Intergraph's combined electronic and mechanical solution since Sun computers were rapidly becoming the preferred workstation platform within the electronics industry.

If nothing else, Intergraph knew how to respond to rumblings among its customers. In February, the company signed an OEM agreement with Sun worth $150 million over three years. This was followed shortly thereafter with the announcement that both MicroStation and I/EMS (the company's new mechanical design software) would be ported to the Sun platform, MicroStation by the first quarter of 1992 and I/EMS by the second quarter. Other than MicroStation and the mechanical product line, however, there were no plans to port other Intergraph software to Sun computers. Meadlock summed up the situation:

> "Today's mechanical engineering marketplace demands the flexibility of a dual platform offering. Our customers tell us they want to be able to easily integrate the electronic and mechanical applications. Having already made the commitment to support our Dazix customers with both Clipper and SPARC workstations, it was a natural decision to move the mechanical product offerings onto the SPARC platform."[32]

Initially, the acquired company was referred to as Dazix, An Intergraph Company. Intergraph continued to pour money into the EDA market. In July 1991, it purchased an 18 percent interest in Silvar Lisco for $1.1 million in cash. By early 1992, the EDA portion of Intergraph was generating over $100 million in annual revenues. Subsequently, the Dazix name was changed to VeriBest. This operation never made any money for Intergraph, however, and it was eventually sold to Mentor Graphics in October 1999 for $11 million.[33] According to *Electronic News*, Intergraph had planned to take Veribest public, but a continuous string of unprofitable quarters, driven by a failure to achieve critical mass, hastened the company's decision to sell VeriBest. Jim Meadlock was quoted as stating:

> "While we think we had an extremely good set of products, we had a hard time making any money. We did set up Veribest to make it an independent company, but we never quite got the economy of scale to be there. (An initial public offering) was the hope, but we finally decided that we weren't going to make it on our own."[34]

---

[32] *Anderson Report*, April 1991, Pg. 3
[33] *Intergraph 1999 Annual Report*, Pg.17
[34] *Electronic News*, November 8, 1999

Intergraph acquires Rand Group

Intergraph added structural analysis software to its product line by licensing a finite element analysis package called Rand-Micas developed by Len Rand. Intergraph named it Intergraph/Rand-Micas and sold it for $25,000 per system. In 1985, Intergraph acquired Rand's Dallas-based company and he went to work for them as president of a new organization called Intergraph-Rand Corporation.

Intergraph becomes a billion dollar company

In 1985, Intergraph became the second largest CAD vendor after IBM, pushing Computervision into third place. From $526 million in 1985, the company's revenues soared to over $1 billion in 1990. By 1992 the company had revenues of $1.18 billion and ranked Number 315 in the *Fortune 500* for that year. That this strong growth came about as other vendors including Auto-trol Technology, Computervision and Applicon stumbled during the latter 1980s did not surprise knowledgeable industry observers. Ken Anderson probably summed it up best in the August 1986 issue of the *Anderson Report*.

> "Competitors and some financial analysts wait for Intergraph to stumble in its relentless growth. Meanwhile the crew in Huntsville seems almost oblivious to outside pressures as they focus on expanding market share across all CAD/CAM applications. Intergraph has a three pronged strategy for growth: internal product development, strategic alliances and acquisition. Two issues are key in the continuing saga of this premier company. Intergraph totally dominates the mapping application and they make the most efficient use of R & D investment of any company in CAD/CAM. This R & D prowess provides a continuing stream of new hardware and software products. Jim Meadlock, Pres. has become a legend in his ability to manage growth and at the same time elicit a high level of dedication from the people at Intergraph."[35]

A critical aspect of Intergraph's product strategy was the selection of Fairchild's Clipper microprocessor to power its workstations at a time when most of the industry heavyweights were going with Motorola's 68020 microprocessor. In mid 1986, the Clipper was perhaps five times as fast as the 68020 but it was an unproven product. One of the issues driving Intergraph to move as rapidly as possible to its own workstations was that Digital was in the process of reducing the discounts it provided to OEM customers. This made the resale of Digital computers less attractive to companies such as Intergraph.

As mentioned above, the major challenge facing Intergraph in mid-1986 was making the transition from a VAX VMS host-based software environment to a UNIX environment using networked workstations and servers. While developing the new UNIX software, Intergraph had to continue maintaining and adding some enhancements to its VAX software in order to keep its existing customers happy. For some time, the company's customers seemed to be content with using the new workstations as VAX terminals while Intergraph chipped away at converting its software products.

---

[35] *Anderson Report*, August 1986, Pg. 3

Intergraph planned to use this software transition as an opportunity to implement some new technologies. In particular, the company began developing software that used "object-oriented" software techniques. Eventually, this would become fairly standard within the software community but in 1986 it was still a fairly radical concept.

At the time, Intergraph's shift to UNIX workstations looked like a smart move and for a number of years it was. Another option existed at the time that might have proven more advantageous in the long run. That was the emergence of the PC as a serious CAD platform. Only a few small companies such as Autodesk and VersaCAD saw this opportunity and pursued it agressively. Already, in areas such as electronic schematic capture, designers were starting to use PC-based software with increasing frequency. Within a decade, Intergraph would end up switching once more – this time from the Clipper-based UNIX workstations to Windows and the PC.

Another issue which would later cause Intergraph untold grief was its focus on being a manufacturing company. By mid-1986 the company had grown to 5,100 employees and was one of the largest employers in northern Alabama. Over the next five years this number would double to over 10,000. Most of these employees staffed the company's growing manufacturing operation.

While the early VAX systems the company sold were virtually standard Digital products except for the File Processor and Graphics Processor, the Micro II systems were Digital's MicroVAXes repackaged by Intergraph. Not only did the company produce its own terminals as did many other turnkey vendors, but it was the only vendor that actually manufactured its own display monitors. The result was perhaps the best CAD display on the market but the cost was a huge manufacturing infrastructure.

The October 1986 issue of the *Computer Aided Design Report* contained a detailed analysis of Intergraph. In it Steve Wolf wrote:

> " We tried hard to dig up an Intergraph user who didn't like the product or the company. We didn't find one. Most reported that the company seems genuinely interested in making suggested improvements. They report that hardware reliability is excellent……Intergraph's software combined with the powerful Interact terminal is probably the best two-dimensional drafting system available at any price……The firm has built good products because it has a small closely knit team of hardware and software wizards lead by one man with a good sense of market timing. As it becomes larger, however, it's doubtful that Meadlock can continue to control Intergraph as easily as he has done in the past."[36]

Intergraph starts serious run at mechanical CAD market

In the latter part of 1986 Intergraph began a major push into the mechanical market space with the launch of I/EMS (Intergraph Engineering Modeling System). The software combined an object-oriented database, NURBS as the means of defining all geometric entities except points and B-REP solids. While these technologies had all been around for several years, no one had combined them in a commercial system due to the computing resources required. With a 5 MIPS InterPro/32C, Intergraph had a platform

[36] *Computer Aided Design Report*, October 1986, Pg. 1

that could handle this software with barely adequate performance. Everyone knew, however, that more powerful workstations were just around the corner.[37]

A prototype of this software was shown at AUTOFACT '86 in Detroit in November 1986. The software was demonstrated running on an InterPro 32C workstation, not on a VAX using the InterPro 32C simply as a terminal. Steve Wolf, who typically was quite reserved when describing new CAD products was ecstatic about I/EMS.

> "Thanks to the computing speed of the Interpro 32C, interactive graphics run faster on this device than on any we've seen. The Interpro 32C is so fast that it lets designers mold sculptured surfaces interactively as if they were putty. Move a control point and the Interpro shows instantly the effect that the change will have on the surface…..Dazzling is the only word we can think of to describe the user controls of Intergraph's new applications."[38]

The version of I/EMS previewed at AUTOFACT supported dimension-driven mechanical drafting. The designer could define the relationships between geometry and when a dimension was changed, the geometry would adapt to that new value. While, this capability was not as comprehensive as what Parametric Technology would introduce a few years later, I/EMS did precede Pro/ENGINEER by several years.

The performance and functional capabilities incorporated into I/EMS were partially due to the fact that it was new software that used advanced concepts such as object-oriented programming. This enabled Intergraph to associate NC tool paths with model surfaces. If the surface was changed, the tool paths could be regenerated without additional user intervention. Wolf stated that tool paths that took 30 minutes to generate on a VAX system took only 30 seconds on the InterPro 32C. The software was scheduled to be released in mid-1987. Intergraph began shipping beta test versions of I/EMS in December 1986 and by May 1987 had installed about 100 copies.

Intergraph becomes a workstation vendor[39]

1987 was a year of transition for Intergraph and for the CAD/CAM industry in general. Other than CADAM, Inc. and a few others, vendors were rapidly switching away from minicomputer and mainframe-based systems to engineering workstations and to a lesser extent, personal computers. Customers were quickly becoming comfortable with the idea of purchasing industry-standard workstations running the UNIX operating system and linking them together in networks using the Ethernet protocol.

By this point, most major users of CAD technology were already on their second or third generation system and the sophistication of the users was increasing rapidly. To some extent, they were willing to purchase hardware and software separately even if it meant dealing with multiple vendors.

---

[37] *Anderson Report*, May 1987, Pg. 1
[38] *Computer Aided Design Report*, December 1986, Pg. 5
[39] Most of this section is based on an extensive report on Intergraph in the June, 1987 issue of *The Anderson Report.*

There was another major trend impacting the vendors in this industry – the price of CAD technology on a per seat basis was falling like a rock. In four years the typical system had dropped from $90,000 per seat to about $40,000. Although the volume was increasing, it was not increasing fast enough to maintain the 30 to 50 percent overall industry growth rates of prior years. By 1987 annual growth had slowed to 12 to 15 percent. In the first quarter of 1987 Intergraph had revenue of $128 million compared to $147 million during the same period a year earlier. Each vendor reacted to these changes differently.

Some companies, such as SDRC were becoming pure software vendors while others such as Calma and Auto-trol resold workstations purchased from Sun and Apollo. Computervision acquired workstation components from Sun and added other hardware elements to the products it sold. The other choice was to become a workstation vendor and sell these systems to the general technical market as well as incorporate them into the CAD/CAM systems the company sold. With the InterPro/32C, Intergraph decided to follow this latter path.

There were a number of reasons why Intergraph became a workstation vendor. First, Digital was becoming more and more difficult to work with even though Intergraph was Digital's largest OEM customer. By mid-1987, the company had installed over 3,000 VAX systems with over 15,000 terminals. Digital was cutting OEM discounts and for a period of time treated details about its VAXBI bus as proprietary information. The latter step made it impossible for Intergraph to interface its communications and file processors to the latest VAX systems. Although the two companies eventually resolved this issue it probably convinced Intergraph managers that Digital was no longer a reliable partner.

Another major reason that Intergraph decided to build its own workstations and servers was that the company had built up a considerable manufacturing infrastructure in Huntsville. Most of these facilities were fairly new and shutting down this operation would have been very expensive. Also, manufacturing its own workstations was expected to generate more profit for the company as compared to reselling workstations from companies such as Sun or Apollo.

Since the company's software did not run on other UNIX workstations, if a customer wanted Intergraph software then it had to buy the workstations from Intergraph also. The extreme degree of vertical integration at Intergraph was demonstrated by the fact that the company had a fleet of ten tractor-trailers crisscrossing the United States and Canada delivering systems to its customers rather than relying on commercial carriers.

Intergraph's customers were enthusiastic about the new InterPro products with nearly 2,000 Clipper-based workstations on back order by mid-1987. The problem was that Fairchild was only delivering 75 to 100 C100 Clipper chips per week, about the same volume as incoming orders. Within a few months this shortage was corrected and Intergraph was able to clear its backlog.

A more significant problem was that Intergraph had decided to fundamentally rewrite its software for the new UNIX workstations rather than simply port the legacy VMS software to these machines. In the long run that was probably the right move but in the short run it led to there being little software that ran in native mode on the InterPro 32/C. There were perhaps a dozen packages available with another 15 scheduled by the end of 1987.

If the company was to be a viable workstation vendor, it needed more software for its customers to use. In February 1987 Intergraph had announced that it was entering the general purpose workstation market and it began soliciting third party software vendors to port their software to the InterPro 32C. There was a fatal flaw in this strategy, however. A large volume of workstation sales at Sun and Apollo came from CAD/CAM software vendors, either directly as OEM resellers or indirectly by referral. This was a major portion of the workstation market in the late1980s and none of these software companies were particularly interested in supporting a platform produced by a direct competitor when viable alternatives were available.

But Intergraph pushed ahead with its workstation strategy and in July 1987 introduced a family of new workstations that still used a 5 MIPS C100 Clipper microprocessor. Memory ranged from 8MB to 80MB and larger disk memories were available. A new GZ graphics accelerator capable of nearly real time generation of shaded images was available at the high end.

