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WHITE PAPER

Digital Prototyping: Autodesk Strengthens Competitiveness of Worldwide SMB Manufacturers

Sponsored by: Autodesk

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IN THIS WHITE PAPER

In this white paper, IDC discusses the global pressures that are forcing business process changes upon small and medium-sized design and engineering companies worldwide. To succeed in this changing economic environment, global small and medium-sized businesses (SMBs) have to rethink their product development processes. How are SMBs approaching this challenge? IDC interviewed two companies — Bosch Rexroth, a Canada-based worldwide leader in drive and control solutions, and HTC, a Swedish manufacturer of professional grinding and janitorial floor systems. Case studies of these two companies appear at the end of this white paper.

The key to success is the abolishment of functionally unconnected "silos" of activities, such as concept development, design, engineering, manufacturing, and sales and marketing. Among market-leading enterprises, these activities are now linked in a process referred to as product life-cycle management (PLM). Although these activities are desirable for SMBs as well, these firms do not have the IT expertise or the funds to acquire and implement such a system, nor do they have the time to train their employees.

Global manufacturing SMBs may now get an answer for their product development needs. Autodesk has introduced a solution for digital prototyping. Digital prototyping provides support for industrial design, design and engineering, data vaulting, and collaboration. In contrast to PLM, this solution does not support the entire product development process from cradle to grave; rather, it stops at the completion of the digital product and its engineering bill of materials, before reaching the physical stage of the product manufacturing. Autodesk has spent the past five years enhancing this new digital prototyping solution with the following components:

- Inventor for competent 3D design product
- A solution for product styling with AliasStudio, ImageStudio, and Showcase
- A solution for digital simulation — ANSYS' embedded DesignSpace and newly acquired PlassoTech and Moldflow
- The DWF file format for engineering design data file sharing, with DWF Design Review for review, markup, measurement, and revision of design sheet sets across project teams
- Vault and Productstream for workgroup data management

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SITUATION OVERVIEW

Global Competition Requires Process Transformation

For many years, product manufacturers have been under enormous pressure to improve their operations. Products must meet ever more specific customer requirements, designs must be completed faster, prices must be competitive, and quality must hold up to a lifetime of use. For example, let's take a look at the automotive industry: Manufacturers now offer a greater range of automobiles than ever before, from quirky subcompacts such as the Smart car to hybrid SUVs and trucks of all sizes; development cycles are being reduced from four years and more to less than 24 months; price competition is hotter than ever; and defect rates, particularly in notoriously buggy U.S. automobiles, have gone down dramatically over the past few years.

The interviewees from Bosch Rexroth and HTC confirmed the importance of these goals for their own companies. Jim Lambert, design manager at Rexroth's Industrial Hydraulics business unit in Welland, Ontario, ranked his company's top 3 strategic imperatives as, first and foremost, innovation, followed by competitive advantage and faster time to market. Karl Thysell, HTC's chief technology officer, listed faster growth, cost control, and competitive advantage. For further details about how these two companies are approaching these business goals, please refer to the case studies at the end of this paper.

To achieve these performance improvements, manufacturing enterprises — not only in the automotive industry but also in the aerospace, industrial machinery, medical devices, and consumer goods industries — have substantially changed their product development processes. The key to success is the abolishment of functionally unconnected "silos" of activities, such as concept development, design, engineering, manufacturing, and sales and marketing. At market-leading enterprises, these activities are now connected. Product data, design intelligence, project management, and performance analysis are linked and can be managed in almost real time. These new processes rely on data vaults, networking, and Web-based collaboration. Beyond that, the addition of 3D modeling to 2D drafting — which will never be replaced completely — improves collaboration and helps to avoid misunderstandings about product intents.

Numerous research studies have thoroughly documented the benefits of this approach to corporate performance in product development. However, these studies have also demonstrated that the fully integrated approach to product development, referred to as PLM, is expensive, complex, and not always fully achievable. PLM requires investments not only in applications software, implementation, integration with ERP applications, and end-user training but also in a well-staffed IT department to reliably run these applications. Clearly, full-blown PLM is not a panacea for every enterprise.

This holds true especially for worldwide small and medium-sized manufacturing sites and for small divisions of larger corporations. Just like large enterprises, these organizations have to deal with the gamut of challenges: cost competition from lower-

