EDS/UGS to Siemens Digital Industry Software
A Remarkable Journey (1991-2010)

Raj Khoshoo and Kevin Eustace

Abstract

This article focuses on the two transformative decades (1991-2010) of the technology and business journey of what is now known as Siemens Digital Industries Software (DISW). It is a complex journey that discusses the evolution of digital applications and tools that help Industrial companies design, engineer, and manufacture complex, intelligent products spanning mechanical, electrical/electronic, and software domains. During this period, application technology changed every five to seven years, driven by significant changes in computing platforms, the integration of dozens of acquisitions — both large and small — and numerous name and company ownership changes, until UGS found a permanent home at Siemens.

During this period, Unigraphics UGS (#3 market position), a division of Electronic Data Systems (EDS), acquired and merged with Structural Dynamics Research Company, SDRC (#4 market position), in 2001. The merged company was named EDS PLM Solutions, providing value to joint customers while supporting and integrating competing portfolios.

Subsequently, EDS PLM was sold to a private equity firm and acquired by Siemens in 2007. This article will also focus on the initial years of Siemens, from 2007 to 2010, during which the foundation for "hyper-growth" was laid. In this article, Unigraphics refers to the CAX (CAD, CAE, CAM) products, while UGS refers to the company.

Introduction

This article follows two IEEE-published papers:

1. The Evolution of Unigraphics 1974-2001 [11]
2. Transformation of SDRC: Company History and Impact on the CAD/MCAE Industry in the 20th Century [7].

This article is a superset of the condensed article published per IEEE standards in *IEEE Annals of the History of Computing*.**EDS, UGS, and SDRC to Siemens Digital Industry Software, 1991–2010**. Jul.-Sept. 2025, pp. 122-134, vol. 47.

a. https://www.computer.org/csdl/magazine/an/2025/03/11132365/29mlnev0q8U
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In this article, the Siemens DISW journey is described from the 'eighties' through the 'nineties' on to the new millennium through 2010. During this period, technology evolved from Computer-Aided Design (CAD) tools to Product Lifecycle Management (PLM), which manages data from multiple design and simulation authoring sources and ultimately becomes part of the

Enterprise Information and Operational Technologies (IT/OT). This integration progressively enabled both the depth and breadth of “digital threads”.

The backdrop of the Eighties:

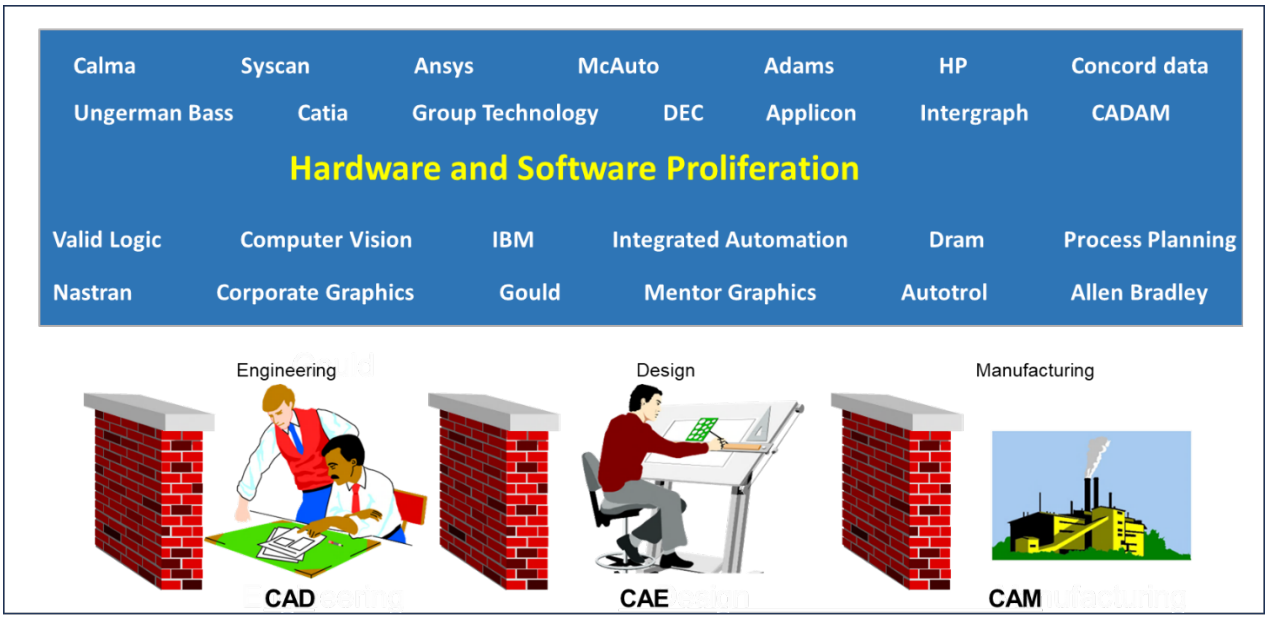

Figure 1: Technology Program Situation Analysis CAD/CAM/CAE/CIM
Source: EDS C4 Presentation to all software vendors

During the 1980s, three-dimensional design tools (CAD) offered value to customers by promising integration with Computer-Aided Manufacturing (CAM) and Computer-Aided Engineering (CAE). This brief section examines market dynamics in the context of large customers, such as General Motors, while laying the groundwork for the transformation's driving forces. Figure 1 above depicts a typical proliferation of CAX systems in large, multi-divisional manufacturing companies

The Nineties:
1990-1999: Due to the explosion of digital technical data, the promise of integrated CAD, CAE, and CAM, combined with Product Data Management (PDM), became a reality, marking the emergence of a new market definition: Product Lifecycle Management (PLM). This section covers EDS's acquisition of Unigraphics from McDonnell Douglas Automation Company. It summarizes the fierce competition among several leaders to gain market share, followed by Unigraphics' NYSE public offering.

The New Millennium:
2000-2010: PLM became integral to the enterprise Information Technology (IT) and Operational Technology (OT) landscape, focusing on “lifecycle” across Design, Engineering, and all enterprise systems. This section begins with EDS's acquisition of SDRC and its subsequent merger with Unigraphics, forming the fifth line of business, EDS UGS PLM. It describes the industry's best practice of combining two competing portfolios while offering “value” through

solutions and growing the business. During this period, EDS faced business challenges, resulting in the sale of EDS UGS PLM to a private equity consortium, followed by Siemens's acquisition. During this period, UGS started to be known for its integration into IT/OT. These changes and adaptations laid the foundation for a significant Siemens investment post-2010, enabling the company to achieve leadership in the DISW market.

Figure 2 below presents an abstraction of the evolution described above, with each phase building on the previous one.

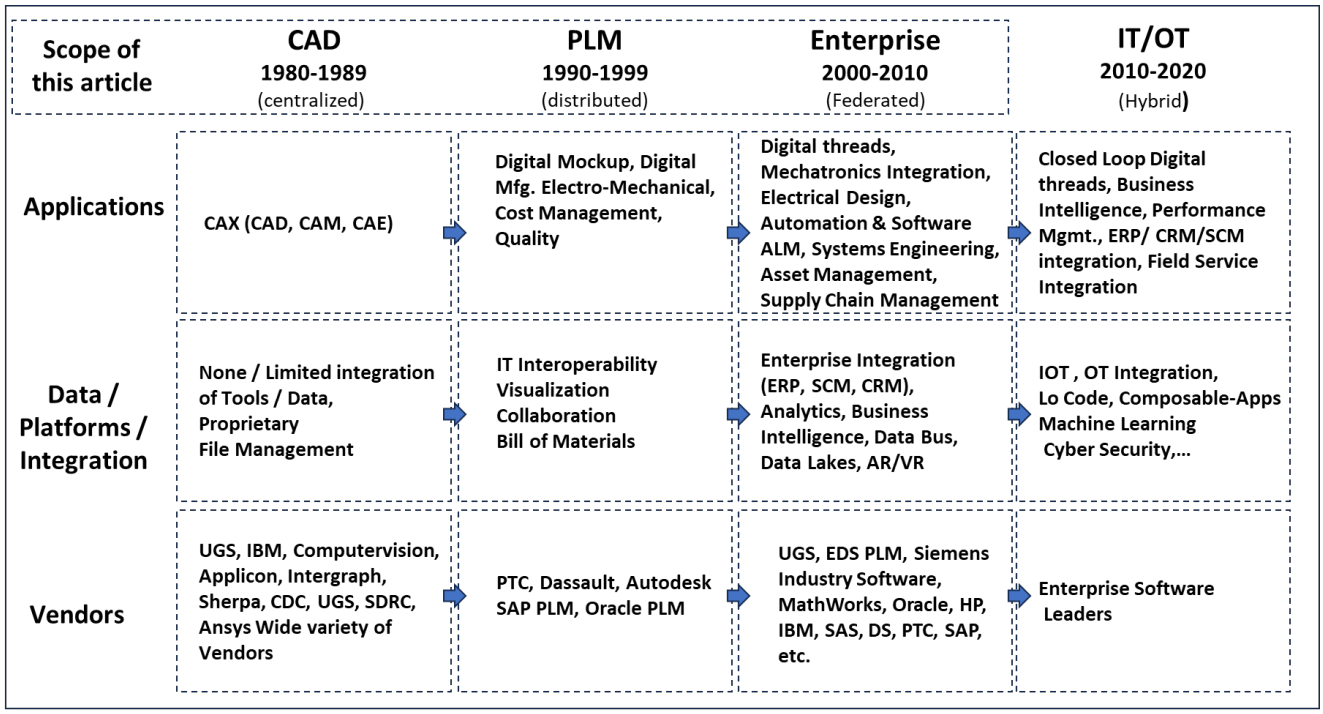

Figure 2: Engineering computing evolution from CAD to IT/OT integration
(Illustrative concept only, not exhaustive only leaders listed)

The Eighties:

Market Dynamics

Rapid advances in computing directly impacted the leaders in 3D CAD, whose businesses were tied to hardware margins. The market saw high growth in Minicomputers from DEC (Digital Equipment Corporation) and DG (Data General). Ironically, not all the prominent CAD leaders in the early eighties survived, e.g., Computervision, Intergraph, GE Calma, and Applicon, while IBM/Dassault morphed from CADAM (2D) to CATIA (3D). Unigraphics and SDRC, which later merged, were in “other” specialties that saw success, focusing on niches such as CAM (computer-aided manufacturing) and CAE (computer-aided engineering). For more details on the history of CAD, please look at references [10] and [13] (Weisberg and Kasik)

In the CAD domain, computing platforms transitioned from mainframes to centralized minicomputers, initially developed by DEC and DG, before being replaced by workstations and PCs.