The GZ was the beginning of a long line of high-performance graphics accelerators that would eventually result in a separate business unit focused just on these devices. With these new workstations and servers Intergraph adopted more industry standards. Its Ethernet communications now supported TCP/IP as well as XNS, the company planned to begin using the X Windows graphics standard along with the MOTIF user interface and Intergraph also planned to support Sun's NFS file protocol.

The company stated that it would continue to market and support VAX systems, but the reality was that little new software was being developed for these platforms. Initially, the concept was that the VAX computers would be used to manage large project data files while the Clipper workstations would be used for interactive work. Most customers did not like the idea of supporting two hardware platforms and two operating systems and once Intergraph's servers were able to handle large volumes of data, this idea faded into the background.

The other problem facing Intergraph as it tried to build a commercial workstation and server business was that it was dependent upon Fairchild for progress in microprocessor performance and Fairchild was only marginally up to the challenge. In July 1987, Sun Microsystems introduced new workstations that used a 10 MIPS SPARC processor, twice the raw performance of Intergraph's then current Clipper systems.

Taking control of its own microprocessor destiny

Fairchild Semiconductor was owned by Schlumberger Ltd., the huge international oil field services firm. Schlumberger had acquired Fairchild in 1979 for $425 million. It turned out to be a major disappointment for its new owner and by mid-1987, Schlumberger was discussing sale of the subsidiary to National Semiconductor. National made no secret of its plans to shut down the Clipper microprocessor operation once it completed the acquisition.

Having selected and then dropped National's microprocessor product line, Intergraph was now faced with making another significant change in its product line. This time it was a much more serious situation since Intergraph had already sold more than 3,000 Clipper-based workstations and servers. An abrupt termination of the product line would have meant the loss of the Clipper development staff and no future processors even if National continued manufacturing the existing products for some period of time.

In September 1987, Intergraph signed an agreement with National to acquire the Advanced Processor Division of Fairchild to be effective when National completed its acquisition of the remainder of Fairchild. Intergraph announced its plans when it did in order to keep the Clipper development and manufacturing staff together. Schlumberger subsequently sold Fairchild to National for $122 million and at the same time Intergraph acquired the Advanced Processor Division for an estimated $10 million including all microprocessor designs and other intellectual property. As described below, the timing of Intergraph's acquisition and what was included as far as intellectual property would be the basis of several major lawsuits a decade later. But for now, Intergraph controlled its own destiny as far as the Clipper was concerned.

Within a few months Intergraph was ready to roll out a new C300 Clipper microprocessor at AUTOFACT '87 that was rated at 13 MIPS, almost three times the performance of the initial C100[40]. Internal floating point performance was rated at 3.0 MFLOPS. According to *The Anderson Report*, this was the level of performance needed to support new object-oriented applications such as I/EMS.[41]

The company also introduced the low-cost InterPro120 which used the older C100 processor. With 6MB of memory, a hardware floating-point accelerator, an 80MB disk and a 15-inch color monitor, this unit had a list price of just $16,000. A 19-inch monitor raised the price to $19,000. Typical of a new generation of customers was Embraer, the Brazilian manufacturer of small airliners, which purchased 135 InterPro workstations and software for $6.4 million.[42]

Creating a new generation of software products

In mid-1986 the company's management structure still had Jim Meadlock as president and CEO with William Zarecor as executive vice president responsible for overall marketing activity. Bob Thurber was also an executive vice president, responsible for most AEC and mapping activity. Under Thurber, Dr. Eddie Boyle headed up AEC and Utilities while Larry Janzen was responsible for mapping and energy industries.[43] Boyle, with a civil engineering degree from Belfast's Queens University, was one of the first non-Americans to hold a senior position at Intergraph.

One of Intergraph's new software packages for its UNIX workstations was Master Architect, a model based design tool that used object-oriented software development techniques. Design elements could be linked together in an intelligent manner so that when a user moved a door or window, the walls were adjusted appropriately. The $10,000 package enabled users to work with three-dimensional views of the building model and two-dimensional drawings at the same time.

Gradually, the number of third-party software packages available on Intergraph workstations began to grow. At AUTOFACT in November 1987, four companies announced plans to port their software to Intergraph's Clipper workstations. These were

[40] Most of the early C300-based workstations were rated at just 10 MIPS operating at 40-MHz. The 13 MIPS performance was probably for a 50-MHz processor which the company initially had problems producing.
[41] *The Anderson Report*, December 1987, Pg. 3
[42] *The Anderson Report*, December 1987, Pg. 7
[43] *A-E-C Automation Newsletter*, June/July 1986, Pg. 9

Moldflow (plastic flow prediction), Cincom (manufacturing information), SILMA (robotic simulation) and Engineering Mechanics Research (finite element modeling).

Intergraph's internal software development organization continued to churn out new software programs in 1988 including one of the first implementations of IGES 4.0, an enhanced Product Data Manager package and a new Intergraph/Network File Manager. The latter package provided check-in/check-out capabilities with the data stored on either a VAX or a Clipper system. The company also added new NC software to the I/EMS product line. Subsequent to the acquisition of Ana Tech described below, Intergraph introduced I/Image software which enabled a user to combine scanned raster data with vector data.

New higher performance workstations and servers

Intergraph announced a number of high performance workstations beginning with the InterPro 3070 at AUTOFACT '88 in Chicago. This workstation used a 40-MHz C300 processor rated at 10 MIPS and had a 27-inch monitor, the largest then sold commercially for CAD/CAM applications. The display processor supported two million pixels at 1664 by 1248 resolution. The 3070 was priced at $56,000. The company was thought to be working on a new version of the Clipper that would run at 60 MIPS.

The 3070 was followed in January 1989 by two C300 servers, the InterServe 3005 and the InterServe 4000. The latter machine supported up to 23GB of disk storage. This was followed by two new workstations, the 3050 and the 3060. A separate Intel 80386 processor supported input/output functions. Display resolution was 1184 by 884 and up to 512 colors could be displayed. In February, Intergraph announced a new higher performance microprocessor, the C300 Plus. Rated at 30 MIPS, it was initially offered in a server configuration, the InterServe 3505 with 32 to 160MB of memory and up to 6.5GB of disk storage.

In the spring of 1989, Intergraph broaden its market reach by introducing an Apple Macintosh version of MicroStation as an entry level design and drafting tool. The software was data compatible with VAX and UNIX versions of Intergraph's IGDS software. It handled three-dimensional models including producing shaded images. Up to 32 reference files were supported as were normal Apple functions such as the clipboard, a one-button mouse and Undo/Redo. The user interface supported over 450 commands.

One of the key features of MicroStation was that data files were binary compatible on all the platforms the software was offered on. Therefore, files could easily be exchanged between PC, VAX, Apple and Intergraph systems without a conversion step. Also, MicroStation operated on disk-based files rather than memory-based files meaning that if there was a power failure or system crash, valuable data would not be lost.

Document scanning

In August 1988 Intergraph acquired ANA Tech Corporation of Littleton, Colorado. ANA Tech was a manufacturer of large format scanners capable of handling engineering drawings and maps as well as a developer of software for editing and converting scanned raster images into vector data files that could be processed by computer graphics software such as Intergraph's IGDS.

ANA Tech had evolved from an earlier company, Interactive Systems Corporation. The key component for processing scanned drawings was a special processor called the VANA for **V**ector **ANA**lyzer as described below. A complete system consisted of:

- A large format document scanner,
- The VANA Vectorizer,
- The VANA Controller (VAX 11/750)
- And software for tying it all together.

In its early days, circa 1982, the company used scanners produced by companies such as Optronics and Systems Group. The latter company produced a scanner specifically for use with the ANA Tech system. The VANA Vectorizer was a custom designed array processor which converted scanned raster data to vectors as a document was being scanned. It was very fast – capable of processing an E-size drawing in several minutes.

The VANA Controller was a standard Digital VAX 11/750 computer with a Megatek 7210 graphics controller capable of supporting two monochromatic or color displays. The software was capable of symbol and character recognition using the vectorized data as its starting point. A complete VANA system including a System Group scanner and VAX computer cost $665,000.

The focus on vectorizing raster data was based on the fact that contemporary CAD systems were not capable of manipulating raster images. These system handled legacy documents using several different techniques. The most common approach was to tape the drawing to a large digitizer table and manually digitize the document line by line. A second approach was to scan the document, display the raster image on a CRT display and use specialized computer software to create a vector and character overlay of the scanned image. The third approach was to convert raster images to vector files either using software in the CAD system or a specialized system such as the Ana Tech VANA.

The key people behind ANA Tech were David Grover, president, Curtis Lipkie, vice president responsible for software development and Eugene Kleca, vice president responsible for hardware development.[44]

Meanwhile, Intergraph was developing its own expertise in the scanning area. Using scanner hardware from Optronics, a company it would later acquire, Intergraph offered a documents scanning product that included a hardware raster to vector conversion unit simply called the Graphics Processor. As with ANA Tech, character recognition was not particularly effective in the 1983 timeframe. Throughout the 1980s, ANA Tech struggled to become a viable company. There were several infusions of additional venture capital as well as management changes until Intergraph acquired the company in 1988. Gradually, the VANA Vectorizor was phased out and the company focused on large format scanners and raster processing software.

In June 1992 ANA Tech introduced the Eagle 4080ET scanner with 800 dpi resolution. It was priced at $35,000 and worked with PCs as well as Intergraph and Sun UNIX workstations. A color version, the Eagle 4080C was introduced in late 1993 priced at $95,000. It could scan a 41-inch wide multi-color map in 12 minutes and at the same time separate the data into seven layers based upon the colors on the original document.

[44] *A-E-C Automation Newsletter*, August 1982, Pg. 8

When a USGS Quad sheet was scanned and then plotted on an HP inkjet plotter it was hard at first to tell the plotted copy from the original.[45]

A key product that came out of Intergraph's association with ANA Tech was the I/RAS software for editing raster data. I/RAS was tightly integrated with MicroStation. The software could be used to replace raster data with vector elements. New vector elements were overlaid on the raster image and then once the user was satisfied with the results, the raster data was removed. There were several different version of the I/RAS software.

In mid-1995, ANA Tech introduced a new low-cost scanner, the Eagle SLI 3840. This 100-pound desktop unit could scan an E-size drawings in as little as 15 seconds at 200 dpi resolution. It was capable of resolutions as fine as 800 dpi and sold for $12,800 in the United States.[46] ANA Tech began to increase its focus on raster editing software around 1996. In that year it introduced its SCANSMITH line of software designed for real-time scanning and post-processing of raster documents. This was followed the next year with the company's PREDITOR (Professional Raster Editor) software package that enabled user to edit large raster images irrespective of the scanning equipment being used.

In April 1998, Intergraph established a new Imaging Systems Division with Lewis Graham as its vice president and manager. This division consisted of the company's photogrametric and reprographics software, the ImageStation Z, PhotoScan TD precision scanners and the ANA Tech scanning hardware. With this change in management, Eugene Kleca and Curt Liepke, both ANA Tech founders, left Intergraph and set up a new company, Image Peak Systems.

Intergraph at the end of the 1980s

During the 1980s, Intergraph grew rapidly, created a global presence, became a significant manufacturer of UNIX workstations and servers and added tens of thousands of users. It was clearly a company "on a roll." The November 1989 issue of *The Anderson Report* was optimistic about Intergraph's future:

> "In our view the company made the right decisions. Intergraph has done an excellent job of merging a UNIX-based product line with their VAX/VMS-based solutions….. rather than porting existing applications to UNIX, Intergraph made a decision to develop new object-oriented foundations for their CAD/CAM software. This choice held even higher risk than the decision to build workstations."

By the end of 1989, over 80 percent of the company's system revenue resulted from the sale of UNIX workstations and related software. The only reason it was not 100 percent was that there were still some applications such as plant design software that were only available on VAX systems. Not only was Intergraph attempting to develop a commercial business selling Clipper-based workstations and servers but its was also attempting to sell Clipper microprocessors to other computer system vendors. In the end, it was successful in doing neither. One area where it was starting to have an impact,

[45] *Engineering Automation Report*, December 1993, Pg. 3
[46] *A-E-C Automation Newsletter*, June 1995, Pg.12

however, was in the PC CAD market. MicroStation was available on IBM-compatible PCs and Apple Macintosh machines as well as Intergraph's own UNIX workstations.

The biggest inhibitor to selling commercial Clipper-based systems was the lack of third party software. Intergraph claimed that there were 500 programs available for these systems, half from independent software firms. The reality was that few of these software companies treated the Clipper systems as a primary platform and many of these packages handled minor applications with limited customer demand. There simply were few main-stream software packages available that could stimulate hardware sales other than Intergraph's own software.Towards the end of 1989 Intergraph introduced several 50-MHz C300 workstations, the 3280 and 3285, which ran at 14 MIPS, the speed originally expected for this microprocessor when it was first introduced. As the year came to a close, Intergraph had an installed base of perhaps 26,000 Clipper systems.[47]

Intergraph had an extremely broad set of its own software products at this point in time, but some cracks were beginning to show. For example, I/EMS which had been introduced in 1986 was only in its second major release three years later. Competitive products such as PTC's Pro/ENGINEER had not only caught up with I/EMS but had surpassed it in functionality. In the mapping and AEC areas, Intergraph was clearly the industry leader with a growing number of applications running on the company's Clipper workstations. New packages such as InRoads for highway design and InFlow for hydraulic design were becoming well accepted industry standards. One weak area was in electronic design where the company offered a rather straight-forward set of packages for the physical design of circuit boards and hybrid circuits.