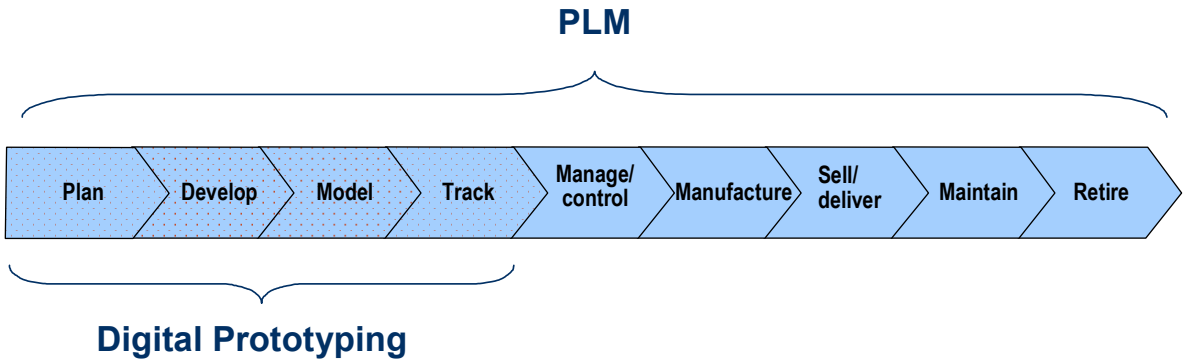
wage countries, performance demands from OEMs and end users, manufacturing flexibility to satisfy the rapidly changing requirements from supply and demand chains, and little time and capital to invest in developing "irresistibly" innovative and stylish products. In reality, many SMB manufacturers have neither the technical savvy nor the time and capital required to invest in the automation of their procedures and to optimize their processes along the lines of the PLM concept. However, as the experiences of Rexroth and HTC demonstrate, there is a way for SMBs to develop an effective method that is low cost and easy to use — digital prototyping.

Product Development Solution for SMBs: Digital Prototyping

Autodesk is opening the door to an approach that is practically tailor-made for worldwide SMBs. Autodesk's definition of digital prototyping includes the basic functions of PLM — industrial design, design and engineering, data vaulting, and collaboration (see Figure 1). However, there are several important differences to PLM: While PLM reaches from a product's cradle to its grave, digital prototyping stops at the completion of the digital product and its engineering bill of materials.

FIGURE 1

Activities in Product Life-Cycle Management Versus Digital Prototyping



Note: Dotted chevrons are digital prototyping; all chevrons are PLM.

Source: IDC, 2008

As a result, the number of participants in the digital prototyping development loop is considerably smaller than the number of participants in full-blown PLM, and the collection, management, and sharing of data are less complex. Furthermore, manufacturing can keep its product development activities separate from operations management and forgo the costly and time-consuming integration with the company's applications for enterprise resource planning (ERP), customer relationship management (CRM), and project and portfolio management (PPM), among others. Overall, digital prototyping is more flexible, more focused, and easier to use than PLM.

From Clay, Drawing Board, and Physical Models to Digital Prototyping

Now, let's drill down and take a closer look at product development and the role of digital prototyping. In IDC's definition, product development consists of two phases: the digital phase (with computer-aided design [CAD], computer-aided engineering [CAE], product simulation, product information management (PIM), and a bill of materials) and the physical phase (with product manufacturing, physical testing, maintenance, and retirement). Over the years, the digital product development phase has expanded the number of digital design and simulation steps that replace and/or postpone the need for dealing with the physical product. This of course saves a lot of time and money and also opens the door for easier team collaboration and customer input earlier in the development phase.

The most important enablers of digital prototyping are conceptual or industrial design, detailed CAD, CAE, and PIM. IDC also includes Web-based collaboration and visualization for locally dispersed product development. *(See the Definitions section at the end of this document for brief descriptions of these five processes.)*

Until recently, the comprehensive use of these five categories of software applications for product development has been limited for the most part to larger enterprises, while many SMBs continued to rely on clay for styling, on overdesign for product quality, on paper files for product information repositories, and on phone, fax, and mail for collaboration. While it is true that most SMBs replaced their drafting boards with CAD some time ago, the majority of product designs are still executed in 2D rather than in 3D. As a result, communication of a product's features and functions from initial ideation to final launch is error prone, the look and feel of innovative products may not meet customer tastes, and manufacturing may misunderstand a product's intent. Rexroth's Lambert described his experience as follows: "2D cannot communicate effectively, nor can it simulate real-world situations. The beauty of digital prototyping is that designs can be tested out before they go to manufacturing."

FUTURE OUTLOOK

Market Message to Worldwide SMB Manufacturers: Innovation, Quality, and Style for Product Hits

Over the past five years, life for SMB manufacturers has become a daily struggle for survival. Clearly, companies with average products that rely primarily on price and acceptable functionality don't stand much of a chance for survival. Manufacturers must target three goals. One is technical innovation. As the recent success of Apple's iPhone has demonstrated beyond a shadow of a doubt, customers worldwide are willing to pay premium prices for market-leading novelties. However, technical innovation by itself cannot ensure lasting success. For vendors to attain long-term brand recognition, products also have to be market leaders in styling and quality.

But how to get there? Manufacturers have to create the right business environment: the right corporate culture to promote innovation, the right skills base among employees, and the optimum combination of in-house talent and outside partners. This is an attainable goal for large enterprises, but until very recently, it would have been a risky and expensive strategy for SMBs to embrace. However, we are now witnessing a revolution both in available technologies and in end-user expertise that will level the playing field between SMBs and large manufacturing enterprises. In fact, we are at the confluence of a number of trends that will work to the benefit of progressive SMBs:

- Growing end-user demand for superior styling of consumer goods
- Availability of software applications for styling, design, quality engineering, and collaboration that are easy to use and cost-effective
- PCs with amazing power and memory at affordable prices
- A new generation of designers who are computer savvy and experienced in a range of styling, design, engineering, and collaboration applications

Few software vendors can build, design, and engineer applications to benefit from these trends as much as Autodesk.