While the enterprise CAD market was shifting towards Unigraphics, SDRC, and CATIA, many vendors, as described in [10, 13], introduced new products to address the shortcomings of the prominent vendors. This is typical of the technology hype cycle, where the market reacts to new ideas with many new products, but only a few survive.

A good example of this technological evolution is Parametric Technologies, which introduced a new constraint-based CAD product built on earlier work in Cognition and Prime Design.

While all this turmoil was happening, the industry witnessed the decline of in-house proprietary CAD systems, such as McDonnell Douglas CADD and GM CGS. The rapid acceptance of UNIX workstations and the commercialization of software on standardized hardware firmly established the new norm for the CAD industry.

In parallel, the market experienced a surge in demand for data and file management. Another focus was the integration of various engineering and design tools. This led to the creation of the Product Data Management (PDM) category in the market.

During this timeframe, Unigraphics achieved a prominent position in the market, becoming the design tool of choice for large companies (General Motors, Eastman Kodak, Pratt & Whitney, and General Electric Aero).

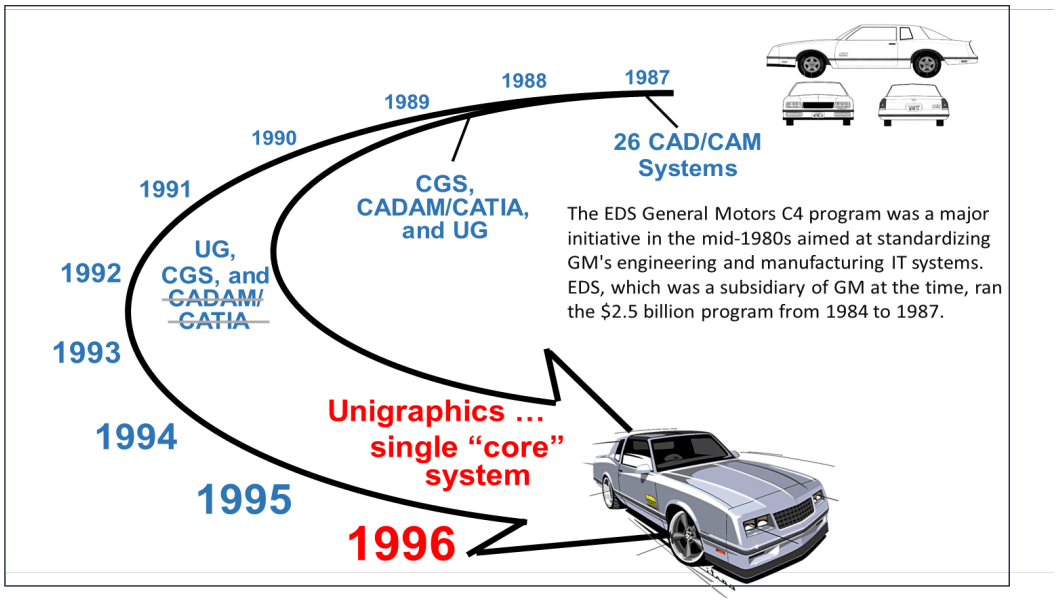

Figure 3: GM / C4 Technology Program Roadmap
Source: EDS C4 Presentation + https://www.shapr3d.com/history-of-cad/siemens-plm-software-unigraphics

In 1984, EDS was acquired by General Motors for $2.5B as a wholly owned subsidiary; the main objective was to improve IT operations and efficiency. Additionally, this acquisition aimed to modernize its operations with digital tools for product design and engineering. To this effect, GM/EDS initiated the C4 (CAD, CAM, CAE, Computer Integrated Manufacturing (CIM)) Program to standardize engineering and design tools across various GM Divisions. Many large companies, including GM, were getting out of control with the proliferation and increasing use of computer-aided tools. Some level of standardization and integration was critical.

In 1987, General Motors selected Unigraphics as its computer-aided design and manufacturing (CAD/CAM) standard, marking the beginning of a strengthened partnership with Electronic Data Systems (EDS)

The Nineties

Due to the explosion of technical digital data, the promise of integrated CAD, CAE, and CAM (CAX) with Data and Information Management (PDM) became a reality, defining a new market: Product Lifecycle Management (PLM).

Acquisition of Unigraphics by EDS (1991)

In the case of Unigraphics, EDS/GM wanted UGS to grow and almost doubled UGS's R&D budget after EDS's 1991 acquisition. With additional funds available, acceleration plans for application development were defined, particularly for digital mock-ups, visualization, and simulation. Focusing on design and the supply chain led to the development of many solutions. Additionally, UGS began focusing on advanced surfacing for automotive sheet-metal design and die machining, paving the way for its selection by many automotive companies and their supply chains.

In 1996, GM and EDS signed the Unigraphics Corporate Software License Agreement (the "Site. License"), in which GM selected Unigraphics software as GM's only vehicle development software platform. By recognizing Unigraphics software as its single Mechanical CAD (MCAD) product development system, GM has expressed its intent to consolidate its MCAD software use. Under the Site License, GM has installed approximately 10,000 seats.

Consolidation of applications continued for several years until Unigraphics became mandatory, following its previous preferred status at GM.

Parasolid, acquired by Unigraphics in 1988, became the basis of Unigraphics' layered architecture. For more information, please refer to [11]. It began to be used for communicating and collaborating with the supply chain. Ultimately a whole ecosystem of application providers adopted Parasolid.

Unigraphics and the competition

The 1990s were marked by the rise of two companies, Parametric Technology (PTC) and Dassault. Unigraphics had been under attack by PTC since early 1988. This motivated

Unigraphics to double down and introduce Unigraphics V10 with rapid quarterly release cycles. These rapid releases helped to build customer relationships in many large Unigraphics implementations by showing visible progress and measurable success. Ironically, this rapid release cycle came from UGS product management rather than R&D. Product management was aligned with delivering quantifiable value and helping customers understand and support new priorities. Working the Golden Thread [7] with customers helped align “needs” with “wants”.

This phenomenon, in which product management drives the “needs” against customer “wants,” was institutionalized at UGS. Putting the “customer first” (values such as industry openness, flexible business models, and customer success) has become embedded in UGS's culture and, over the years, has been integrated even more strongly with the cultures of SDRC and Siemens.

The competition with PTC in the industrial mid-market domain was quite bitter due to their well-organized, military-like sales program, which initially caught UGS and the entire industry off guard. With its aggressive go-to-market strategy, PTC changed the market landscape, leading the industry to adopt “value” as a driving criterion for competing effectively. Value for our customers is measurable improvements in, Cost, Quality, and Time. We continually worked with customers, in collaboration with product management and development, to listen to their needs, discuss them, and then explain our product directions and rationale. We then collaborated to educate and align customer and product management on the best value proposition.

Despite these market changes, a significant number of customers remained loyal to Unigraphics. Given our efforts and the roadmap's visibility, they believed UGS would also reach its goal. The organization became more thoughtful, flexible, and resilient. The significant learning from the PTC competition was to involve product management and R&D with the customer to focus on customer value.

On the other hand, Unigraphics and Dassault Systèmes (DS) primarily collided in the Automotive and Aerospace sectors. They began competing after 1996, when DS CATIA was ported to Unix. UGS greatly enhanced our automotive sheet-metal capabilities, weakening Dassault’s prior foothold. The main competition area was around Class A surfaces, which were deemed critical for both industries. Class A surfaces primarily relate to complex geometric surfaces that model product shape, style, and aerodynamic performance. The external parts of a car, which create an overall style, are good examples. Soon thereafter, Dassault released Catia V5 with much fanfare. The market could see the IBM relationship begin to fracture.

By the year 2001, IBM and Dassault's divorce was finalized. The key lesson learned from IBM's strategy: A services-oriented company will not succeed in selling software, especially in CAX. One of the few exceptions is Tata Consulting Services (TCS), which began distributing Unigraphics in the early nineties, followed by the co-development of the Unigraphics portfolio. TCS ultimately built a robust PLM and manufacturing services business. Additionally, through its

work with TCS on offshore development and various UGS acquisitions, UGS developed a highly effective distributed R&D capability across approximately 14 R&D centers worldwide.

UGS was involved right from the beginning in the emergence of SolidWorks, and since its first release in 1995, it has been based on Parasolid as the kernel modeler. The acquisition of SolidWorks by Dassault followed in 1997.

The emergence of SolidWorks led to UGS's 1998 acquisition of SolidEdge from Intergraph whose R&D was based in India. Intergraph exited the CAD market to focus on Geographic Information Systems (GIS). SolidEdge, which was based on Dassault's ACIS, a competitor to Parasolid, was quickly ported over to Parasolid. One of the significant advantages UGS realized from this acquisition is the potential for offshore development in India. This acquisition, coupled with TCS's relationship and the subsequent acquisition of SDRC, created one of the largest UGS R&D centers in the industry.

UGS goes public

EDS decided to take UGS public in 1998 while retaining 80% ownership. With Y2K approaching, the market buzz centered on "Collaborative commerce" as part of the evolving boom, which was later followed by the dot-com bust. The rationale for a public offering was to capitalize on the dot-com boom and create an acquisition currency to fuel UGS's growth. EDS's majority ownership presented a barrier that could not be overcome, as the NYSE listing price was $14 a share. The exit later at $33 a share did not meet the "dot.com" multiples expected.

Collaborative commerce (C-commerce)

The UGS Go-to-Market (GTM) strategy was based on "powering collaborative commerce." Collaborative commerce was the "talk of the market" based on the dot-com era. Gartner, an analyst, had the following to say about C-commerce: "C-commerce is an idea whose time has come- a new business equation redefining how we work in today's global marketplace. Enterprises that embrace c-commerce can expect streamlined business processes, new cost efficiencies, greater customer satisfaction and loyalty, and exponentially expanded revenue potential. It involves the dynamic, web-enabled exchange of information and ideas between trading partners- and within enterprises- to maximize product design and development, supply chain operations, and manufacturing operations".

UGS viewed Collaborative commerce as a step toward achieving PLM, leveraging proven parts of the necessary technology stack. The market was evolving to understand the value of integration and collaboration between software, systems, and people. Figure 4 illustrates Collaborative commerce leveraging PLM components to facilitate collaboration and communication across the product lifecycle by linking and integrating other components from PDM and CAX, creating "digital threads" as seen in Figure 4.