The end of 1989 also marked a significant management change at Intergraph. The company acquired Quintus Computer Systems, a developer of Prolog-based[48] software development tools. The president and CEO of Quintus was Elliot James who subsequently became president of Intergraph. Jim Meadlock retained his chairmanship of the company's board and his position as CEO. There never was any question as to who was really in charge, however. Although he was supposedly semi-retired and was spending more time at his vacation home in Jupiter, Florida, Meadlock's influence continued to be felt throughout the company.

Overall, as the company got ready to enter the 1990s, it was functioning as a well oiled machine. It had excellent hardware products that covered all the typical user's needs except for plotters and these were readily available from companies such as Hewlett-Packard and CalComp. Its software dominated the high-end mapping and AEC markets and it had adequate mechanical software. The company was profitable and had fairly good management depth. The problem was what over the horizon – the shift to PCs and an entirely different economic model for CAD vendors – changes that would see Intergraph stumble, make some hard decisions and eventually emerge as a well financed software company focused on specific market sectors.

Trying to offer something for everyone

One significant characteristic of Intergraph's product strategy in the early 1990s was an attempt to be all things to all people. The company began to aggressively market

[47] *The Anderson Report*, December 1989, Pg. 4

[48] Prolog is a programming language used to develop logic oriented software packages sometimes referred to as "artificial intelligence."

its Clipper workstations and servers as industry standard products, taking specific aim at Sun Microsystems. Ads appeared in a wide range of publications claiming feature by feature that Intergraph's systems did everything that Sun's products did. Intergraph pushed hard to increase the number of third party software packages available on these systems. The company's attempt to market the Clipper microprocessors to other computer manufacturers, however, was suspended in October 1990.

By late 1990, the company was claiming the availability of 900 software packages on the Clipper platform, 600 of which came from other companies. In spite of this momentum, industry observers as well as users were questioning the long term viability of proprietary processor technology. Shortly after Intergraph committed to porting MicroStation and I/EMS to Sun Microsystems workstations as described earlier, *CAD/CIM Alert* commented on the Clipper product line:

> "However, we wonder how long these platforms can last. Even though there is a large installed base of customers, the days when proprietary hardware platforms ruled the roost are long since gone."[49]

Intergraph continued to expand the Clipper product line, however. At AUTOFACT '91 in Chicago, the company launched the two chip C400 Clipper processor. Running at 40 MHz, it was rated at 33 SPECmarks, 33 MIPS and 9 MFLOPS. This was faster than anything Sun Microsystems then had on the market and the expectation was that Intergraph could crank the speed up to 100 MHz in the future. The new 6400 workstation product line using this processor started at $24,900 for the Model 6450. The 6480 with 24-bit graphics was priced at $37,900[50] Around the same time, Intergraph announced that it would no longer offer Digital systems.

Intergraph's revenues reached a high water mark of $1.2 billion in 1991 although earnings were no higher than they were in 1987. The company's stock price in mid-1992 was $17 per share, about what it had been nearly a decade earlier and half what it was in mid-1991.[51] The commoditization of the CAD industry was becoming increasing clear. Maurice Romaine, one of the company's multiple executive vice presidents, stated: "The question is how we will be able to deliver lower and lower cost hardware seats and still provide the level of complete package solutions and value-added services." This is an issue that would plague the company for the next decade. About this time the company's employment peaked at somewhat over 10,000.

Additional C400 workstations were introduced throughout 1992 while prices on older C300 units decreased substantially. In early 1992 the C300-based InterPro 2020 with 16MB of memory, a 486MB disk and 19-inch color monitor was reduced from $16,900 to $12,500. A similarly configured C400-based 2430 was priced at $18,500. While Intergraph was moving fast to improve the price/performance of its workstations, the competition was moving even faster. Hewlett-Packard's Model 705 offered about the same performance as the 2430 but at the price of a 2020. Intergraph kept pushing and an 80 MHz C400 processor was launched in early 1993 along with a new batch of workstations. Some of these sported a two-megapixel 21-inch color monitor.

---

[49] *CAD/CIM Alert*, March 1991, Pg. 12
[50] *The Anderson Report*, December 1991, Pg. 3
[51] *Engineering Automation Report*, June 1992, Pg. 6

Well into 1992 Intergraph's management was adamant, at least to outside observers, that building their own workstations with their own microprocessors was the right way to go. At that point in time there was no clear winner among the many RISC processors on the market and companies such as Sun, Digital and Hewlett-Packard had already switched directions several times. Intergraph justified development costs by stating that at $12 million annually, the Clipper represented less than 10 percent of the company's total R&D budget.

Spread over 17,000 computer systems per year, this was a little more than $700 per unit. Since they did not have to pay another company for these systems, they felt they were able to maintain competitive prices. In addition, by building all the components, Intergraph was able to fine tune them to work effectively together. Although the latter was a valid point, economics would soon force Intergraph to change directions.

While Intergraph was focusing much of the company's energy on the hardware side of the business, it was also pouring considerable resources into software development as described below. This was the most comprehensive set of application programs offered by any one vendor.

MicroStation – Although the Clipper and PC versions of this software took top priority, work progressed on porting MicroStation to other UNIX platforms. A Sun version of MicroStation Version 4.0 began shipping in early 1992. While Intergraph was a proponent of the industry-standard MOTIF user interface, Sun was pushing its own OPEN LOOK interface. Intergraph and its Bentley partner compromised and provided both interfaces and left it up to the user to select which would be utilized.

Early versions of this software did not fully take advantage of the graphics hardware in the Sun workstations resulting in mediocre performance compared to Intergraph's InterPro and InterAct workstations. Interestingly, if the Sun workstation was equipped with dual monitors, the software would support them much like the way MicroStation ran on a dual screen Intergraph workstation.[52] Support for Hewlett-Packard workstations followed in mid-1992. MicroStation was competitively priced against AutoCAD at $3,450.

AEC Applications – Intergraph offered as broad a suite of architectural and civil engineering applications as any vendor. These covered everything from electrical to HVAC to surveying to roadway design. Most worked fairly well with each other. This particular market was rapidly shifting from UNIX workstations to PCs and the company's dealers were taking on more of the sales and support responsibility for these customers.

Plant Design System – The PDS software developed working with Zydex Engineering was rapidly becoming a key part of Intergraph's business. While the AEC software tended to be sold to small firms except in the highway design sector, PDS was still a workstation oriented market and the customers were large engineering firms and owner/operators. The primary competition was PDMS developed by the UK's Cadcentre. Several visualization packages were available to support PDS and AEC applications. ModelView provided a variety of color selection and texture definitions as well as several alternative ways of generating images including ray tracing. DesignReview extending this capability to include navigation through complex three-dimensional models.

---

[52] *Engineering Automation Report*, April 1992, Pg. 4

Mapping – The company's mapping software had been rebuilt during the prior several years and reintroduced as the Modular GIS Environment (MGE). It was much more database oriented than earlier software and supported Oracle, Informix and Ingress database management systems. The major focus was in producing maps for government agencies as well as for organizations engaged in oil and gas exploration. The company's primary competitor was ESRI which was more focused on thematic mapping.

Facility Information Management – A growing portion of Intergraph's business was selling mapping system to electrical, gas and telephone utilities. Automated Mapping/Facility Management (AM/FM) software was a combination of mapping, database management and specialized applications. Intergraph called its newest product in this area FRAMME (Facilities Rulebase and Application Model Management Environment). Intergraph was particularly proud of utilities that had computerized 100 percent of their maps. They called this the 100% Club. In mid-1992, there were 15 members of the "club".

Dispatch Management – Intergraph took its mapping software and graphics visualization capabilities and added some specialized software to meet the needs of emergency dispatch centers. This was a good case of extending existing technology into a new market. Eventually, this would become a major component of Intergraph's business, but not without some growing pains.

Mechanical – Intergraph began putting more resources in developing mechanical design and manufacturing software in the late 1980s. I/EMS Release 1.3 came out in early 1990 with dynamic dimensioning, interference checking, a customizable user interface and other productivity enhancements. This was followed later in 1990 by I/Punch for water-jet and laser cutting machines, I/Fold for sheet metal design and I/Design for conceptual modeling.

Several additional releases followed in short order. Intergraph offered its own analysis software as well as Applied Structure licensed from Rasna Corporation and sold as I/Rasna. In March 1993, Intergraph dropped the entry level price for I/EMS from $20,000 to $9,900 when it began selling a version with just basic design and modeling capabilities called EMS Foundation. Other bundles of EMS modules sold for $17,000 to as much as $25,900.

Electronics – By mid-1992, Intergraph Dazix subsidiary was selling a fairly complete suite of software for the design of integrated circuits, printed circuit boards and multichip modules.[53]

Intergraph and the Federal Government

No discussion about Intergraph would be complete without a detailed review of the company's relationship with the federal government. Over the years this activity had three primary components: custom programming projects, many of which involved classified work; the sale of standard Intergraph hardware and software products; and large competitively bid contracts particularly with the U.S. Army Corps of Engineers and the U.S. Navy.

Intergraph sold several VAX-based systems to various Corps of Engineers offices prior to 1986. In 1986 the Corps issued a Request for Proposal (RFP) for about 20 CAD systems that would be installed its design offices around the country. In addition to

[53] *Engineering Automation Report*, June 1992, Pg. 6

Intergraph, serious bidders included Auto-trol Technology[54] and McAuto. Intergraph won this contract eventually worth over $80 million.

The Navy's CAD-2 program was much larger than any CAD procurement previously or since. In 1981 the Navy awarded Computervision a large contract for systems to be used for both mechanical and AEC applications. Known as CAEDOS for Computer-Aided Engineering and Documentation System, it was the first in the CAD industry for what was known within procurement circles as an "indefinite quantity, indefinite delivery" contract. What this meant was that the government awarded a contract to the winning bidder without any guarantee that it would procure the full amount of product covered by the contract although there was typically a minimum quantity defined. A maximum quantity for each line item was also defined in the contract.

Sometimes these contracts were a goldmine for the vendor and sometimes they were a disaster. CAEDOS was a goldmine for Computervision. The contract, which was actually awarded by the Naval Weapons Center at China Lake, CA, called for a minimum of 135 workstations and a maximum of 405. By 1985, the Navy had purchased the maximum number of workstations allowed and Computervision had received orders for $99.9 million of hardware, software and maintenance services. As of December 1985, the Navy expected to have a new contract for next generation CAD systems in place by 1987. That did not happen and Computervision probably booked millions in additional revenue from the Navy with small sole source deals for additional systems and workstations as well as maintenance over the next six years.

An extensive CAD-2 briefing was given by Dale Christensen in Washington in December 1985 at the Defense Computer Graphics Conference. Christensen had been involved in the earlier Computervision contract and was instrumental in the establishment in 1980 of the National Computer Graphics Association (NCGA). The formal launch of the CAD-2 procurement occurred with a pre-solicitation conference at the Naval Surface Weapons Center in White Oak, MD on February 7, 1986 in the midst of a fairly heavy snowstorm. At this time, the Navy issued a preliminary Request For Information (RFI).

CAD-2 (that name actually came into use somewhat later) was intended to be the middle stage of a three stage process. CAEDOS, which automated discrete processes, was considered stage one. CAD-2, the second acquisition, would cover the period from 1987 to 1991 and would extend the automation of these discrete processes. In 1993, the Navy planned a third procurement which would link together multiple automated processes. It sounded good. The problem was that the Navy proved incapable of executing the CAD-2 procurement in a timely manner and the technology kept changing faster than the Navy could keep its specifications updated.

The initial plans for the CAD-2 procurement took the form of a matrix of functional requirements. Five different technical areas were identified: design, engineering analysis, manufacturing, drafting and technical publishing. There were four processes identified by the Navy: naval architecture, mechanical, electronic and AEC. Except for the fact that ship design and AEC had no manufacturing requirements, each process had needs in each technical area. A July 1986 amendment to the RFI added an additional area, aircraft design, to the initial draft specifications.

[54] I was the head of Auto-trol's Government Systems group at the time and directly responsible for the company's bid to the Corps of Engineers

In 1986 the plan was to award multiple contracts for commercially available hardware and software. These would be indefinite quantity, indefinite delivery contracts from which Navy organizations would order what they needed. Although the Navy kept stating that CAD-2 would be a large program, no dollar figures were provided by government personnel. One number did catch everyone's attention. That was the fact that there were over 40,000 civilian and military technical professionals in the Navy. This was the time when the federal government under President Reagan was working towards a 600-ship Navy. The media started talking about this procurement as a $500 million to $1 billion program.

Most vendors expected a formal RFP before the end of 1986. Instead, the Navy scheduled a series of meetings with potential bidders for the purpose of discussing the specifications. It wanted industry input on what was considered beyond current vendor capabilities as well as what had been left out. These meetings took place at the Naval Weapons Center, China Lake, CA. Over 50 companies made the trek to this facility in the middle of the Mohave Desert to spend a few hours discussing the preliminary specifications with Navy personnel who had been drawn together from a wide range of Naval organizations.

At China Lake, Christensen stated that the RFP would be out sometime between February and April, 1987, but it quickly became apparent that this was not to be. Instead, the Navy issued a second Request For Information in early January 1987. With this second RFI, the Navy made several major conceptual changes. Most significant was that instead of focusing on discrete engineering disciplines, the procurement was being restructured into five specific command-centric procurements:

- Ships - Naval Sea Systems Command (NAVSEA)
- Airplanes – Naval Air Systems Command (NAVAIR)
- Buildings – Naval Facilities Engineering Command (NAVFAC)
- Electronics – Space and Naval Warfare Systems Command (SPAWAR)
- Printing – Naval Supply Systems Command (NAVSUP)

There was a growing recognition within the Navy that each of these areas had unique requirements. The new plan was to have a common core of requirements for computer and communications equipment, operating systems, office software and basic CAD capabilities with mission specific software for each command. In January 1987, the Navy asked vendors for a quick response to the second RFI so that RFPs could be issued. One problem was that the Navy planned to issue a single consolidated RFP document with each requirement identified as to its applicability to specific solicitations.

In early 1988 responsibility for CAD-2 was transferred from the Navy Sea Systems Command to the Naval Data Automation Command. At this point, numbers as large as $2.5 billion for the acquisition were being kicked around.

The General Accounting Office had initiated an analysis of the program in early 1987 based upon a request from the House Appropriations Committee. Its initial report, *Issues Concerning Technical Specifications for Navy's CAD/CAM Acquisition*, which was issued in March 1988, basically agreed with most vendors that the specifications were excessively detailed and would result in greater than necessary cost.

A second GSA report released in May 1988, *Navy CAD/CAM Acquisition Has Merit but Management Improvements Needed*, claimed that the Navy had not followed Department of Defense procurement regulations. Specifically, the report stated that

"Regulations require that user needs be established and validated, alternative solutions be evaluated, and a management plan for guiding an acquisition be developed, respectively, before a system solution is defined in a technical specification." This report recommended that the Navy postpone release of CAD-2 RFPs.

Throughout the entire procurement process, the Navy was adamant that this was a UNIX workstation procurement and that PCs did not have the horsepower to satisfy its needs. In June 1988, the Navy was struggling with its budget for computer equipment and concern was growing as to where the money would come from for CAD-2. In one step to conserve funds, the Navy limited any CAD purchases to $50,000 until CAD-2 was awarded.

What this did was to create an opportunity for local AutoCAD dealers to begin selling PC systems to the Navy as "interim" solutions. The Trojan Horse was inside the gates of the fortress. Eventually, the Navy narrowed the procurement to three RFPs, one each for NAVSEA, NAVFAC and NAVAIR. These were released in 1999 and 2000.

Intergraph was awarded the first of the Navy's CAD-2 contracts, a $362 million 12-year NAVSEA deal, in April 1991. The major competitor was Planning Research Corporation which was the prime contractor for Computervision's bid. When the award was first announced in March, PRC filed a protest but this was soon dropped and the contract with Intergraph was finalized shortly thereafter.

The NAVSEA contract involved I/EMS software and Clipper-based workstations and servers. Although the Navy's specifications called for industry standard computers, particularly the use of the UNIX operating system, they did not rule out proprietary components such as Clipper microprocessors. Within the first three years, Intergraph delivered $115 million of hardware, software and services to the Navy based on this contract.

The second of the Navy CAD-2 contracts to be awarded was the one for the Navy Facilities Command. Commonly called NAVFAC, this contract for 4,200 workstations and over 1,000 servers was initially awarded to Intergraph in September 1992 but was protested by Federal Computer Corporation (FCC) and Cordant Incorporated, a system integrator based in Reston, Virginia (originally called Centel Federal Systems).

The protest was based on the claim that the Navy's benchmark had favored Intergraph. The GSA Board of Contract Appeals instructed the Navy to either award the contract to the low bidder, in this case FCC, or go through a new round of bidding with the benchmark evaluation criteria better defined.

After a year-long legal struggle and a new round of bidding, the Navy negotiated a deal to split the contract, estimated to be worth $550 million, between Intergraph and Cordant. The latter company offered a solution based on Autodesk's AutoCAD software running on Sun Microsystems workstations. Intergraph's proposal envisioned a combination of Clipper workstations and Windows NT systems. FCC, the original protester, eventually decided not to participate in the rebid of the contract. In typical government procurement practices, only $1 million in actual purchases was guaranteed to each vendor. This was quickly passed for both vendors within the first 30 days of the contract award.[55]

[55] I was a member of an advisory board established by the Navy to help guide it through the implementation of these systems.

The NAVFAC contracts included the ability for other federal government agencies to buy hardware and software products from Intergraph and Cordant. This enabled the Army Corps of Engineers to upgrade the VAX systems it had procured from Intergraph in the late 1980s with higher performance and lower cost UNIX and PC systems. Federal government civilian agencies such as the Department of State and the Department of Energy were also able to buy off the contracts up to a maximum of $50 million of hardware and software.[56]

Over the next four years, the Corps of Engineers, the Navy and other government agencies procured almost $250 million of CAD-2 hardware, software and services off the two NAVFAC contracts, about evenly split between the two vendors. The Army tended to purchase Intergraph products while the Navy tended towards AutoCAD. Most systems installed were PCs running Windows NT.[57]

The third piece of CAD-2, the NAVAIR/SPAWAR contract, was awarded to Intergraph in July 1994. Like the other contracts, it was also protested, this time by Grumman Aircraft. The GSA held up the award for a few months but it was finalized in November. This contract was for 3,600 workstations and 1,000 servers and included both mechanical and electronic design software. Worth $398 million, it provided Intergraph with the opportunity to sell a total of over $1 billion of hardware, software and services to the DOD over a period of nearly 15 years from when the first NAVSEA contract was awarded.

One interesting aspect of this latter contract was that the Navy's benchmark test was done nearly 18 months prior to the contract award. At the time Intergraph was proposing its 6400 series Clipper workstations. Since that product line had been discontinued by the time the contract was awarded, the Navy was able to switch many seats to newer PCs running Windows NT at a considerable savings in unit costs. This final CAD-2 contract was awarded nearly nine years after the Navy initiated plans for upgrading its engineering design infrastructure.

Intergraph's relationship with the Navy became complicated when Intergraph sold its mechanical business unit, including both I/EMS and Solid Edge, to Unigraphics Solutions in early 1998 as described below. I/EMS only ran on Intergraph's Clipper workstations and UGS had no interest in continuing the development of this now obsolete package. Also, the Navy was seriously switching away from UNIX and towards Windows NT PCs as its standard platform. In mid-1999, UGS and Intergraph got the Navy to agree to replace I/EMS with the Windows NT version of Unigraphics over a period of time.

The game gets tougher

Working with Bentley Systems, Intergraph launched MicroStation PC 4.0 in the fourth quarter of 1990. It included a new user programming language, MicroStation Development Language (MDL), which enabled users to embed C code in their customized MicroStation applications. This proved to be a key development and for well over a decade Bentley would use MDL as a primary application development toolkit. Around this time, Intergraph starting developing a dealer organization to sell the PC version of MicroStation and related PC applications. The company's direct sales force

[56] *A-E-C Automation Newsletter,* April 1994, Pg. 10
[57] *A-E-C Automation Newsletter*, July 1997, Pg.10

was the exclusive distribution channel for MicroStation on Intergraph's own Clipper workstations.

In 1992, Intergraph finally seemed to recognize Autodesk for the competition that company presented to traditional turnkey vendors. One competitive move was to offer a copy of MicroStation for $500 for each copy of AutoCAD turned in.

As the PC picked up steam in the CAD market, Intergraph started to take it more and more seriously. In November 1992 at AUTOFACT '92 the company announced that MicroStation 5, due out in 1993, would be available as a Windows NT application. In addition, the company announced that its broad range of MicroStation-based applications would also be ported to Windows NT to run on both PCs and the company's own Clipper workstations which would soon support NT as well as the company's own version of UNIX, usually referred to as CLIX. At the same time, Intergraph stated that it planned to continue manufacturing its own UNIX workstations. According to Tommy Steele who had recently joined Intergraph after a long career at IBM, "…our users will have a choice of operating environments: UNIX or NT. Intergraph will ensure seamless interoperability for mixed OS environments."[58]

As 1993 started, it looked as if Intergraph was in for a rough time making the transition to Windows NT while maintaining all of its existing UNIX products. In fact *Engineering Automation Report* said, "1993 is a year Intergraph might wish it could just skip. It is becoming harder for them to produce workstations that match the computational performance that other vendors bring to the table."[59] Early 1993 saw the introduction of a number of new workstations and servers based on the C400 processors. Although the company would introduce additional C400 systems in the future this was the last major Clipper introduction by the company.

For the most part, these units were price competitively with what the competition was offering. Intergraph had an advantage over its hardware competitors in that it offered 19-inch, 21-inch and 27-inch monitors, some of which it manufactured itself while other vendors did not offer the larger displays. The major issue the company was facing was the fact that its customers were increasingly interested in standardizing on a single computer manufacturer. If a company bought Hewlett-Packard workstations and MicroStation and later decided it wanted to switch to Pro/ENGINEER it could do so. This flexibility did not exist if the company purchased Intergraph proprietary machines.[60]

March 1993 saw a series of management changes at Intergraph. Elliott James who had been the president for the previous three years left the company and Jim Meadlock returned from semi-retirement to take over the reins once again. Lew Epstein, vice president of sales also left as did Warren Winterbottom who had been building the company's MicroStation dealer network. Doug Gerull, executive vice president for the company's mapping business was an additional casualty of the reorganization. Winterbottom eventually joined Bentley to head its sales operation as it prepared to go its separate way from Intergraph as discussed below.

The pending product transition was starting to have an impact on the company's financial results. In the first quarter of 1993 Intergraph eked out a small 2 percent gain in revenue to $282 million but showed a loss of $7.7 million. Foreshadowing future

[58] *A-E-C Automation Newsletter*, December 1992, Pg. 18
[59] *Engineering Automation Report*, January 1993, Pg. 3
[60] *Engineering Automation Report*, February 1993, Pg. 5

problems was a drop in orders to $140 million from $184 million during the same quarter a year earlier. At this point in time the company's business was approximately one third software (20 percent of which was MicroStation) and two thirds hardware. The second quarter wasn't any better with revenue down to $249 million and a loss of $18.6 million.

At A/E/C SYSTEMS '93 in June 1993 in Anaheim, California, Intergraph showed off the new MicroStation Version 5 it expected to release later that year as well as several new architectural and civil engineering applications that were a result of its acquisition of a small Huntsville software company called AEC Group the prior year. When asked about plans for a new C500 processor, company executives were very evasive.[61] In fact, by the summer of 1993 it was clear that the C500 would not happen. On July 7, 1993, Intergraph announced that it had agreed to work with Sun Microsystems in the development of a new 64-bit SPARC microprocessor known as the UltraSPARC.

As part of this new strategy, Intergraph's Clipper design team was being integrated into Sun's design organization. The plan at the time also envisioned Intergraph implementing Windows NT on the SPARC platform although Sun made it clear that this would not be a Sun product. Intergraph already had a version of Windows NT running on the Clipper platform which it demonstrated at Windows World '93 in May 1993. At the time the joint effort with Sun was announced, the expectation was that the UltraSPARC would not be available until 1995. If Intergraph was simply looking for a replacement to the Clipper, it is surprising that the company did not select a readily available alternative such as DEC's Alpha or the R4400 from MIPS. Intergraph's response was that there were business issues to consider and they liked Sun's long term product strategy.[62]

Intergraph delivered on its MicroStation NT commitment in August 1993 along with a number of architectural, engineering and GIS applications. A combined hardware and software system called the PC 433 was launched at an attractive $6,500 price. It consisted of a 33 MHz Intel 486 processor, 16MB of memory, a 17-inch color monitor and MicroStation software.

Indicative of the shift to the PC was a new entry-level GIS system called MGE DOS SOLUTIONStation bundle. It consisted of Intergraph's Modular GIS Environment PC Product (MGEPC-1), MapInfo for Windows 2.1 and an Intergraph Technical Desktop-1 (TD-1), all for just $11,999. The TD-1 was a 66-Mhz Intel 486-DX-based PC with 16MB of memory, a 248MB hard disk and a 17-inch monitor.