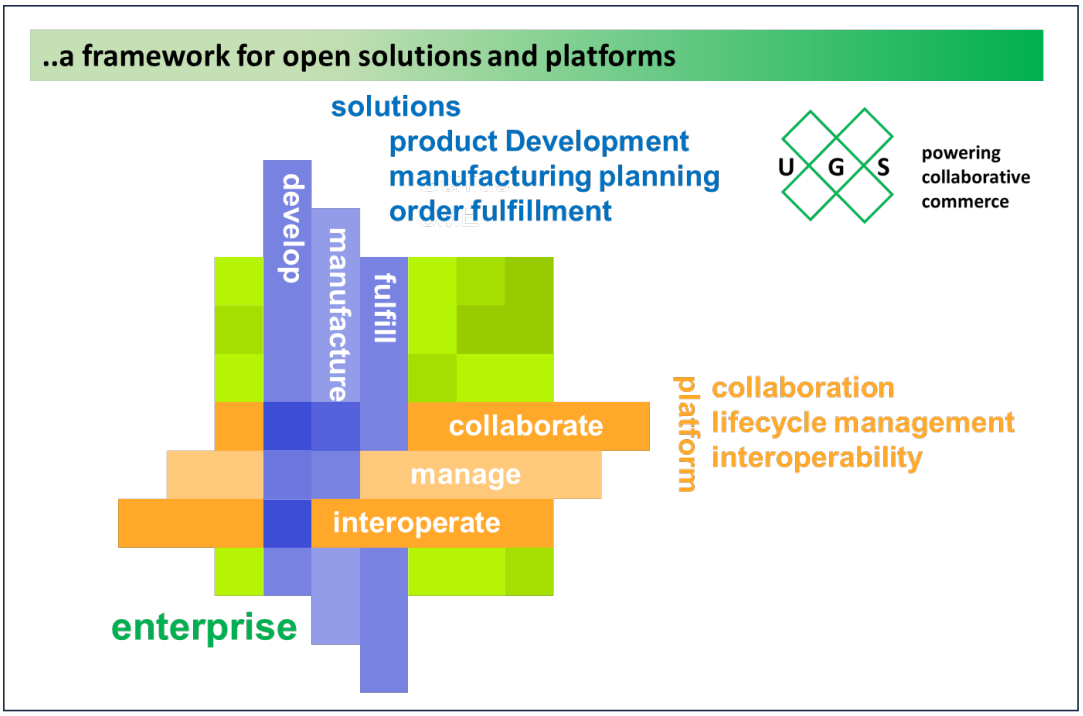

Figure 4: The PLM Fabric " weave of digital threads"
Source: UGS NYSE Launch Analysts Briefing

In 1998, UGS's products—Unigraphics, Solid Edge, Parasolid, and IMAN—competed based on functionality, technical performance, price, operating system compatibility, integration, customization capability, marketing, technical support, and training. The company employed over 2,200 people and conducted business in more than 85 offices worldwide.

UGS completed the acquisition of Applicon, one of the leading CAD companies in the 1980s, which had experienced a downturn. Applicon focused on technology development for the global GM account.

In addition, UGS introduced two initiatives, Product Vision and Virtual Product Development (VPD)

ProductVision(TM) was introduced in 1999 for use across the entire portfolio. It consists of visualization software applications that enable both technical and non-technical users to view, markup, and analyze two-dimensional and three-dimensional product information. This product had embedded EAI technology (later acquired by UGS) but was branded as a UGS solution. The objective was to establish a common visualization framework across the product portfolio, as depicted in Figure 5.

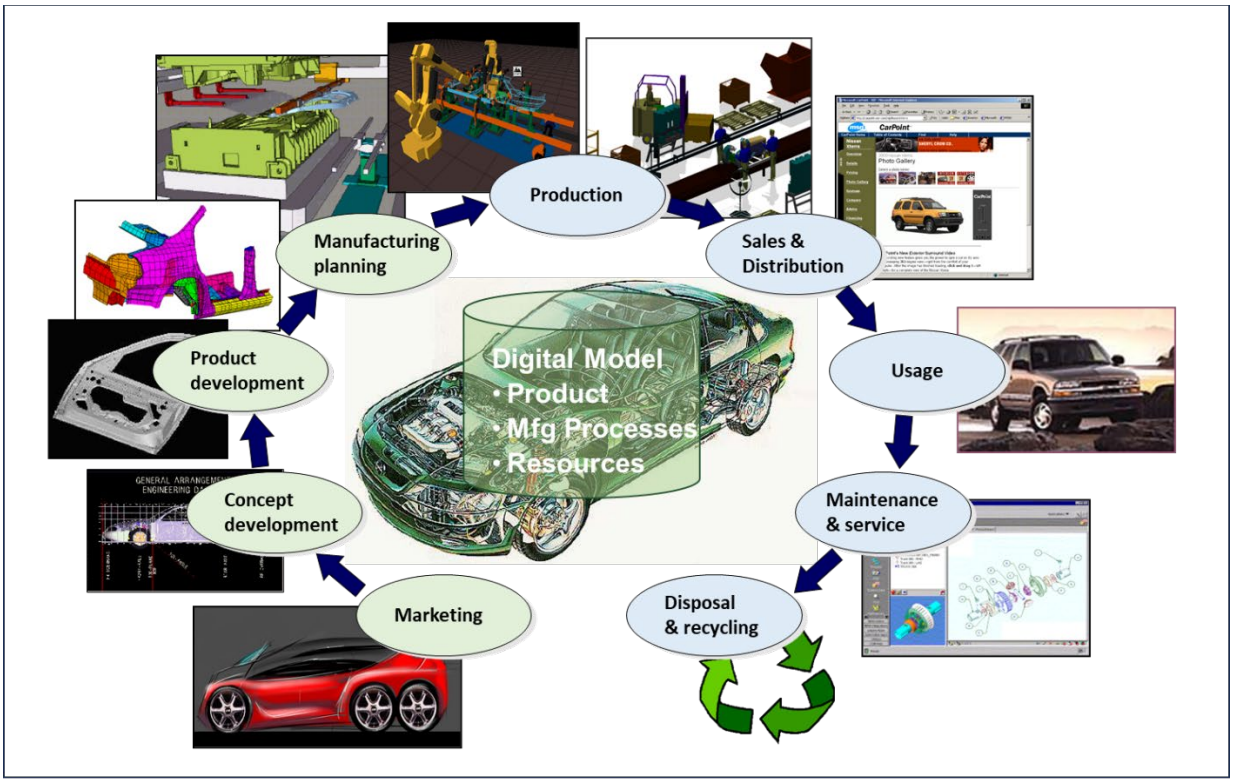

Figure 5: ProductVision visualization pipeline across the lifecycle

Source CEO presentation at Daratech Boston Conference

Virtual Product Development (VPD) is an environment in which a complete, accurate representation of a product and its associated data is created, tested, drafted, manufactured, serviced, and marketed digitally. In its purest form, all aspects of the product development process are performed collaboratively and concurrently across departments, sites, divisions, alliances, suppliers, and geographies as depicted in Figure 5.

The New Millennium

From a technical transition standpoint, during the 2000-2010 decade, PLM became integral to the enterprise IT and OT landscape, focusing on the "lifecycle" across Design, Engineering, and Manufacturing Planning, and linking to Manufacturing Execution Systems (MES) and other enterprise systems as part of the evolution of "digital threads".

Acquisition of SDRC

Here, we will quickly summarize some key SDRC changes in the 1990s, focusing on what was achieved and why they better positioned SDRC for sale. Please refer to Reference [6] for further details.

SDRC continued its transition strategy from a consulting company to a software company. Services were now significantly focused on software implementation and leveraging experience as the PDM business grew. Best practices and rapid implementation quickly secured more

seats, increased software revenue, and delivered measurable value to customers. Services revenue declined as a percentage, while software revenue and profitability increased.

From a technology and software standpoint, there was a strong focus on moving forward with PDM and further integrating across CAX modules.

SDRC's market and technical strategy was to expand the engineering and manufacturing planning enterprise footprint within the customer base, consolidate leadership in PDM through SDRC's 1996 acquisition of single ownership of Metaphase, and acquire Sherpa in 1998. This leadership in data management helped sell more high-value integrated CAD offerings. From a PDM standpoint, based on customer requests, SDRC viewed CAD as one of many applications across various domains and vendors, and defined the term "multi-CAD" to enable standard data management processes across and between multiple applications from multiple vendors. Late in the 1990s, following the Sherpa acquisition, SDRC held 40% of the installed market in terms of total revenue, with a combined user base of approximately 350,000.

SDRC's business success was mainly based on its focus on groundbreaking integrated software and its sales approach. Sales employed a consultative selling approach that led to the development of the Challenger Process. The Challenger Process refined the sales process, challenging companies to assess their standing relative to industry or department performance and how our solutions could enable improvement. Sales were organized to sell the entire portfolio, not just individual products.

With revenue continuing to grow to $351 million and profit of $30 million in 1997. The SDRC board and leadership recognized that significantly more investment was needed to stay ahead and fuel growth. Selling the company was the go-forward strategy. The primary purpose of the CEO change was to position SDRC for sale.

EDS and UGS Opportunity

EDS and UGS saw an opportunity, as many of their large customers faced problems similar to GM's: a proliferation of hardware and software systems across their design, engineering, and manufacturing planning. This proliferation was high across CAX (CAD, CAE, and CAM), with many tools used even within the same discipline. Commonization and standardization were necessary, but there was also a need to manage data and processes across applications and disciplines. iMAN had begun to demonstrate the potential of CIM/PDM for data and process management, and Unigraphics was integrating CAD and CAM applications, leveraging the Parasolid kernel. These were the technology building blocks for the future.

UGS was not the market leader, but in 2000, it was well-positioned with EDS to pursue acquisitions that could achieve leadership. SDRC was of acquisition interest due to its potential as a sale opportunity. The opportunity and goal, early in 2000, for UGS and EDS to merge Unigraphics (#3) and SDRC (#4) was to achieve market leadership (#1) in the Product Lifecycle Management (PLM) market by 2006.

The Integration of SDRC and Unigraphics into UGS

In late May 2001, EDS announced an agreement to acquire SDRC for approximately $1 billion in cash, equivalent to $25.00 per share. EDS, UGS, and SDRC senior management emphasized that EDS had acquired SDRC to create a company that would emerge as the clear leader in the product development marketplace, rather than to eliminate a competitor. Following the acquisition, over 40% of the world's digital product information will be stored in the EDS/UGS solutions.

Almost in parallel with the merger, which was encouraged by large customers, UGS acquired EAI, which formed the basis of Product Vision and provided several additional applications for engineering and supply chain collaboration. Over the next decade, EAI's JT (Jupiter Tessellation) significantly impacted collaboration and interoperability between systems, repeating what UGS achieved with Parasolid in solid modeling. JT ultimately became an ISO standard widely adopted and well-regarded by the market [9].

EAI's JT technology provides quick, safe, and convenient access to the breadth of a customer's data. An OEM and supplier can easily exchange data from multiple authoring systems and share a common environment for collaboration and communication of changes. It enabled collaborative commerce (Figure 5). JT was the format for this shared environment, and most application development companies, under pressure from their customers, generated JT from proprietary systems that authored the master data

Also, just before the merger, as we entered the new millennium, EDS branded "UGS, an EDS company" as the fifth Line of Business. Having UGS as a separate business allowed UGS to operate as a software company rather than a services company and also made it easier to separate and sell.

The business unit that could potentially provide UGS customers with high-value services was AT Kearney's offerings of "Engineering Effectiveness Management—New Product Introduction and Complexity Reduction." Jointly with AT Kearney, UGS embarked on value engineering as an extension of its leading sourcing capabilities. The other EDS line of business that had common customers with UGS was iSolutions, a classic IT infrastructure management company.

UGS also acquired a sourcing suite, eBreviate, from AT Kearney in a swap deal for a Teamcenter collaboration suite. Integrating sourcing with engineering enabled UGS to introduce "design to source, " enabling engineering to work with procurement right from the start of design. We received several industry recognitions from the Supply and Demand publication, recognizing the paradigm shift UGS proposed. Several large implementations at P&G and Visteon delivered the promised savings. Today, this suite is integrated into the Teamcenter portfolio, including costing to provide the basis of complexity reduction and value engineering.

Earlier, when we discussed the 1990s, we explored the SDRC and the Unigraphics software portfolio, as well as their direction. However, SDRC's executive management had begun moving

away from CAD and toward the enterprise PDM and PLM markets. The breadth and cost of the needed SDRC CAD enhancements were reduced to the core of the products. Just before the merger, they disastrously lost a key automotive customer while attempting to secure funding for critical CAD enhancements from some customers.

SDRC had a premier implementation at Ford for “digital buck”. In contrast, UGS had equivalent success with iMAN with JT in GM to create “Repeatable Digital Validation (RDV)” which provided digital models and applications to validate design direction and decisions. In today’s parlance, these are referred to as “digital twins”. Lessons learned from these implementations continue to provide the basis for UGS's solution extensions and differentiation. The “digital buck” and RDV were a virtual representation of the entire product, enabled by EAI’s JT, which allowed designers, engineers, and manufacturing planners to examine packaging, performance, and manufacturing layout scenarios early in the design cycle.

Merging the products- formation of UGS PLM

After the merger, bringing the I-DEAS master series and Unigraphics together was a critical task. The CAD Products team began examining and understanding the two systems, defining options for initial coexistence, and quickly merged the two products without creating market or customer concerns. Unigraphics Parasolid, a geometric modeling core, provided an opportunity to facilitate unification and short-term enhancements for both products. The I-DEAS master series provided CAE with product components to be leveraged in the merged product. Based on the SDRC's CAD direction, as voiced by the SDRC CEO before the merger, and the common agreement to leverage UGS Parasolid, Unigraphics was the go-forward core system.

Examining the PDM suite, UGS iMAN and SDRC Teamcenter (formerly Metaphase) had many customers actively using each product. However, the focus of each product was different—UGS iMAN was to simplify engineering information management, while SDRC Teamcenter offered an enterprise-level data and process management platform.

EDS/UGS announced two technical roadmaps: one for CAD and the other for Teamcenter. The diagrams below illustrate the information announced at the time of acquisition.

On the CAD side, the approach is outlined in Figures 6 (announced) & 7 (delivered) to leverage the two products in the short term by quickly facilitating better interaction and associativity while migrating the best features of both systems into a next-generation system, named NX. NX indicated “Next” as new and different from the current. However, the NX name was rapidly accepted internally and across the market and customer base. Software releases were aligned, and increasing levels of data exchange and associativity were determined and incorporated into both Unigraphics and I-DEAS product plans.

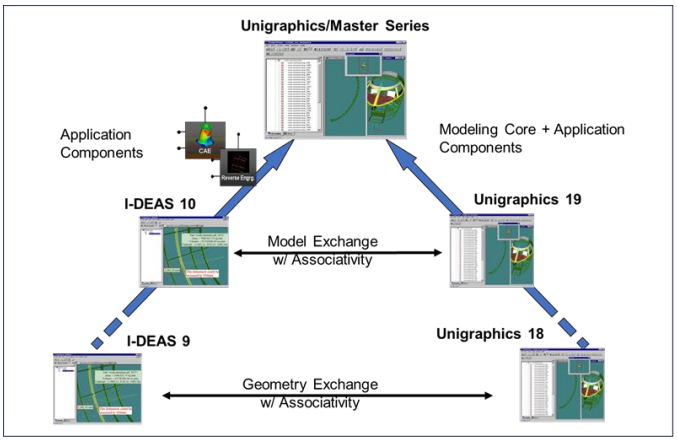

Figure 6: Unigraphics and Ideas convergence
Source: Analysts' briefing on the acquisition

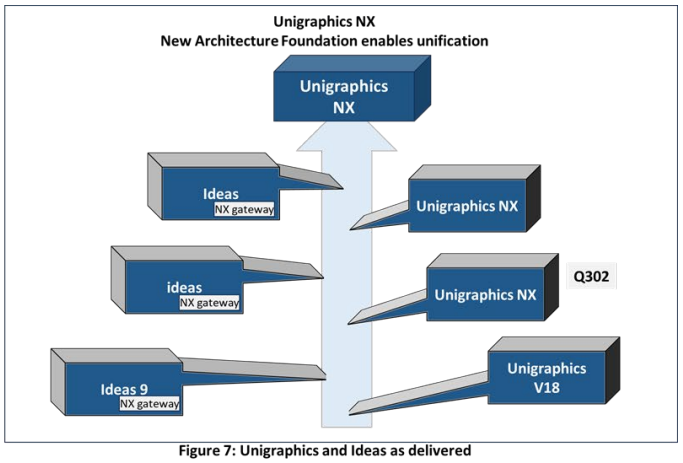

Figure 7: Unigraphics and Ideas as delivered
Presented during the PLM World Users group

A coexistence strategy for PLM, based on the strengths of each, involved UGS iMAN (Teamcenter Engineering) and SDRC Metaphase (Teamcenter Enterprise). A third system, Efactory, was also crucial to planning a unified PLM system. Efactory came from Tecnomatix and provided the manufacturing planning data. Efactory later became known as Teamcenter Manufacturing. The intent was clearly to support all customers and evolve the three products into a unified system. This was not an easy task because data and process management systems cannot be taken offline quickly or modified without a clear migration strategy and customer planning. See Figures 8 (announced) & 9 (delivered).

Over the course of three years, the UGS and SDRC combination, known as EDS PLM Solutions, employed a stepwise approach to implement commonality. It was intended to maintain iMAN's simplicity in engineering information management while offering an enterprise-level platform, represented by SDRC Teamcenter and Teamcenter Manufacturing. This initiative was called Teamcenter Unified.

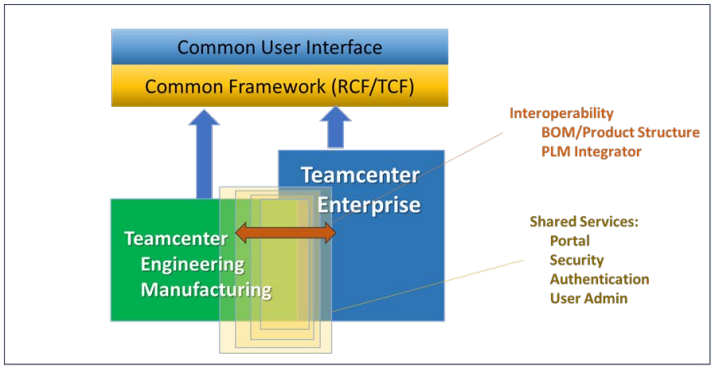

Figure 8: Teamcenter Engineering (UGS iMAN) & Teamcenter Enterprise (SDRC Metaphase) co-existence
Source: Analysts' briefing on the acquisition

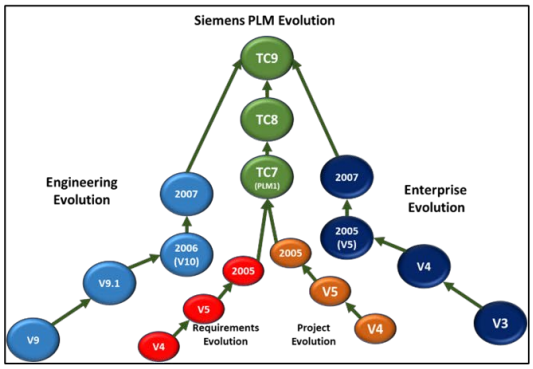

Figure 9: Roadmap to Unified Teamcenter
Source CIMDATA Paper: Teamcenter "unified "Siemens PLM Software's Next Generation PLM Platform"

UGS PLM focuses on solutions

Although the primary focus of the merger was to combine two software companies, services and consulting were also assets within Unigraphics and SDRC that complemented EDS's existing services. Quick discussions and understanding led to a new comprehensive services portfolio with defined offerings. See Figure 10.

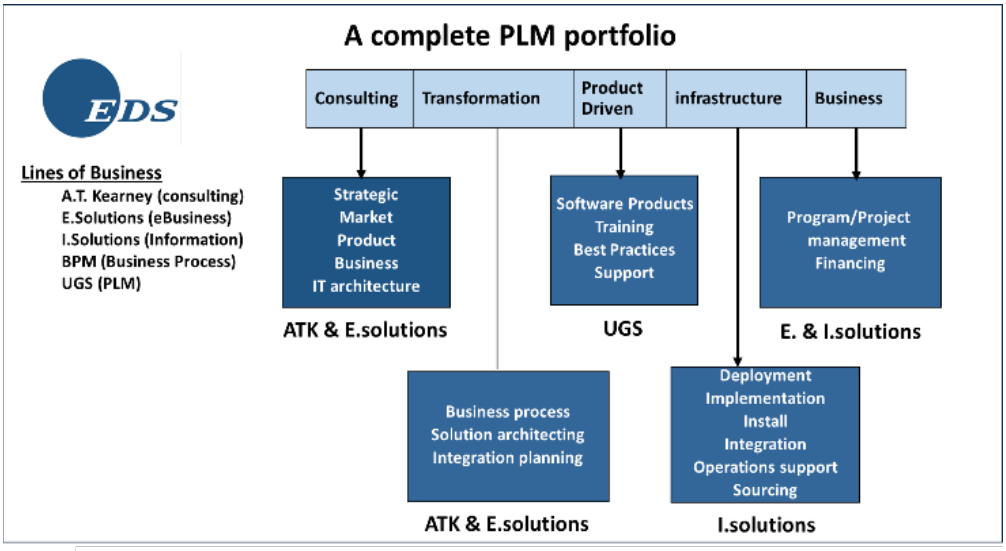

Figure 10: PLM Products and Services from EDS Lines of Business
Source: CEO presentation at Analyst/Press event 2001

Before the merger, SDRC Services was rebranded as 'ExperTeam' based on its knowledge and experience in deploying software and understanding the key processes and how our software could enable them. The result was to ensure customer success by achieving expected value metrics using our software.