MicroStation Version 5 began shipping in late 1993 for Windows, DOS (there was still a large number of user who liked the way DOS provided close control over computer operations), and Windows NT. One key capability of Version 5 was its ability to read and write AutoCAD .dwg files. Interoperability with AutoCAD would be a hallmark of MicroStation from this point forward. Availability of Version 5 on UNIX platforms including Intergraph-built hardware was scheduled for the first half of 1994.

Meanwhile, the company continued to pour money into its mechanical software activity which was headed by vice president Bill McClure. I/EMS Release 3 was introduced at AUTOFACT '93 with a variational and parametric design tool called SmartSketch. It utilized a smart cursor that allowed users to quickly grasp relationships and constraints.

---

[61] *Engineering Automation Report*, July 1993, Pg. 11
[62] *Engineering Automation Report*, August 1993, Pg. 5

By early 1994 the company was doing approximately $200 million annually in the mechanical area although more than half was hardware and MicroStation made up a substantial percentage of the software portion. To support MicroStation as a two-dimensional mechanical design and ANSI-standard drafting tool, Intergraph licensed a $500 package called MicroDraftsman from HLB Technologies of Blue Ridge, Virginia. A separate package, Mechanical MicroStation which supported ISO and DIN drafting standards was sold in Europe.

Intergraph's marketing theme for its mechanical software was "art to part" or the ability to do everything from creative styling to detailed product engineering and documentation to manufacturing. One package that received little media attention was I/Design, an EMS option that provided functionality and a user interface that was more receptive to the needs of industrial designers than simply design engineers. Visualization was provided by the company's ModelView software.

It is hard to say why Intergraph was not more successful in the mechanical market. A number of factors influenced what happened: the lack of aggressive marketing, a sales force focused on the company's mainstream AEC and mapping products, mechanical software that was very broad in scope but not as functionally complete as the competition and simply insufficient corporate focus on this market. [63]

I/EMS was available on Sun and SGI workstations[64] as well as on the company's own Clipper workstations but there was no indication that the software would be ported to PCs nor did the company follow through with its plans to port I/EMS to Hewlett-Packard workstations. While Intergraph was moving the majority of its software product line to the Windows NT platform, the exception was I/EMS which remained a UNIX application. The lack of interest in NT regarding I/EMS was primarily because the company had an entirely new mechanical product under development – Solid Edge.

Intergraph's hardware concentration continued to shift towards PCs. In the spring of 1994 the company launched the TD-2 (Technical Desktop-2) which incorporated Intel's Pentium microprocessor and Microsoft's Windows NT operating system. With a 66-Mhz processor, 16MB of main memory, a 540MB disk, a Weitek P9000 video board and a 17-inch monitor, the TD-2 sold for $4,875. It was quickly added to Intergraph's NAVFAC contract described above.

The Bentley/Intergraph relationship changes

In retrospect, 1993 was the year that it became obvious that Intergraph's business model was fundamentally flawed. During that year's fourth quarter the company's sales were down 12.5 percent to $269 million and the company showed a $70 loss after taking a $76 million charge that resulted from closing manufacturing and distribution facilities in Europe.[65]

The May 1994 International Graphics User Group (IGUG) meeting in Huntsville marked a further significant shift in hardware strategy and a major change in the relationship between Intergraph and Bentley. Meadlock announced that while Intergraph

---

[63] *Engineering Automation Report*, January 1994, Pg. 6

[64] Control Data Corporation had an agreement with Intergraph to resell I/EMS on SGI workstations along with additional CDC software. It does not appear that this ever resulted in significant revenue for Intergraph.

[65] *Engineering Automation Report*, February 1994, Pg. 14

would continue to resell MicroStation software, it would no longer be the exclusive channel for Bentley products effective January 1, 1995. See Chapter 10 for additional discussion concerning the split between the two companies.

In a presentation worthy of COMDEX, Jim Meadlock announced that Intergraph's future was with computer systems powered by Intel microprocessors and Microsoft operating systems, specifically Windows NT. He was joined on the podium by David House, a key Intel vice president and Mike Maples, the executive vice president of Microsoft. The company went all out to present itself as a "big league" player in the computer industry. Tommy Steele commented that: "Intergraph is the largest NT development site outside of Microsoft."[66]

Only eight years earlier, Intergraph had announced that the future was UNIX and the Clipper workstation. Now customers had to prepare for another substantial platform shift. To some extent, the company was forced into making this announcement. It had gone through a string of five profitless quarters and it was becoming increasingly clear that the Clipper was costing far to much in both R&D and production while the company was having problems keeping up with the competition from a performance point of view.

During the prior months talk about porting Windows NT to the Clipper platform had dried up and the agreement with SUN to jointly develop a 64-bit UnltraSPARC processor that would run NT never seemed to get off the ground. The Intergraph employees who had been working with Sun had quietly become Sun employees. Supposedly, Intergraph was still working on porting NT to the Sun platform but was doing so under contract rather than as a joint venture.

In typical Meadlock fashion, he saw that within a few years Windows NT and its derivatives would replace UNIX as the preferred operating system for engineering applications. As usual, he was not only right, but was also a few years ahead of most competitors. The company's intent was to use standard Intel microprocessors and add Intergraph's own graphics accelerators and monitors. The resulting units would be somewhere between PCs and workstations in performance and, as a result, Intergraph decided it would call them "personal workstations." By building its own product line of PCs and servers, Intergraph hoped to keep as much of its manufacturing infrastructure as busy as possible. Part of the announcement included three new PCs based on Intel's 90-Mhz Pentium processor called the TD-3, TD-4 and TD-5.

Intergraph's personal workstations were typically priced higher than standard PCs but less than UNIX workstations. While a TD-2 started at around $6,000, a TD-5 with dual 27-inch monitors and the high performance GLI graphics accelerator would set a customer back nearly $58,000. The company set out to sell these units to a much broader market than simply to their own CAD and mapping customers. As part of the company's strategy in establishing itself as a PC vendor, Intergraph had a separate booth at the A/E/C SYSTEMS'94 conference in Washington, D.C. just for its hardware products and had its computers in other vendors booths as well. It was strange to see AutoCAD running on an Intergraph computer system in the Xerox booth.[67]

Although the transition to personal workstations was rather straightforward for most of Intergraph's software, it caused substantial problems for the company's mechanical organization. In late 1994 the company was still talking about porting I/EMS

[66] *The Anderson Report*, May 1994, Pg. 5
[67] *Engineering Automation Report*, July 1994, Pg. 8

to Windows NT but in the interim, Intergraph decided to offer Sun Microsystems' Solaris version of UNIX on its TD systems. This enabled Intergraph to offer I/EMS including a new I/EMS Lite version, on these computers. It was a cobbled together solution that did not excite many customers. I/EMS Lite was a stripped down version of EMS that sold for $7,900. It included SmartSketch, feature-based solids with dimension-driven revisions, drafting and integration with analysis and manufacturing applications. At the same time, Intergraph reduced the price of EMS Foundation to $4,900 and EMS Cornerstone, which was the most commonly purchased bundle of modules from $17,900 to $14,900.

In early 1995, the personal workstation nomenclature was changed. The TD-3 became the TD-30 and so forth and the multi-processor versions of these systems were relabeled TDZ-30, TDZ-40 and TDZ-60. These latter units utilized Intel's 100-MHz Pentium processors and supported up to six processors in the case of the TDZ-60. The TDZ-60 came with 128MB of memory expandable to 1GB.

By mid-1995, Intergraph had restructured the company five business units, each with profit and loss responsibilities. These were Software Solutions, Computer Systems, Federal Systems, Electronics (Dazix) and Public Safety, the latter a relatively new activity targeted towards selling mapping systems used for emergency dispatch. By the end of 1994, 85 percent of the computer systems the company was shipping were Intel-based PCs and servers. Most were being sold for use with Intergraph software with relatively few being purchased for general engineering and graphics applications. According to *Engineering Automation Report*: "Most potential customers, however, still seem reluctant to pay a premium for the Intergraph systems as compared to plain vanilla PCs."[68]

In late 1995, Intergraph introduced personal workstations that incorporated Intel's new 150-MHz and 200-MHz Pentium Pro processors. They used Intergraph-built motherboards, error correcting memory and the company's high-performance graphics cards. In general, they were a match for most RISC-based mid-range workstations.[69]

A new technology direction

By the mid-1990s, object oriented technology was taking the software industry by storm and Intergraph was no exception. At the May 1995 IGUG meeting, the company announced a major new initiative called Jupiter (named after the Florida city where Meadlock had a home and where the plan for this software was conceived in 1993) that would be used as the base for future applications. Knowledge about Jupiter had been restricted to a small group of individuals and when it was announced at IGUG many Intergraph marketing and development people had little idea how it fit into their specific plans.

In addition to its own Jupiter technology, Intergraph worked closely with Microsoft and other graphics software vendors interested in expanding Microsoft's OLE (Object Linking and Embedding) technology to handle three-dimensional objects. This extension to OLE was called OLE for Design & Modeling Applications (DMA) and was the rationale for establishing an industry organization called the Design & Modeling Applications Council (DMAC). Among the other companies involved were Autodesk, Bentley, SDRC, and Spatial Technology.

---

[68] *Engineering Automation Report*, June 1995, Pg. 6
[69] *Engineering Automation Report*, November 1995, Pg. 3

The intent was to be able to handle mechanical assemblies or AEC models where individual objects were created by different applications. When the user selected a particular item, that action would initiate the appropriate design software. The integration of Jupiter with Windows' OLE for DMA sent the clear message that Intergraph had no intention of implementing Jupiter on any UNIX platforms. DMAC fell apart when it turned out that Intergraph held a patent for certain aspects of this technology and the other vendors were unwilling to go along with licensing terms proposed by Intergraph.[70]

It was becoming increasingly obvious that Intergraph planned to create an entirely new product line of applications built around Jupiter rather than MicroStation. Jupiter enabled applications were to be developed that communicated directly with the Windows operating system and did not require a CAD system such as MicroStation to handle graphical input, menu selections and display functions. Some people described the need to use a CAD system to support applications as a "CAD tax."[71]

At IGUG '95 Intergraph showed off prototypes of two Jupiter applications. The first was Imagineer Technical, a two-dimensional sketching program that was expected to sell for less than $1,000 per copy.[72] Eventually, this package would be renamed SmartSketch. The other application was a mechanical design product that was simply referred to as MD. It used Spatial Technology's ACIS geometric kernel together with Jupiter development tools. Rather than try to convert I/EMS to the new Jupiter environment, Intergraph had decided to make a fresh start. *Engineering Automation Report* had an extensive article on Intergraph's new software strategy in its June 1995 issue.

> "We are in solid agreement with the general strategic directions Intergraph is taking. The Jupiter technology recognizes the underlying flow of technology that is taking place in the computer industry. In particular, much of the actual code incorporated into legacy CAD systems is redundant with the software functionality found in the latest operating systems. And with Intergraph's strong relationship with Microsoft, they probably have a pretty good insight into where Microsoft is going.
>
> During the past 15 years, the most significant new CAD developments have come from startup companies such as Autodesk, Parametric Technology and Mentor Graphics which had the luxury of being able to start 'with a clean pad of paper.' Established vendors were forced to split their development resources between maintaining legacy software and implementing new ideas.
>
> Unfortunately, the new ideas were frequently just glued on the side of the existing products. Jupiter is one of the few attempts we have seen where an established vendor is attempting to create totally new technology and at the same time maintain application level compatibility with existing applications."[73]

---

[70] Versprille, Ken, *Engineering Automation Report*, October 1998

[71] *A-E-C Automation Newsletter*, August 1997, Pg. 10

[72] Imagineer Technical was actually introduced at just $279 per copy for a short period of time before settling at $495.

[73] *Engineering Automation Report*, June 1995, Pg. 6

These comments were made two years before Clayton Christensen wrote *The Innovator's Dilemma* which succinctly described the problems companies have trying to satisfy the needs of existing customers while, at the same time, creating innovative new products. Intergraph was a perfect example of Christensen's analysis.[74]

At IGUG '95 it appeared that Intergraph planned to replace all MicroStation-based applications with Jupiter technology. A year later the attitude softened somewhat and the company stated that it planned to continue supporting MicroStation applications for the foreseeable future. Part of the reason behind this change in attitude was input from users who indicated that they had little desire to make the switch. [75]

MD was formally announced as Solid Edge in the fall of 1995 and released in April 1996. Priced at $5,995, it appeared that Intergraph planned to go after PTC and its Pro/Jr. product. Some of the key characteristics of this new package were:

- Solid Edge was oriented towards the design of assemblies rather than just individual parts.
- The user interface was Windows compatible, greatly reducing learning time.
- Use of OLE for DMA enabled users to insert MicroStation, EMS and AutoCAD parts in Solid Edge assemblies.
- Sketching tools automatically recognized constraints such as parallel and perpendicular lines.
- The transition for I/EMS users was expected to be a problem since EMS only ran on UNIX platforms and Solid Edge was a Windows application. Also, the analysis and manufacturing applications provided with EMS were not available for use with Solid Edge, either from Intergraph or third party software developers.[76] Intergraph did team up with ANSYS to offer analysis software that seamlessly worked with Solid Edge.