Using Process Lifecycle Analysis (PLAN), the Golden Thread database [6], and documenting industry templates and success metrics, service knowledge was leveraged more effectively across EDS. Its leverage included supporting big deals, achieving more wins, deploying faster, consistently ensuring customer success, and improving EDS's growth and margins. Effectively, we moved from product sales to solution sales.

The following key concepts from SDRC development and services met with market success:

1. The Introduction of SDRC Multi-CAD enabled OEMs to take various CAD data from the supply chain and construct complex digital mock-ups.
2. The platform/enterprise concept enabled UGS to engage with the ecosystem, developing applications and expanding into adjacent markets.
3. The SDRC PLM implementation practice, which focused on metrics-driven value delivery, was adopted for both tracks.

A good example is the proposal developed for GM in partnership with AT Kearney in 2002 (Figure 11). During the presentation to GM, we were told that the value was conservative, and

GM expected much more. The PLM implementation practice was then used to develop metrics for the GM implementation. The golden thread [7] links the end value to process change, leveraging technology and proven best practices.
This value-based approach was scaled for all PLM implementations with AT Kearney.

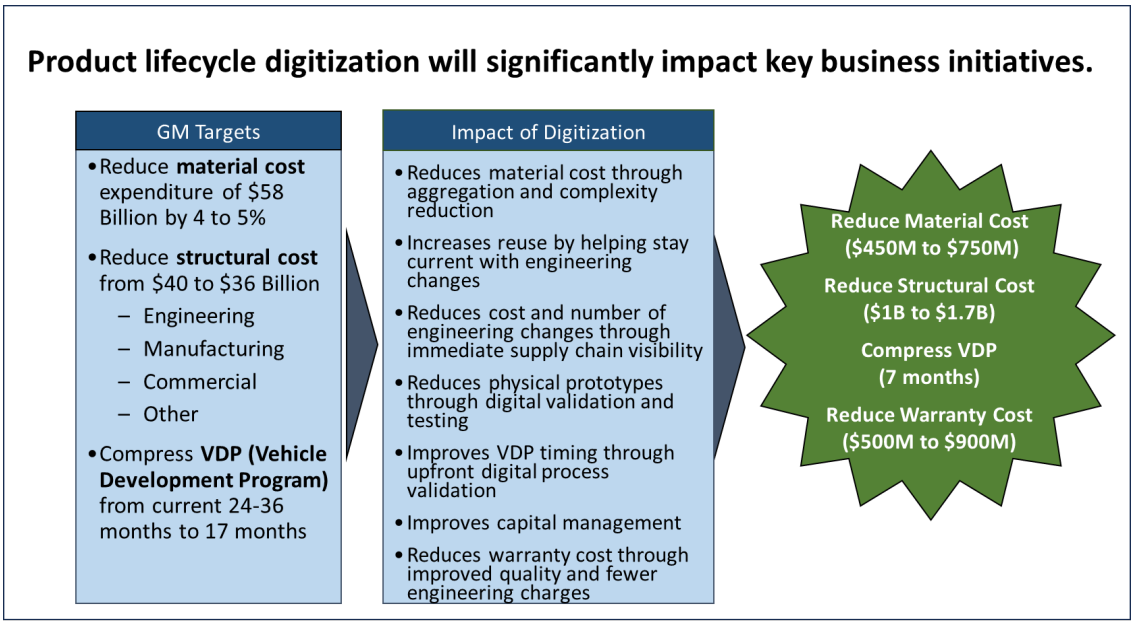

Figure 11: Value approach example for PLM implementation
Source: Presentation to GM by AT Kearney and EDS PLM Solutions

Merger strategic conclusion

The business, by design, continued to grow, proving the decision to acquire SDRC was the right action. This growth continued as we moved into the private equity ownership phase and the early years of Siemens ' acquisition. This period is the subject of the following two sections.

The “headwinds” at EDS resulted in the sale of UGS PLM to private equity

EDS CEO in the SDRC acquisition press release in May 2001 made the following quote:
"In the last 24 months, we have seen the beginning of a network-based revolution in the way products are designed, developed, and manufactured," said Dick Brown, EDS chairman and chief executive officer. "UGS has given us a window on this change and on the emergence of product life-cycle management, where digitized information is shared instantly and globally. Now is the time to move quickly and decisively to capture opportunities in this space."

Ironically, by sheer contrast, just three years later, in March 2004, the press reported, “The decision by outsourced services provider EDS to sell its product lifecycle management (PLM) unit to a group of three private equity firms may be a winning move for all parties, according to at least one industry analyst.” EDS announced earlier that week that it had reached a definitive

agreement to sell its UGS PLM Solutions unit for $2.05 billion in cash to a group that includes Bain Capital, Silver Lake Partners, and Warburg Pincus.

This change in direction was primarily driven by the need for a substantial cash infusion into EDS's Core competency around high-margin IT services and solutions. Unfortunately, the IT services market has never been the same since the entry of low-cost competitors from India. While UGS was profitable, it was not central to EDS's core strategy. Private equity seeks opportunities for operational improvements, market expansion, or eventual resale at a higher valuation. The PE consortium took advantage of the EDS issue to secure a great price at a low price-to-revenue multiple.

Life under Private Equity (PE) ownership

The UGS company underwent yet another transformation. From its IPO in 1997 to 2001, EDS PLM's line of business was followed by the launch of “UGS-The PLM Company” with the tagline “UGS-Transforming the Innovation Process.”

The highlights of the PE transaction included a purchase price of $2.135 billion; PE firms contributed approximately half of the purchase price, with the remainder covered by loans and bonds on the UGS balance sheet. The PE's initial focus was to achieve an IPO quickly through growth rather than financial engineering. The PE ownership period was positive for UGS, as we successfully repositioned the company's operations into a fully independent software business.

During this time, a key market concept was “design anywhere, build anywhere.” UGS had successfully implemented design across Detroit, Russelsheim (Opel), and Stuttgart (Porsche engineering), keeping data in sync across multiple sites throughout the design evolution.

It was manufacturing's turn to be added to the UGS portfolio. Tecnomatix and UGS enjoyed a long-standing relationship with many automotive OEMs. UGS's acquisition of Tecnomatix in January 2005 for $228 million formalized the relationship.

For the Siemens UGS acquisition, Siemens identified the Tecnomatix portfolio as a key consideration for extending the Siemens Automation portfolio, given its functionality that aligns with plant operating needs. The operating principles were:

1. Single associative source for manufacturing information for both Part and Assembly planning
2. Optimize plant performance
3. Human-centered design and validation
4. Quality analysis
5. Production execution management.

The growth target industries were automotive, aerospace, hi-tech, and consumer goods, with industrial machinery being a common element.

Cimdata, in its published assessment on January 30, 2005, [1] commented on the acquisition, "Digital manufacturing has become a key component for PLM."
UGS invested in PLM XML, which covered PMI (Product Manufacturing Information), Process, Geometry, features, and Structure. The market recognized the superiority of the UGS solution, featuring a Teamcenter manufacturing backbone and numerous authoring applications for manufacturing engineering. UGS introduced the "bill of process" concept associated with the "engineering bill of material," furthering the integration of simultaneous design and manufacturing engineering.

Figure 12 below mentions the coverage of all three tiers of manufacturing: Part, Assembly, and Plant.

Figure 12: Simultaneous virtual product and process development
Source: Industry Analysts briefing

Figure 13 below illustrates the value of the enterprise bill of materials, which connects multiple plants to produce local product variants required by various geographies.

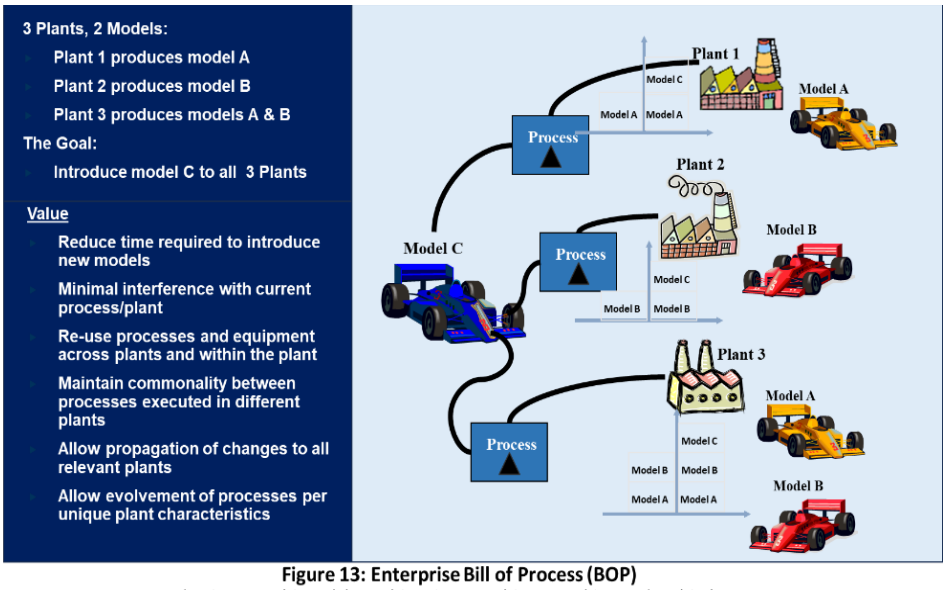

Figure 13: Enterprise Bill of Process (BOP)
adapting to multi-models, multi-variants, multi-geographies, and multi-plants
Source: External presentation to analysts and user groups

Sales of UGS to Siemens: From 2004 onwards,

UGS had two distinct threads of activity. The corporate direction was to look at "where to win" and "how to win." A significant effort was made to analyze IPO readiness. However, the interest in acquiring UGS from a leading Industrial company in 2005 morphed the UGS corporate direction into entertaining interest from several strategic buyers. During that process, Siemens showed great interest. Discussions with Siemens began in the summer of 2006, progressing to the acquisition of UGS in the Spring of 2007. The focus on an IPO remained an alternative until later in 2006. In 2006, UGS was labelled as the leader by Gartner (figure 14).