Solid Edge Version 2 was released in October 1996. It incorporated ACIS 2.0 which itself had a significant number of functional and performance enhancements. Rather than mount a frontal attack on the major mechanical software vendors, Intergraph was focused on two aspects of the design process, individual part design and the management of large assemblies.

Part modeling included the ability to design parts with open profiles – i.e., profiles with one or more contiguous elements missing. Solid Edge could also create parts starting with disjointed components and then fill in the gaps between these components. The assembly modeling was structured so that a user could model a part while working with the assembly, taking key dimensions from other parts.[77] NASA'a Marshall Space Flight Center in Huntsville was an early user of Solid Edge Version 2 acquiring 130 seats in December 1996.

Around this time Intergraph became increasingly agnostic regarding the base graphics systems used to support its applications. No longer married exclusively to Bentley's MicroStation, the company began to market applications that worked with

---

[74] Christensen, Clayton, *The Innovator's Dilemma*, Harvard Business School Press, 1997
[75] *A-E-C Automation Newsletter*, May 1996, Pg.10
[76] *Engineering Automation Report*, November 1995, Pg. 1
[77] *Engineering Automation Report*, November 1996, Pg. 11

Autodesk's AutoCAD software as well as with MicroStation. The first of these Jupiter-based applications that worked with AutoCAD as well as MicroStation were InRoads and SiteWorks which were released in early 1996.[78]

Eventually, the company began to call this ability to use different CAD systems in support of its civil engineering software SelectCAD and the company soon added IntelliCAD 98 to the CAD packages it supported. Intergraph also began to demonstrate AutoCAD at tradeshows running on its PC products which probably drove the wedge between it and Bentley even deeper.

The transition away from the high-margin Clipper workstations was beginning to show on Intergraph's revenues and earnings. The company was consistently loosing money each quarter, although typically not a great deal. Revenue, which had exploded in the 1980s was fundamentally flat throughout the 1990s. In the third quarter of 1996, for example, Intergraph's revenues were down 1 percent at a time when competitors such as SDRC, Dassault and PTC were experiencing growth rates in the range of nearly 30 percent to almost 50 percent.

Focus shifts to information management

Intergraph announced an object-oriented information management product, DM2, in late 1995 based on Metaphase. (see Chapter 17). Two of the first users were DuPont and the Navy's CAD-2 NAVFAC project. A year later the company emphasized the significance of this activity by establishing an Information Management and Foundations division under the direction of executive vice president Rich Buchheim. DM2 was subsequently renamed Asset & Information Management (AIM). A new version that added workflow and configuration management to the existing information management capabilities was announced in late 1996 for delivery in early 1997. By mid-1997, the company had installed AIM software at over 130 customer sites.[79]

AIM was a classical client/server implementation that was supported on Sun and HP UNIX workstations as well as Intel-based PCs and servers. Intergraph developed a series of industry-specific features on top of the basic Metaphase software. These were tailored for specific industry segments through the creation of data and processing models or templates.

For example, one of the first such templates was for the plant design and operating industry. It was called Plant Data Management Environment (PDME). A similar solution was developed for manufacturing industries. AIM also used the Active/CGM technology developed by the company's InterCAP subsidiary as described elsewhere in this chapter.

Becoming a player in the graphics market

Almost from the day it first began manufacturing computer terminals, Intergraph created significant internal expertise in the area of graphics hardware. Throughout the 1980s, the company's systems had some of the best graphics performance available. While the company was designing and manufacturing its own graphics processors, competitors were increasingly switching to commercially available devices typically produced by the same manufacturers from whom they purchased the workstations.

---

[78] *A-E-C Automation Newsletter*, March 1996, Pg.13
[79] *Engineering Automation Report*, June 1997, Pg. 15

In early 1990, Intergraph introduced the EDGE product line of graphics processors. The EDGE-1 displayed 110,000 two-dimensional vectors per second while the EDGE-2 displayed 400,000 two-dimensional or 350,000 three dimensional vectors per second. Both handled 256 colors. An InterPro 6040 workstation with the EDGE-1 graphics sold for $29,900 while an InterPro 6280 with a new 60-MHz Clipper processor and EDGE-2 graphics sold for $45,900.[80]

Before 1990 was over, Intergraph substantially increased the graphics performance of its lower-priced workstations. The previously described Model 2020 with a 12.5 MIPS Clipper microprocessor supported 360,000 two-dimensional vectors per second. Intergraph sold 500 of these units to Sandia laboratories to support electronic design as well as a large number to Brown & Root as part of a $7.9 million contract.[81]

At this point in time, the company's workstation sales were about 90 percent single screen InterPro units and only 10 percent dual-screen InterAct systems.[82] Customers had mixed emotions about Intergraph's dependency on its own microprocessor technology. User comments ranged from "We like the fact that we can pick up the phone to a single source vendor and get service. It ends the finger pointing" to "For the long term I feel a little uncomfortable."[83]

The EDGE graphics subsystems were followed by the GT series. Introduced in early 1992 , the GT+ produced 760,000 two-dimensional and 530,000 three dimensional vectors per second when installed in a 2730 workstation while the GT II handled 830,000 two-dimensional and 640,000 three dimensional vectors per second in a 6750. The top-of-the-line EDGE product, the EDGE II+ had comparable vector performance to the latter unit but also handled 50,000 Gouraud-shaded polygons per second when used with a 6780.

The performance of Intergraph's display processors was somewhat dependent upon the speed of the computer to which they were attached. When attached to a higher-speed 6850, a GT II display was capable of 900,000 two-dimensional and 700,000 three-dimensional vectors per second.

When Intergraph began building Intel-based Technical Desktop systems, it also began producing some of the highest performance graphics accelerators available for PCs. These included the G90 and G91 that produced 600,000 two-dimensional vectors per second and the GLZ and GLI which added 250,000 shaded triangles per second, the latter unit with texture mapping.

In mid-1996 Intergraph became serious about the commercial PC graphics market. This interest was reflected in two ways. First, the company began developing a series of high performance graphics cards which were initially used on the company's own TD computer systems but eventually sold as add-ons for other vendor's machines. Second, Intergraph began pursuing the video industry with a combination of high-performance graphic systems and supporting software. In this later area, the company offered a combination of hardware and software called Studio Z. The system contained multiple PCI buses and Pentium Pro processors that were capable of handling broadcast quality video.

---

[80] *The Anderson Report*, February 1990, Pg. 2
[81] *The Anderson Report*, September 1990, Pg. 2
[82] *The Anderson Report*, November 1990, Pg. 5
[83] *The Anderson Report*, November 1990, Pg. 5

To some extent it became difficult to separate Intergraph's interest in high performance personal workstations from its work on graphics accelerators. In July 1996 the company introduced three new workstations, the TDZ-310, TDZ-410 and the TDZ-610 with one (optionally two), two or four 200-MHz Pentium Pro microprocessors respectively. New graphics accelerators were labeled the Z10,Z13 and Z25.

The top-of-the-line Z25 produced 1.25 million shaded triangles per second and could be equipped with up to 64MB of optional texture mapping memory. While an entry level TDZ-310 cost $9,995, a fully equipped TDZ-610 could set a customer back $70,000 or more. Unfortunately, there was little Windows-based CAD software on the market that could take advantage of the multi-processing capabilities these machines offered. According to *Engineering Automation Report*:

> "Intergraph is going through somewhat of an identity crisis. Most of the media and many potential users see these systems as simply souped-up PCs and tend to compare them to other Pentium Pro systems offered by Compaq and Gateway 2000. Intergraph sees them as cost effective alternatives to RISC-based workstations sold by Silicon Graphics, Hewlett-Packard, etc. *EAReport* believes that they fall into the latter category and that you need to understand that these are not simply PCs on steroids."[84]

Several months later, Intergraph expanded its PC product line to include several lower priced machines, the TD-20 and the TD-200 which used standard Intel motherboards. With a 17-inch monitor, the TD-20 started at $2,590.[85] The company even began selling preconfigured systems using an 800 toll-free number in May 1997. Prices for these systems started at just $1,899.

In October, 1994, Intergraph acquired InterCAP Graphic Systems, a vendor of technical illustration software that also had significant experience working with CGM (Computer Graphics Metafile) software, for about $10 million. CGM is an international standard that supports both vector and raster two-dimensional data in a single file and was one of the key components of the Department of Defense's CALS initiative.

Dr. John C. Gebhardt, the company's founder and chief technical officer, was one of the country's leading experts on CGM. InterCAP subsequently adapted the CGM format for the Internet, calling it ActiveCGM. Within a few months, it was fairly obvious that Intergraph was interested in InterCAP more for its CGM expertise than for its technical illustration software. Intergraph only owned InterCAP for a few years, selling it in April 1999 to Micrografix for $12.5 million in cash and securities.

Establishing a new generation of software

Intergraph Software Solutions (ISS), the software portion of Intergraph, was headed by Tommy Steele who both president of ISS and an executive vice president of Intergraph itself. He held this position until late 1997 when he left Intergraph to become

[84] *Engineering Automation Report*, August 1996, Pg. 4
[85] *Engineering Automation Report*, December 1996, Pg. 10

president and CEO of CyberGuard, a network security firm.[86] A significant portion of ISS was focused on the mapping and utility markets. Called Intergraph Infrastructure Software Solutions, it was headed by executive vice president Dr. Eddie Boyle while Preetha Pulusani was executive director of marketing. A few years later, Pulusani would end up running this portion of the Intergraph enterprise.

The Process & Building Solutions division was headed by David Stinson. Stinson was a former vice president of engineering at the Tennessee Valley Authority. By this point in time, Intergraph was de-emphasizing architectural software. According to Meadlock, there simply was no money to be made in that segment of the CAD industry.

With the launch of the new Jupiter technology Intergraph set out to recruit third party software firms that could provide applications in support of Intergraph's base mapping products. The newest GIS technology was called GeoMedia. It was a complete stand-alone product by itself but also provided integration with third party products such as Oracle's Spatial Data Option and subsequent versions of this database technology.[87] Intergraph recruited over 50 third party software firms to add capabilities to the GeoMedia product line by early 1997.

Indicative of the large projects Intergraph's mapping products were being used for was the development of a seamless cadastral database for the Province of Ontario, Canada. The actual work was done by Teranet Land Information Services of Toronto which was working on producing a database of nearly four million property parcels. By mid-1997, the company had produced maps coving 2.2 million properties and had loaded over one million parcels into a database utilizing Intergraph's MGE technology. Teranet was also using GeoMedia and AIM.[88]

The Infrastructure group was also responsible for Intergraph's civil engineering software. By 1997 there were over 12,000 seats of the company's InRoads software in use worldwide.

At the June A/E/C SYSTEMS '97 conference in Philadelphia, Jim Meadlock and Keith Bentley shared the conference keynote presentation with Carol Bartz, the CEO of Autodesk. This was where Bartz described her position on the podium as "a rose between two thorns." The animosity between Intergraph and Bentley was increasing on a regular basis to the point where Meadlock described it as a love/hate relationship. Since Intergraph still owned 50 percent of Bentley, whenever Bentley beat out Intergraph at a particular account, Intergraph still won, although not as much as if they had received the order.

At a press conference following the keynote Meadlock responded to media comments that the company seemed to be moving slowly replacing its MicroStation-based AEC applications with Jupiter-based software. He stated that what Intergraph was doing was filling in the gaps with new Jupiter software rather than simply replacing existing MicroStation-based applications and that once this was done, the company would move ahead replacing the legacy packages.

---

[86] Steele subsequently ran into trouble regarding improper revenue recognition issues while president of CyberGuard and was the subject of an SEC administrative proceeding.

[87] Oracle's Spatial Data Option was subsequently supplemented by the Oracle 8 Spatial Cartridge. Today, this technology is simply an integral component of the Oracle database management software.

[88] *A-E-C Automation Newsletter*, October 1997, Pg. 3

He made it clear that plant design would be the last area to see Jupiter software and that PDS would be around for some time. When I asked him to provide some detail as to how Intergraph intended to regain profitability (it had lost money virtually every quarter since the early 1990s), his response was a brusque "You will see next quarter."[89]

Restructuring Intergraph

The end of 1997 saw the beginning of a series of major changes at Intergraph. On one hand, the company began to focus on a narrower set of industry segments and announced a new mechanical joint venture with EDS that eventually led to the outright sale of the mechanical division. It was fairly clear to nearly everyone that EDS was primarily interested in Intergraph's Solid Edge software rather than the I/EMS product line.

This acquisition got started when Intergraph began talking to EDS' Unigraphics Division about using Parasolid as the geometric kernel for Solid Edge in place of Spatial's ACIS. Once that decision was made, it led to an initial plan to create a new company that would be jointly owned by EDS, Intergraph and the company's employees. The deal didn't work out quite the way it was originally planned. In January 1998, EDS decided to set up the Unigraphics activity as a separate entity called Unigraphics Solutions (UGS). This business enterprise then acquired Intergraph's mechanical activity for about $100 million. Dassault Systémes had acquired Solid Works a few months earlier for $310 million and since Intergraph had roughly the same size installed base for Solid Edge, one could say that EDS got a bargain. As part of this deal, UGS took on the responsibility of supporting Intergraph's I/EMS customers, especially those that resulted from the Navy's CAD-2 contracts.

The second reorganization was the establishment of the company's computer hardware operation as a separate business unit called Intergraph Computer Systems with its own profit and loss responsibility with Wade Patterson as president. This move became effective January 1, 1998. Supposedly, while Intergraph owned the majority of ICS stock some was being reserved for the employees of the operation.

ICS put on a hard push in 1998 to provide PCs with some of the best graphics capabilities available in the industry. The company's TDZ 2000 3D Graphics Workstation with RealiZm II was particularly powerful at the time, outperforming similar machines from Compaq and Hewlett-Packard and even UNIX workstations such as SGI's OCTANE R10000.[90] A few months later, ICS introduced a even higher performance dual processor machine called the TDZ 2000 GT1 that had peak memory bandwidth of 1.6GB/second. One of the problems with this technology was that there was very little CAD software other than some analysis and visualization programs that took advantage of multiple processors.

The next step in this restructuring was to take the group within ICS that specialized in high performance graphics cards and set it up as an independent business unit, similar to what had been done earlier with VeriBest. Called Intense3D, it was headed by Jerry Peterson[91] who previously had been vice president of engineering for

---

[89] *A-E-C Automation Newsletter*, July 1997, Pg.2 and personal recollection

[90] *A-E-C Automation Newsletter*, March 1998, Pg. 13

[91] Peterson was employed by AutoTrol Technology in the early 1980s, working on that company's advanced graphics hardware. He then went on to work at Tektronix before joining Intergraph.

ICS. At the time, this group was a major vendor of high-end graphics accelerators used on computers produced by Dell, Compaq, IBM and Fujitsu as well as Intergraph. Intense3D's primary product was its Wildcat graphics accelerator.

At SIGGRAPH '99 in Los Angeles, the company introduced the Wildcat 4110 that rendered up to six million triangles per second. This was one of the first commercial devices that was capable of volumetric texture mapping which enabled cross-sectional texturing of three-dimensional objects.

Between 1990 and 1998 Intergraph's revenues had stagnated at a little over one billion dollars and after earning $8.4 million in 1992, the company lost a total of $320 million during the next six years. Only the occasional quarter was profitable during that period and the worst was yet to come. In the August, 1999 issue of *A-E-C Automation Newsletter*, I wrote a front-page editorial that recommended that Intergraph get out of the PC hardware business and concentrate on the software applications that were its strong suit. Little did I know how close Intergraph was in doing just that.[92]

Intergraph's most significant restructuring announcement came on September 2, 1999. According to Jim Meadlock, "Intergraph is a technical solutions and systems integration company made up of business units that provide customizable core software and services to our chosen markets."

The following specific actions were announced by the company:

1. The company was reorganized into nine business units, each addressing the needs of specific industries or markets in which Intergraph was an established leader or had long-term potential. The systems-oriented business units are described below.
2. Intergraph would exit the generic PC and server business, which according to the company, suffered irreparable harm from the Intel actions which were the basis of its then current lawsuit against Intel as described later. These were the machines that carried the TD brand. ICS made a specific point with the media that the company planned to continue marketing its TDZ and Zx workstations. The company had sold its PC manufacturing operation in late 1998 to Huntsville's SCI Systems[93], a rapidly growing contract manufacturer.
3. It planned to strengthen its high-end workstation and graphics accelerator businesses by seeking partners with complementary technology and sales channels for Intergraph Computer Systems' ViZual Computing and Intense3D units. It appeared to *Engineering Automation Report* at the time that if another company made the right offer, these two units could well be sold off. In a separate deal, Intergraph had recently sold its ANAtech scanner division to Colortrac.
4. Intergraph stated that it would strengthen VeriBest's value and market reach by seeking partners with complementary technology and sales channels in the electronics design automation market. Less than two months later, on October 31, 1999, Intergraph sold VeriBest to Mentor Graphics.
5. To accelerate the pace of forming these partnerships, Intergraph's president and COO Manfred Wittler was given the task of coordinating partnering discussions with other companies. Wittler had become president and COO in May after spending ten years in Intergraph's sales and marketing organizations.

[92] *A-E-C Automation Newsletter,* August 1999, Pg. 1
[93] Known today as Sanmina-SCI

6. Intergraph planned to cut expenses across the board in order to bring costs in line with revenue. As part of that effort, the plan was to eliminate about 400 jobs worldwide. This would result in a special charge of $20 million in the current quarter. It would turn out to be just the first of a string of special charges resulting from restructuring the company.

Meadlock tried to paint the need to make these changes on contractual issues with Intel. I believed that the real cause of the company's problems with its ICS operation was the lack of an effective distribution organization. In reality, while the problems identified by Intergraph where Intel was slow in providing technical information on new microprocessors were annoying, it generally did not stop the company from introducing new systems in a timely manner. When Intel introduced its new 600-MHz Pentium III, Intergraph was right there with other PC vendors offering new machines using this microprocessor the same day.

The actual structure of this reorganization changed during the following months and by early 2000 the new systems oriented divisions and their leaders were:

1. **Mapping/Geographic Information Systems (Preetha Pulusani) -** included software products for civil engineering, photogrammetry, mapping/GIS, imaging, plotting and scanning support.
2. **Public Safety (Roger Coupland) -** public safety solutions for integrating police, fire and emergency services.
3. **Process & Building (Dave Stinson) -** with a nearly 60% market share in 3D plant design, Intergraph was the clear leader in this industry sector. This division was also responsible for the specialized Intergraph software used by shipbuilding companies.
4. **Communications (Arthur Spencer) –** developed and sold geospatial solutions for the telecommunications industry.
5. **Utilities (Kevin Hitt) –** provides geospatial and information management solutions to gas, electric, pipeline and water utilities.
6. **Federal Systems (William Salter) -** this business unit provided off-the-shelf and specially developed products and services to federal government agencies around the world.
7. **Z/I Imaging (Lewis Graham) –** established in August 1999, this new company combined the photogrammetry divisions of Carl Zeiss and Intergraph into a new jointly owned company called Z/I Imaging.[94] This venture was 60 percent owned by Intergraph and 40 percent by Zeiss.

By late October 1999, Intergraph's stock price had dropped to just $3.25 per share. Wall Street was probably a little premature in writing off the company. Intergraph actually made a profit of $3.6 million in the fourth quarter of 1999, primarily due to a gain of $14.4 million on the sale of Veribest. Revenue, which was down to $224 million in the last quarter of 1999, would continue to fall in succeeding years as the company struggled to turn itself around. From 1995 through 1999 shareholder equity dropped from $504 million to $277 million due to the losses the company was incurring. What Wall

[94] *Engineering Automation Report*, October 1999, Pg. 1

Street was missing was Intergraph's 50 percent ownership of Bentley Systems which was still privately held and the fact that Intergraph's case against Intel and various PC manufacturers had more life to it that they gave it credit.

The next major development occurred on March 2, 2000 when Jim Meadlock turned the CEO title over to Jim Taylor. Taylor was the first non-founder to join the company in 1969 and had been on Intergraph's board of directors since 1976. He had "retired" from Intergraph in 1992 but returned in 1995 to head the newly formed Public Safety business unit. Meadlock retained his position as chairman of the board and made it clear that he intended to focus on the Intel lawsuit. At the same time, Nancy Meadlock retired from the company. Manfried Wittler, who many thought would be the next president of Intergraph, retained his position as CEO of Intergraph Computer Systems having replaced Wade Patterson at the beginning of 2000.

The breakup continues

In measured steps, Intergraph continued to extract itself from the hardware business. In April 2000, the company announced plans to sell the Intense3D operation to 3Dlabs for 3.69 million shares of 3Dlabs stock then worth about $26 million. The deal also called for Intergraph to receive up to an additional $25 million based upon the performance of the Intense3D unit during the remainder of 2000. About 95 Intense3D people became employees of 3Dlabs as a result of this acquisition. 3Dlabs eventually exited the graphics accelerator market in 2006.

The next step was to work out a deal with Bentley Systems under which Bentley acquired Intergraph's InRoads suite of civil engineering software, the company's InterPlot and Digital Print Room software and its I/RAS raster editing applications. Bentley paid Intergraph about $42 million for these applications, $14 million up front and the balance over time. There were approximately 100 Intergraph employees involved in developing and supporting these applications, a number of whom were subsequently hired by Bentley. The agreement also called for Intergraph to continue acquiring MicroStation/J and related applications from Bentley for resale to its customers.

One additional move was to sell off the company's architectural design software products in June 2000 to a new organization, AEC DesignWare, headed by a long-time Intergraph marketing executive, Tom Zurn.[95] Then in July, Intergraph announced a deal with SGI under which it would purchase $100 million in SGI products and services over a period of three years and SGI would acquire Intergraph's remaining PC and server products. The Zx10 product line would be marketed exclusively by SGI which had recently introduced its own Intel-based computer systems. With this move, Intergraph was now out of the hardware business and was strictly a software and services company.[96]

The new Intergraph

By September 2000, the restructuring of Intergraph was virtually complete. Hardware elements of the company had either been sold or were in the process of being sold and non-core software product lines including architecture and civil engineering were also going or already gone. What was left was still one of the largest software and

[95] *A-E-C Automation Newsletter,* July 2000, Pg. 15
[96] *Engineering Automation Report,* August 2000, Pg. 14

system integration companies in the technical computing marketplace. The divestitures had the effect of reducing overall corporate revenue but were expected to result in a profitable company, something the company had been unable to accomplish consistently for far too many years.

Intergraph restructured itself into six independent divisions, each with its own profit and loss responsibility and with independent business strategies and plans. The business units were Intergraph Public Safety; Intergraph Utilities & Communications; Intergraph Government Systems; Intergraph Mapping/GIS; Z/I Imaging; and Intergraph Process & Building Solutions (PBS).

Not many people realized quite how large of an operation PBS had become. Once it was an independent division, its financial numbers were reported separately rather than just commingled with the entire Intergraph business. Those numbers showed a profitable business entity with over 1,000 employees and more than $180 million in annual revenues. That made PBS a substantial business activity in its own right, about the same size as Bentley Systems at the time and four and a half times the size of Cadcentre Group, its nearest competitor in the plant design arena.

According to Daratech, Intergraph had a 59 percent share of the three-dimensional plant design and visualization market in 2000 and 26 percent of the drawing-centric portion of the market. The total combined market for plant design software and services in 2000 according to Daratech was about $270 million. Intergraph's share of the three-dimensional portion had been steadily increasing in prior years while its portion of the two-dimensional market had jumped significantly due to new software.[97]

In addition, Dave Stinson was promoted to president of PBS in May 2000 when this organization was changed to an independent Intergraph division with its own profit and loss accountability. Other key individuals in PBS were Kurt Ingenthron, a 22-year Intergraph veteran who was the division vice president of product development and its chief technical officer, Ed Edmondson, who had recently joined the division from Black and Veatch as executive vice president and chief operating officer, and Shiraz Jaffer, the former president of EA Systems, who was vice president of marketing.[98]

In the mid-1990s Intergraph began supplementing its PDS software with new applications using the SmartPlant nomenclature. One of the first of these was SmartPlant Explorer which enabled users to browse through PDS P&ID and instrument data as well as data from non-Intergraph systems using Microsoft's Internet Explorer. This was followed by a new SmartPlant P&ID package.

Early 1999 saw Intergraph ink an agreement with Aspen Technology to interface the latter company's plant simulation software with SmartPlant P&ID. Intergraph also acquired a small software firm, Design & Software Industries, that developed software for the design and maintenance of process instrumentation.

The Process & Building Solutions Division's software was undergoing rapid transformation at this point. Most of the software customers were using, however, dated back to the previously described PDS product. These were all MicroStation-dependant applications that were gradually being replaced by new SmartPlant packages. As described earlier, these included SmartSketch (new name for Imagineer Technical), SmartPlant P&ID, SmartPlant Explorer and in early 2000, SmartPlant Review. The latter

[97] Daratech, Inc., Cambridge, MA, Undated press releases
[98] Intergraph Press Release, May 8, 2000

package was a successor to earlier Intergraph visualization products including DesignReview and SmartPlant Viewer.