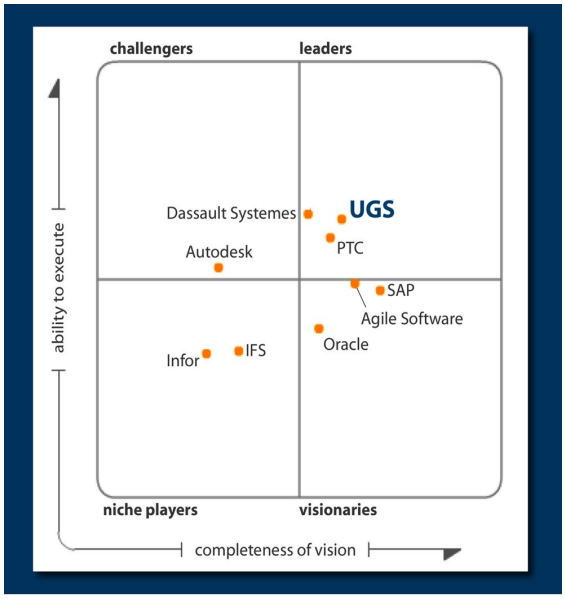

Figure 14 UGS ranked best PLM company overall for completeness of vision and ability to execute
Source Gartner PLM Magic Quadrant, Q3 2006

Focus on financials—namely, software revenue growth and EBITDA—remained central throughout the PE ownership phase until 2007, when Siemens acquired UGS. PE companies were not interested in the details of UGS's operations, but rather focused on its financials. However, they were interested in the value we delivered and what customers thought about us. Private jetting for customer review meetings was a good way to travel!

The detailed dialogue with Siemens was quite different. They wanted to understand UGS's history (Figure 15) and how we did things. The whole focus with Siemens was on growth. As engineers, we spoke the same language and were entirely focused on broadening PLM's growth across the industry. In contrast, the Private Equity/IPO was laser-focused on achieving repeatable profitability. During the dialogue with Siemens, UGS explained how it had been positioned since the merger transition in 2001, leading to independence with PE, followed by two years of driving change and achieving leadership. Siemens agreed that the joint focus with Siemens would be growth.

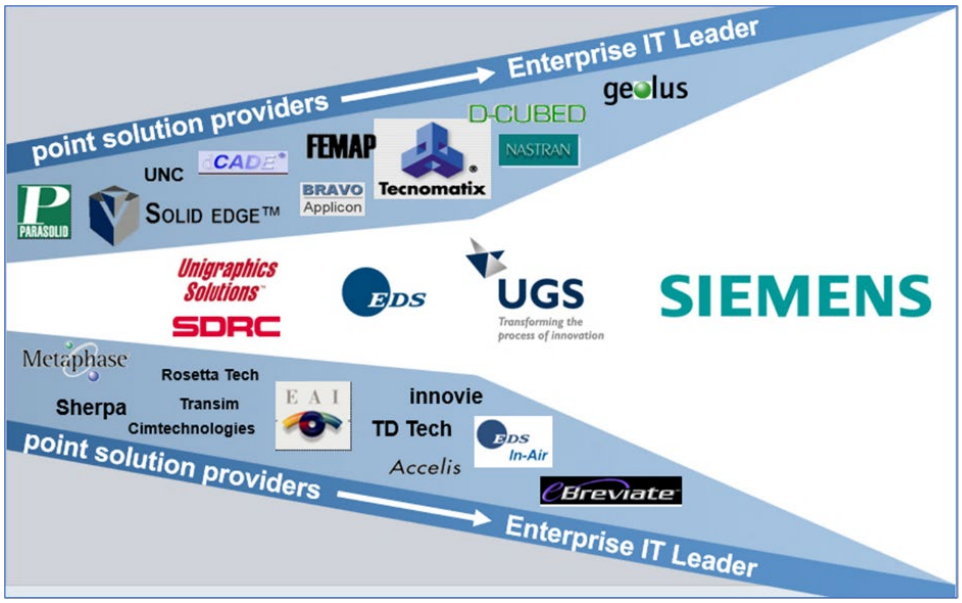

Figure 15: UGS Presentation to Siemens - Rich Legacy and History from CAD to PLM to Enterprise
Source: External Market presentation

<u>Siemens acquisition rationale</u>

The UGS acquisition was made by the" Automation and Drives" division of Siemens, the most profitable division of Siemens, as an extension to its predominantly hardware and automation business.

Three key executives of Siemens A&D (the President and two group VPs) demonstrated remarkable foresight by acquiring a synergistic software company, guided by a clear vision of the manufacturing enterprise. More importantly, this vision extended to operations, with a

clear mandate to keep and grow the channel, which remains a key tenet. The relationship with Siemens customers and Siemens corporate technology started from the get-go.
Figure 16 in [9] from the Siemens Press conference provides a business rationale for the UGS acquisition.

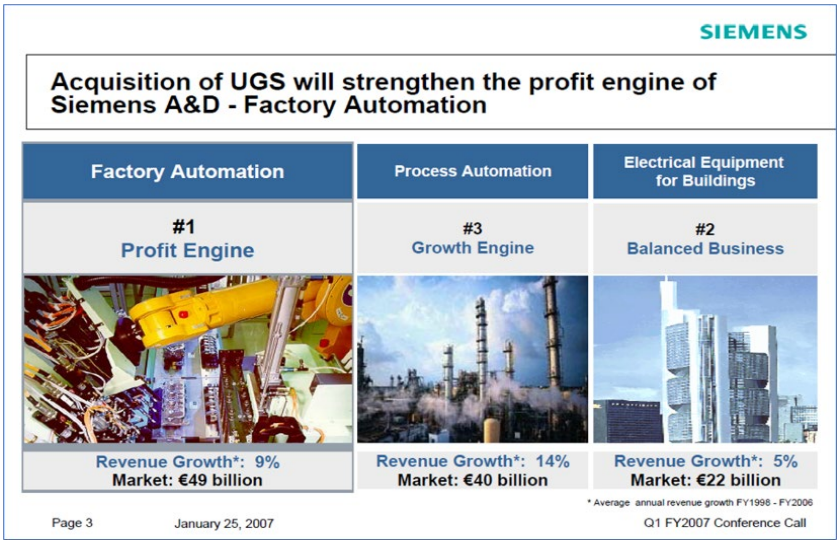

Figure 16: Acquisition of UGS: creating the world's first supplier of software and hardware across the complete product and production life cycle
Source: Siemens Press Release [8]

The following figure 17 [9] from the Siemens Press conference provides a roadmap for product and production integration.

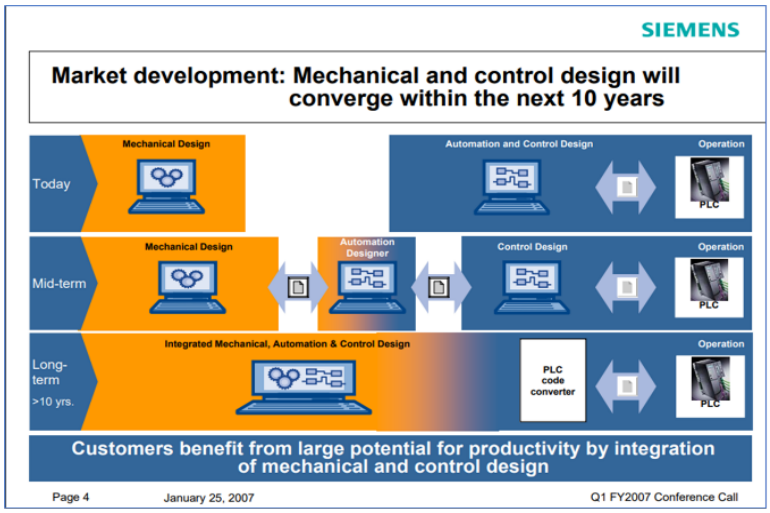

Figure 17: The Siemens product and Production roadmap
Source: Siemens Press Release [8]

A joint team consisting of key executives authored the following mandate:

- UGS's go-to-market strategy was based on no interruption in ongoing account relationships. Siemens and UGS lead their respective industries in customer satisfaction, and the companies expect their integration to strengthen their customer relationship. The exact position was held for UGS's relationship with Siemens's competitors.

- Continue to operate an independent organization with their direct and indirect channels with the existing leadership team.

- The expectation was that UGS would continue its past 13 quarters of YOY revenue growth, expanding its portfolio and building a strong ecosystem of partners.

- Siemens' "Totally Integrated Automation" was uniquely powerful for the evolution of PLM, and UGS was best positioned to work with a world leader, Siemens, to make it happen.

This structure and mandate led to several initiatives, in addition to the business-as-usual described earlier.

Accelerating mutual leverage UGS and Siemens

For most key UGS employees who had witnessed numerous ownership changes, Siemens's ownership was like coming home to an established engineering company. Additionally, Siemens respected UGS by maintaining its autonomy while transitioning to shared services for administrative and corporate functions. Siemens respected all the elements we articulated as the needs of a software company. The credit goes entirely to the key Siemens executives responsible for acquiring UGS.

A few highlights of the period from 2007 to 2010 can be summarized in the following four initiatives.

- Role of UGS in the Automation Picture of the Future (POF)
- Framework for Product and Production Lifecycles
- What can Siemens Divisions learn about software from UGS?
- Positioning PLM as part of Enterprise IT systems

Role of UGS in the Automation Picture of the Future (POF)

Siemens published "Pictures of the Future (POF)" by Siemens Corporate Technology (CT), a very popular set of articles detailing the future environment of manufacturing customers. This research is published by Siemens CT on a quarterly basis, highlighting each of Siemens' divisions and business units. A few colleagues from UGS and CT were tasked with mapping the current UGS portfolio into the Siemens Automation POF. This resulted in the following high-level picture mapping of each UGS product portfolio into the Automation POF as a starting point. This exercise was repeated with greater detail for the PLM portfolio post-2010 to project the next decade of "hyper-growth."

Figure 18 below shows a schematic of the Automation POF, excluding the details of which UGS portfolio element was mapped. One of the significant advantages of UGS was its ready access to a wide variety of Siemens manufacturing business units, many of which specialized in building “mechatronics” products. This offered UGS Product/Program managers a “dream” assignment to focus on “needs” and not just “wants”.

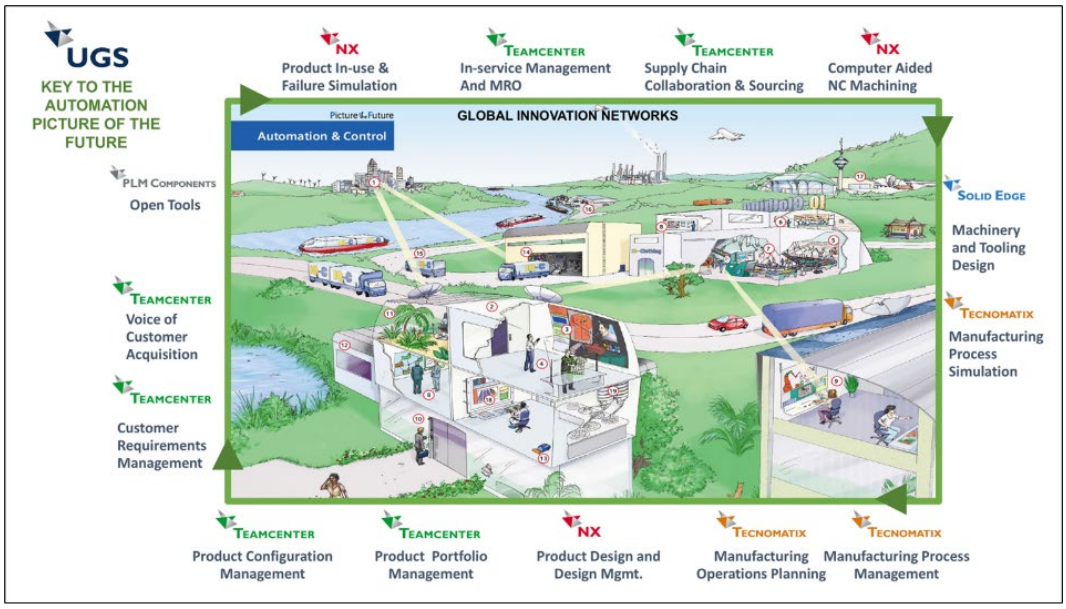

Figure 18: UGS portfolio mapped into Automation POF
Source: Siemens Pictures of the Future

Framework for Product and Production Lifecycles

Siemens provided incremental funding for the high-value integration of Automation with PLM projects within the Siemens framework for the Totally Integrated Automation (TIA) domain. TIA represented the complete Siemens Automation and Drives Portfolio, comprising a vast array of Systems for both Discrete and Process Industries, including controllers, software applications for PLC programming, human-machine interfaces, integration tools, and Manufacturing Execution Systems.

In collaboration with UGS, specific new budgets were agreed upon to facilitate the definition and piloting of new integration capabilities, thereby accelerating digital collaboration. Figure 19 shows various core communication enhancements, such as knowledge exchanges and new high-value capabilities, like “Virtual Commissioning.”, UGS CAM, Direct Numerical control integration, and Control Engineering for Shop Floor systems. Part of the activity involved integrating product definition directly into the Siemens Shop Floor Systems. Figure 20 illustrates the long-term approach, which involves accelerated capabilities funded through new budgets.

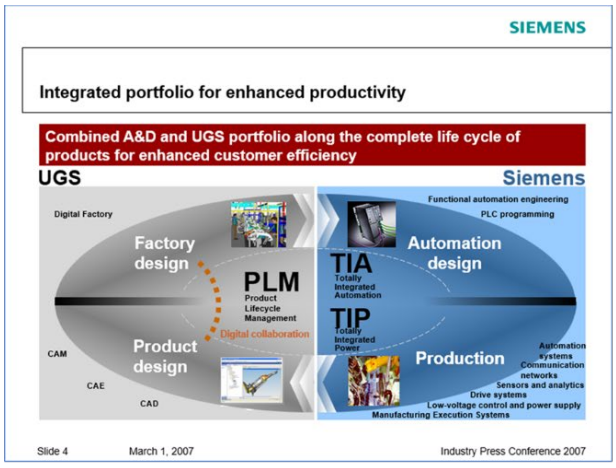

Figure 19: Source Industry Press Conference, 2007

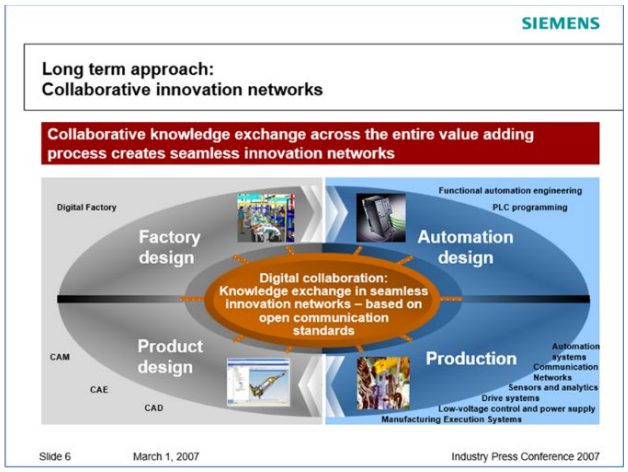

Figure 20: Source Industry Press Conference, 2007

What can Siemens Divisions learn about software from UGS?

Various business Units and Divisions asked UGS after the acquisition, "What can Siemens Divisions learn about commercial software from UGS?"

Listed below are the key highlights from the UGS presentation

a. Business model: UGS generated ~45% of its annual revenue as a recurring stream.
b. Top-line optimized business: Low cost of goods sold (COGS) in the SW business requires that various aspects be managed differently than in a traditional Siemens hardware business.
c. Global nature of the business: Global sourcing of customers, strict revenue recognition rules, and piracy require global standards and processes.
d. Customer orientation and know-how: UGS's key value, "Never let a customer fail," is being applied by all parts of the organization.
e. Marketing for Software: Marketing an intangible and complex product requires a different approach than marketing hardware.
f. Collaboration: UGS organization is spread widely across the world; employees are very comfortable with different ways of collaboration.

Positioning PLM as part of Enterprise IT systems

The Siemens A&D executives asked UGS to position PLM as part of Enterprise IT/OT systems. As discussed earlier in this paper, this exercise is the basis for PLM's expansion into the enterprise.

The answer to this request was in several parts.

First, the ISA 95 standard was used to position PLM in the framework. See Figure 21.

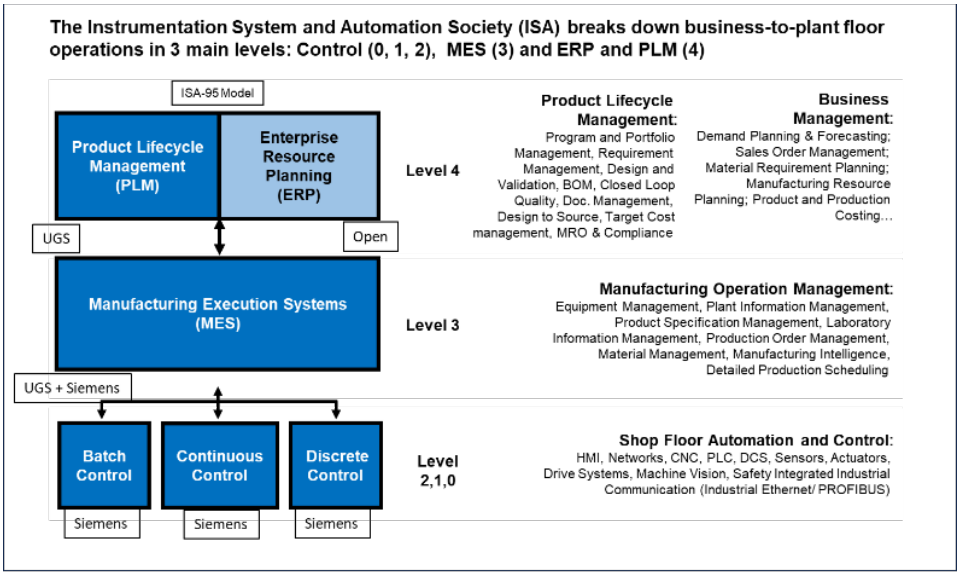

Figure 21: Using ISA 95 framework to position PLM

Second, incorporate PLM as the enterprise enabler to bring a new product to factory/plant execution (Figure 22)

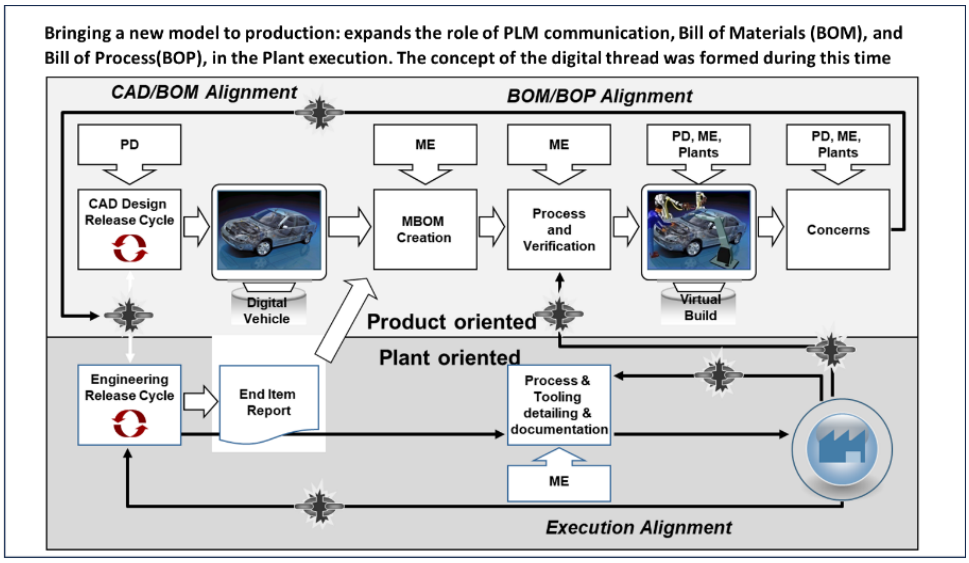

Figure 22: Overall process flow of bringing a new product to factory/plant execution
Source: Presentation to Automotive Steering Group on Digital Manufacturing, March 2007

Third, establish the role of PLM in Virtual prove-out and validation (Figure 23).
Showing the PLM's ability to support the virtual prove-out and validation for both product and plant and the ability to provide feedback through lifecycle management clarified the role of PLM.