The company made a point of the fact that SmartPlant Review was not just for viewing PDS models but could also be used to navigate through three-dimensional models created with MicroStation, AutoCAD or Solid Edge without the need for any data translation. Review used a standard Windows interface to enable users to navigate models up to 300MB in size.

The major development effort at the time was focused on plant modeling software. Called SmartPlant 3D, it would enable multiple users to work on the same section of the plant with each seeing what the others were doing. This approach eliminated the need to break the plant into multiple sections in order to avoid conflicts. Clash detection ran continuously in the background, immediately alerting users when there was a design problem. The software also incorporated parametric design capabilities. If one aspect of the design was changed, related objects changed accordingly. For example, if the height of a pump was changed, the foundation and connecting piping would adapt to its new position.

This software was heavily database oriented. Intergraph offered two data management tools, Directa which was a document and asset management tool and Notia which was used primarily to support plant operations.[99]

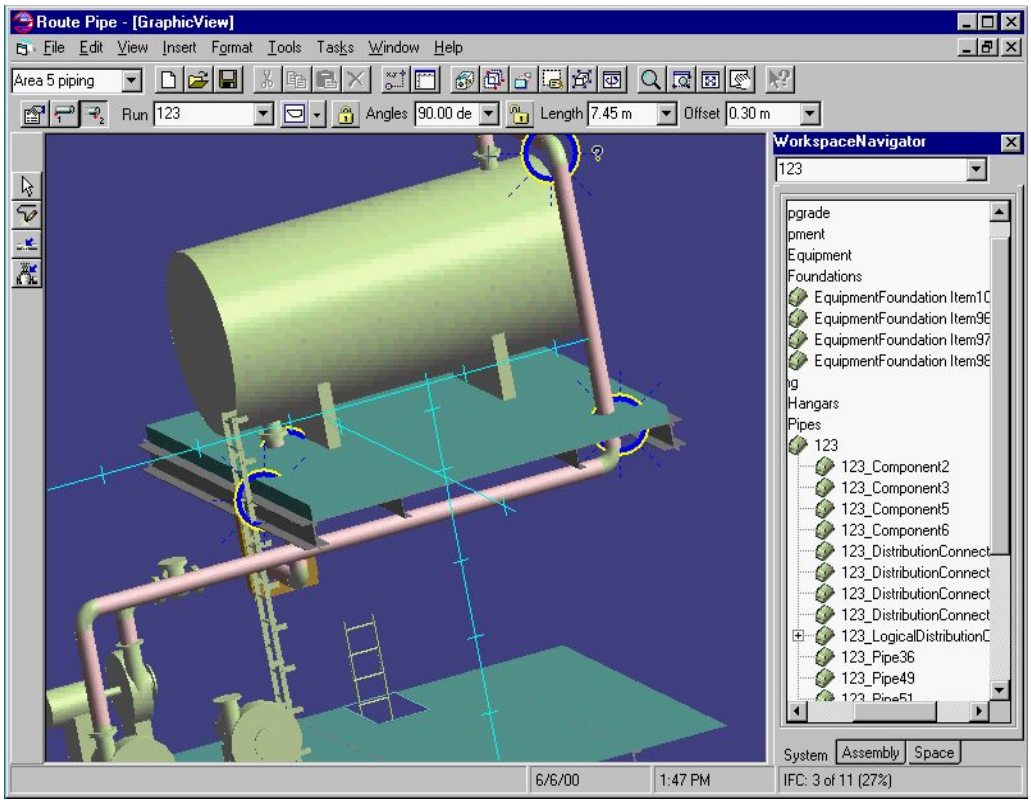

Figure 14.3
SmartPlant 3D

[99] *Engineering Automation Report*, September 2000, Pg. 6

Intergraph as a pure software company

Once all the hardware elements of the company had been sold off, Intergraph concentrated on re-establishing its reputation as a vendor of high-end technical software, particularly in the plant design arena. The Process & Building Solutions division was soon renamed the Process, Power & Offshore division now that the company was no longer marketing architecture software. Although I was shown a prototype of SmartPlant 3D in 2000, it was the fall of 2003 before it was ready for broad customer installation.

Intergraph recognized the fact that this was complex software and implementing it would tax the technical abilities of most user organizations. It therefore put together what it called the *Early Adopter Program* that consisted of a mix of SmartPlant 3D software and consulting services. While the version I saw demonstrated a few years earlier focused on the actual design process, the released software was significantly more database oriented.

An underlying SmartPlant 3D concept was that the people working on the design and construction of a complex plant or offshore facility would typically be located in multiple offices, possibly spread around the world. Coordinating the design work resulted in the concept of using replicated databases at each design and construction center. When a designer at one location made a change, that change was transmitted to all the other sites as a transaction. Keeping all the databases synchronized was not a major communications problem because each of these transactions typically represented only a small amount of data.

One concern was what would happen if the communications to a remote site were inoperative for a period of time? Would the people at that location be unable to work due to the communication failure? That is what would have happened if everyone was working off a single central database. The worse that would happen at the remote location in this situation was that they would work with the local data until communications was re-established at which point the remote database would be updated and any conflicts caused by this worked would be flagged so they could be resolved.

Intergraph sues Intel over patents[100]

On November 17, 1997, Intergraph filed a 22-count lawsuit against Intel that alleged that Intel applied undue pressure on Intergraph to grant Intel rights to certain microprocessor patents regarding cache memory management and that when Intergraph refused, Intel withdrew expected technical support, delaying the introduction of Pentium II workstations. Needless to say, Intel had a different opinion about these matters. On December 3, 1997 Intergraph amended its complaint to include a count charging Intel with violations of federal antitrust laws.

The patents in question go back to September 1987 when Intergraph purchased the Advanced Processor Division ("APD") of Fairchild Semiconductor. APD produced the Clipper RISC-based microprocessor described earlier that Intergraph used in its UNIX workstation and server products. As part of this acquisition, Intergraph acquired

[100] The entire Intergraph/Intel patent dispute as well as Intergraph's lawsuits against other computer vendors is an extremely complex story that is far too detailed to be covered in this book. It really has little to do with the development of engineering design technology. As a consequence, I have decided to simply cover the highlights of this long drawn-out legal dispute.

the rights to technology that resulted in patents eventually being issued in 1990 and 1992..

As also mentioned earlier, National Semiconductor acquired the bulk of Fairchild at the same time Intergraph acquired APD. Intel had a technology sharing agreement with National and claimed that as a consequence it had rights to this technology. To a certain extent, the case revolved around whether Intergraph acquired the APD directly from Fairchild or from National after it acquired all of Fairchild Semiconductor.

In its complaint and related material, Intergraph describes its relationship with Intel from 1992 through 1996 as particularly harmonious where the two companies readily shared technical information concerning the implementation of computer systems using the latest Intel products. In fact, when Intel launched the Pentium Pro in late 1995, the company used Intergraph workstations at the product launch.

According to Intergraph, the turning point in the relationship occurred when Intel inquired about rights to the Clipper patents, particularly one or more related to microprocessor memory management. The complaint stated that Intel basically wanted access to these patents simply in return for providing Intergraph with proprietary information about new microprocessors. When Intergraph refused to accede to Intel's request, the complaint stated that Intel began to withhold technical information from the company and otherwise interfered with Intergraph's business activities. Intergraph subsequently held that this delayed new product introductions by up to six months and that it was late 1998 before the company's products were technically in line with its competitors.[101]

Intel's side of the story was quite different. In a conversation shortly after the lawsuit was filed, an Intel spokesperson, Chuck Malloy, told me that Intergraph actually fired the first shot when it began to assert patent rights against other computer manufacturers in late 1996 but not against Intel. These manufacturers asked Intel to resolve the issue. Discussions went on between the two companies up through the week before the suit was filed. Apparently a settlement offer was made by Intel but not accepted by Intergraph. Intel also believed that the Clipper patents in question were not valid and the company filed its own suit in California to that effect. Intel did not deny that it cut off Intergraph from technical information concerning future microprocessors.

At the time Intergraph's lawsuit was filed, it was hard to take it very seriously. The expectation was that the dispute would soon blow over, the two companies would kiss and make up and perhaps Intel would pay Intergraph a few million dollars to make them withdraw the lawsuit. Little did most people realize how strongly Jim Meadlock felt about this issue, that the Intel lawsuit as well subsequent lawsuits against Hewlett-Packard, Dell and Gateway would drag out for over seven years and would result in Intergraph receiving hundreds of millions of dollars from Intel and the computer manufacturers.

Following is a rough chronology of the major events involving these lawsuits and settlements:

April 10, 1998 – Judge Edwin Nelson of the U.S. District Court, Northern District of Alabama ruled that while the lawsuit proceeded, Intel must provide technical information to Intergraph on the same basis that it provided that information to other

[101] *Intergraph 1999 Annual Report*, Pg. 20

major computer vendors.[102] Intel appealed this ruling shortly thereafter. Subsequent to this ruling, Intel signed a consent decree with the Federal Trade Commission that it would not withhold such information from PC manufacturers while patent disputes were being resolved.

June 17, 1998 – Intel filed its answer to the Intergraph lawsuit claiming that Intergraph violated several Intel patents and Intel initiated what was subsequently called the "license defense," as described above.

June 4, 1999 – Judge Nelson ruled that Intel's license agreement with National did not give it rights to the intellectual property Intergraph acquired from Fairchild.

August 1999 – Intergraph filed a claim with the court that Intel was not providing technical information in a timely manner as required by the court.

October 12, 1999 and November 5, 1999 – Intergraph took a double hit when Judge Nelson reversed himself and ruled that Intel was correct when it held the position that it acquired rights to Clipper technology when it acquired Fairchild. Intergraph immediately appealed this decision. The United States Circuit Court then overruled the April 10, 1998 decision that Intel must provide technical information to Intergraph. In actuality, this later ruling had little effect on the immediate relationship between the two companies since Intel was bound by the FTC consent decree to provide such information to Intergraph. Unless overturned by higher courts, these two rulings left Intergraph with just its claims of coercive action on the part of Intel.[103]

March 10, 2000 – The Alabama Court dismissed Intergraph's antitrust claims against Intel.

April 15, 2002 – Intergraph and Intel settled the Alabama cache memory case and the lawsuit was dismissed. Intergraph transferred several patents to Intel and Intel agreed to pay Intergraph $300 million. The agreement also set terms for resolving a separate lawsuit involving parallel computing patents being heard in Texas. If Intel won the Texas lawsuit, Intergraph would not owe anything to Intel but if Intergraph won, Intel would pay $150 million and if Intel appealed the decision and lost the appeal, it would pay an additional $100 million.

October 2002 – The judge in the Texas case ruled in favor of Intergraph and Intel paid the company the $150 million it had previously agreed to. Intel did appeal this finding although the $150 million payment was non-refundable.

December 16, 2002 – Intergraph sued Hewlett-Packard, Dell and Gateway in United States District Court for the Eastern District of Texas claiming infringement of patents having to do with parallel instruction computing.

January 2003 – Intergraph resolved outstanding patent issues with IBM and the two companies signed a cross-license agreement.

January 2003 – Intergraph filed a lawsuit against Texas Instruments regarding parallel instruction computing.

September 2003 – Texas Instruments settled with Intergraph for $18 million.

May 28, 2003 – Hewlett-Packard sued Intergraph in United States District Court for the Northern District of California, San Francisco Division for infringing on patents related to computer-aided design, video display technology and information retrieval technology.

---

[102] *Engineering Automation Report*, May 1998, Pg. 12
[103] *A-E-C Automation Newsletter*, December 1999, Pg.12

March 30, 2004 – Intergraph settled all outstanding issues regarding its parallel instruction computing lawsuit with Intel for $225 million. This settlement also resolved the lawsuit with Dell. After Intergraph had sued Dell, Dell in turn sued Intel claiming that that an earlier settlement between Intergraph and Intel absolved Dell of responsibility regarding these patents.

May 14, 2004 – Gateway settled with Intergraph for $10 million plus future royalties on certain computer systems.

January 21, 2005 – Hewlett-Packard settled with Intergraph for $141 million. This made the total of all patent settlements $860 million before considering Intergraph's legal fees which were considerable. The net amount was $768 million. A large portion of this was used to buy back company stock.

Intergraph subject of leveraged buyout

From a low of $501 million in 2002, revenues at Intergraph climbed back to $577 million in 2005. The company's stock recovered from a low of $3.19 in October 1999 to a high of $51.47 in December 2005. None of the founders were employed by the company at this point. The president and CEO was R. Halsey Wise who joined the company in that position in 2003. The company was now organized in two primary division, Process, Power & Marine under Gerhard Sallinger and Security, Government & Infrastructure under Ben Eazzetta. At the end of 2005, Intergraph had 3,450 employees, less than third what it had at its peak.

On August 31, 2006, Intergraph announced that it had signed a definitive agreement to be acquired by an investor group led by Hellman & Friedman LLC and Texas Pacific Group in a transaction valued at approximately $1.3 billion. Shareholders were to receive $44 per share in cash. The transaction in late 2006.