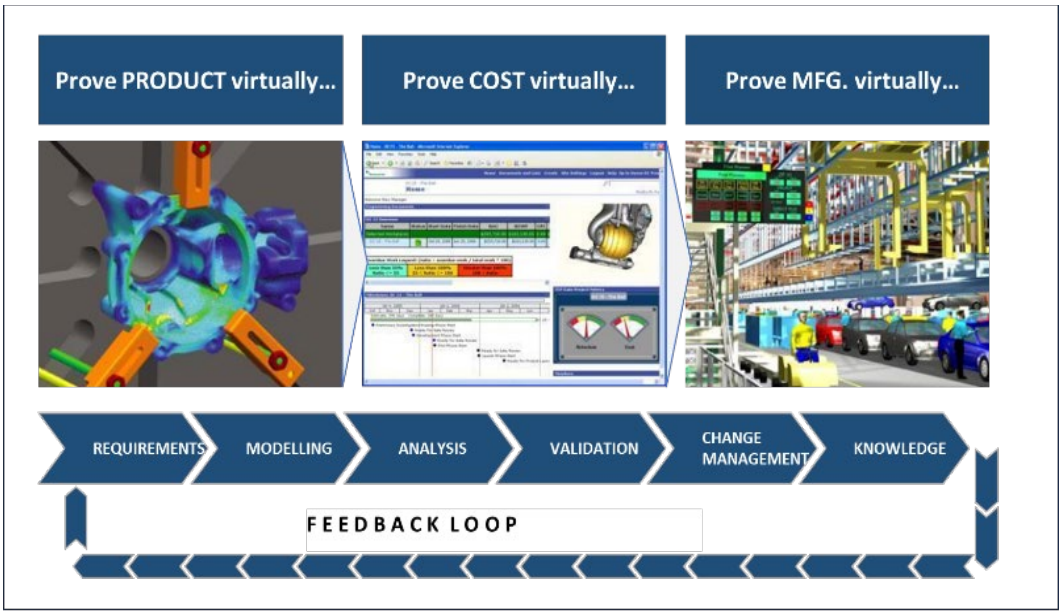

Figure 23: Role of PLM in supporting digital prove-out and validation
Source: Siemens presentation to Automotive Steering Group

The above diagram is an illustration only. The role of PLM – i.e., "Virtual prove-out" covers the following domains:

Form / Appeal, Fit, Function, Cost, Geography, Manufacturability, Serviceability, Sustainability, Quality, IP, Packaging / Logistics, Regulations, etc.

Finally, clarifying the position of PLM in an enterprise IT space showed its role across and with other enterprise systems, enabling a lifecycle data and process backbone that better supports companies' need for improved product and business intelligence. See Figure 25. Following 2010, with the inclusion of OT, this picture changed significantly.

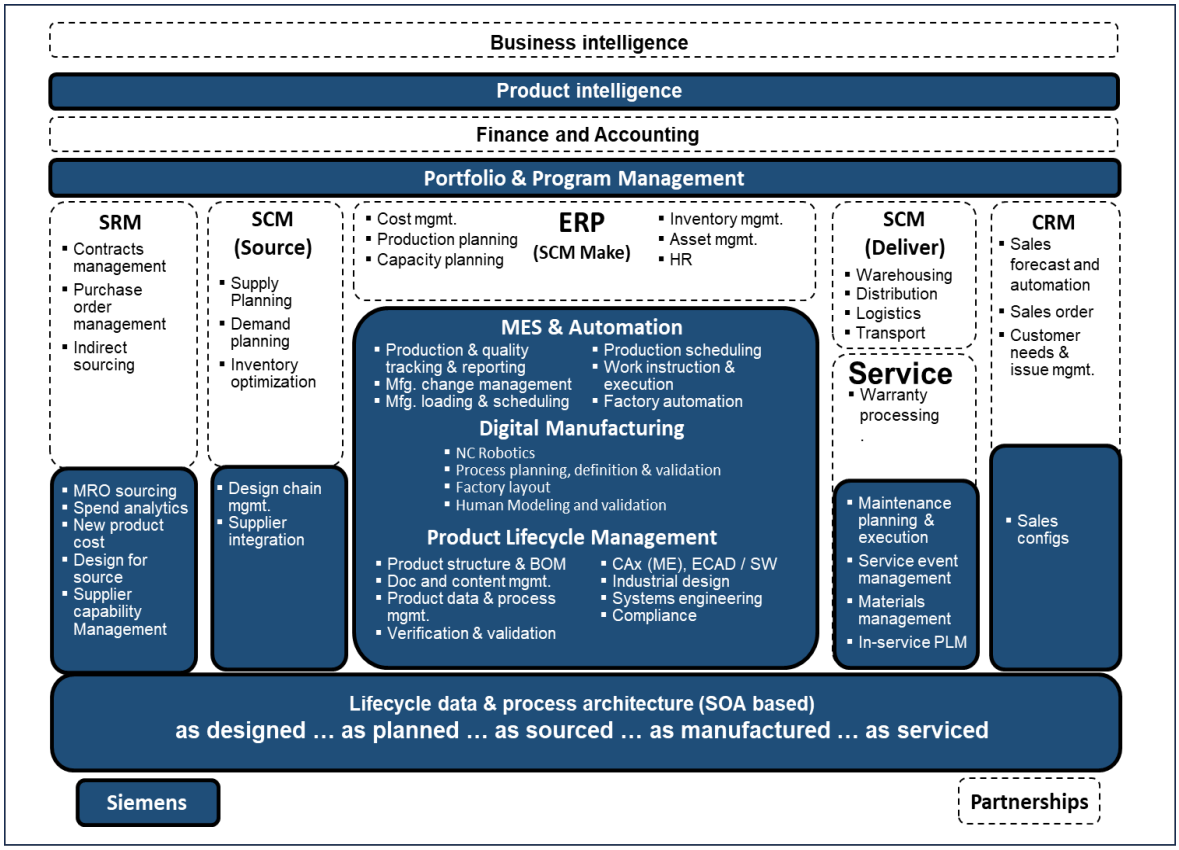

Figure 25: Position of PLM in an enterprise IT space

Source: PLM World presentation Orlando, FLA June 2008

The above four activities laid the foundation for UGS as Siemens PLM Software to lead a new definition of PLM as an enabler for product and production: “Closed Loop Digital Twins.”

Feedback from the market was very positive, both on the technology and business fronts. A selection by VW for Siemens PLM Software had the most significant upside, as VW had misgivings about the $1B debt carried by UGS during the PE ownership. VW had no reservations after Siemens announced its acquisition of UGS. This win was typical of the UGS's growth.

The intent of covering this brief Siemens section was to provide the reader with a bird's-eye view of the well-thought-out frameworks for success and hyper-growth that emerged after 2010 (not within the scope of this paper).

The authors would like to conclude this historical journey with the following message, one year after the Siemens acquisition. The financials showed the stability and growth of Siemens' PLM software business. However, our motto was “never let a customer fail,” and this objective drives our company.

Below are key customer successes and some of our key customers' thoughts about Siemens PLM Software, a year after the acquisition.

1. Ford Q1 designates Siemens PLM Software as the preferred supplier of engineering software products and services.
2. Honda Engineering named Siemens PLM Software as the supplier of the year for their engineering expertise and execution.
3. GM named Siemens PLM Software as the supplier of the year.
4. Fiat Quality award for quality, business value, professionalism, responsiveness, and on-time delivery.
5. Visteon gave Siemens PLM Software a VIP Award for exceeding expectations and demonstrating excellence in collaborative efforts with Visteon.
6. Nissan and Siemens executives agree NISSAN NX project was a success after working together from 2006 to 2010.

Conclusions

This article covers the journey from EDS/UGS to Siemens DISW. The authors began with an introduction that outlined the journey from a technical and business standpoint. In conclusion, we summarize this journey as follows:

1. During the 1980s, three-dimensional design tools (CAD) provided value to customers with the promise of integration with manufacturing (CAM) and simulation applications (CAE)

2. 1990- 1999: Due to the explosion of digital technical data, the promise of integrated CAD, CAE, and CAM integrated with Data and Information Management (PDM) became a reality for a new market definition- PLM (Product Lifecycle Management)

3. 2000-2010: PLM became integral to the enterprise Information Technology (IT) and Operational Technology (OT) landscape, focusing on “lifecycle” across Design, Engineering, and all enterprise systems

Hopefully, the authors have provided readers with details on each of the three major phases, elaborating on collaboration with customers, adaptation to technological changes, and business expansion within the broader market evolution.

Acknowledgements

Many people contributed to the growth of dozens of companies that ultimately became Siemens DI SW, whose contributions made the success possible.

The authors would like to specifically acknowledge the four outstanding UGS CEOs —John Mazzola, Tony Affuso, Chuck Grindstaff, and Tony Hemmelgarn —who guided the company over these three decades. Each left a unique and indelible mark on the business as we grew from the “other” market category to being a “leader”.

All of them grew up inside the company, as did many of us who were part of this journey described in this paper.

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Raj Khoshoo retired as Senior Vice President of Portfolio Management at Siemens Software, overseeing Mergers, Acquisitions, and Equity Investment planning. He focused on strategic software portfolio initiatives with measurable business impact. In 2022, Raj was honored as the Siemens Inventor of the Year.

Raj led various “market-facing” Technology Business Segments in multiple domains in Product Lifecycle Management, always focused on hyper-growth. With over 43 years of experience, Raj also held senior management positions, including Business Lead in Product Lifecycle Management, Supply Chain, and Manufacturing Engineering.

Raj is a Mechanical Engineer with a graduate degree in Computer Science and is currently a Venture Partner at SUM Ventures.

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Kevin Eustace joined SDRC as a consulting engineer focusing on design, testing, and analysis in 1976, becoming one of its first two U.K. citizen employees.

Kevin held various management positions throughout his tenure at SDRC, including serving as VP and GM of European Operations and, at the time of the EDS acquisition, Vice President and General Manager of SDRC’s Worldwide ExperTeam consulting and services business.

Kevin retired from Siemens Digital Industry Software at the end of 2021 as Senior Vice President and General Manager of Product Driven Services focused on ensuring customer value.

He has a bachelor’s degree in aeronautical engineering and a master’s in aeronautical structures from the Imperial College of Science and Technology, University of London.

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