Autodesk: Provider of Digital Prototyping Solutions to Worldwide SMBs

Autodesk has been in the market of low-cost and easy-to-use design applications for a very long time. Founded in 1982, and with over 7,000 employees, customers in 160 countries, and revenue of $2.17 billion in fiscal 2008, Autodesk is one of the world's leading design software and services companies. Therefore, it is no surprise that the company has taken the initiative to develop a comprehensive all-digital and Web-enabled solution for its design, engineering, and manufacturing clients in the SMB market. Over the years, the company has split its business into five divisions, two of which are of particular importance to its digital prototyping initiative:

- Manufacturing Solutions (MSD)
- Media and Entertainment (M&E)

Inventor for 3D CAD

Autodesk's flagship for manufacturing applications is Inventor 2009, developed and marketed by Autodesk's Manufacturing Solutions division. Since the product's introduction in 2000, Autodesk claims to have sold 819,000 seats (as of July 2008). Originally, Inventor had to fight an uphill battle against SolidWorks, which had succeeded in establishing itself as the leader and primary growth engine for the midrange 3D mechanical computer-aided design (MCAD) market. During the past five years, Inventor has definitely matured and is now reasonably competitive against SolidWorks, Solid Edge, and Pro/ENGINEER. According to Rexroth's Lambert, "With Inventor, Autodesk has a superior product for digital prototyping, and adopting their technology in our design workflow has been a real success story."

DWF File Format

Autodesk is increasingly successful with its DWF file format for engineering design data file sharing, with DWF Design Review for review, markup, and revision of design sheet sets across project teams. Lambert described the benefits of DWF Design Review for Rexroth's manufacturing sign-off: "I book a meeting room for all participating departments when complex equipment must be visualized, put the 3D model on the projector, do the markup using 3D DWF Design Review, and we are done in about a hour. No surprises." DWF is also available as a free viewer and has been downloaded 14 million times. Design Review 2008 includes on-demand access to both the ThomasNet and GlobalSpec product and service information catalogs. Users can locate suppliers of the parts they need without leaving the design. In late 2006, Autodesk and Microsoft announced their intention to seamlessly integrate DWF technology with Windows Vista. DWFX files created with Autodesk products can now be seamlessly viewed in Internet Explorer without needing plug-ins.

Alias for Styling

Next came styling. In 2006, Autodesk acquired Alias Software for conceptual/ industrial design from Silicon Graphics Inc. It now is the foundation for Autodesk's expansion into ideation, which is critical for styling in discrete manufacturing. This product line includes:

- AliasStudio, an integrated suite of tools for industrial design and visualization — from concept sketches through engineering
- ImageStudio, with rendering for designers
- Showcase, with realistic imagery from 3D design data and an environment in which to present and review designs for important product decisions

Autodesk did not stop there. In September 2007, the company acquired three more companies with visualization technology: Skymatter, Opticore, and NavisWorks. In IDC's opinion, some of their technologies will flow into an expanded visualization product offering that will be specifically targeted at Autodesk's discrete manufacturing customers. HTC considers styling important for the success of its competitive advantage. According to Thysell, HTC has acquired one 3D Studio license for use by its outside design partner but plans to bring styling in-house in the near future.

DesignSpace, PlassoTech, and Moldflow for Simulation

Although these applications make Autodesk's digital prototyping suite more comprehensive than most of its competitors' offerings for the SMB market, it still has several gaps. One is CAE. In the past, CAE was the exclusive domain of highly trained engineers who specialized in engineering analysis. Their software applications were complex and costly, and they did their analyses after a design was close to completion, definitely not the optimum time for product changes. As many studies have shown, product changes are more costly the later in the design process they take place. That means that it is highly desirable for product designers themselves to be able to use CAE tools as part of their work. To respond to this need, Autodesk OEMed ANSYS DesignSpace and embedded it into Inventor.

With DesignSpace, product designers now have the tool to do first runs of product analyses to confirm the physical strength of their designs early in development. In the future, Autodesk may also offer a CAE product by newly acquired vendor PlassoTech that is easier to use and less expensive.

With the acquisition of Moldflow for $297 million in mid-2008, Autodesk will play a leading role in the world of plastics and composites as engineering materials. The public company achieved revenue of $55.8 million in 2007 and is a market leader in CAE applications for the plastics injection molding industry. Moldflow will allow Autodesk's Manufacturing Solutions division to open new business opportunities for digital prototyping in the fast-growing area of plastic engineering materials.

CAM Partnerships for Machining

Another area that is currently covered by partnerships with third-party vendors is computer-aided manufacturing (CAM). Depending on their particular needs, Autodesk's customers can select from a range of CAM applications by business partners. Many of these vendors are represented by VARs that provide implementation, training, and ongoing user support.

Competition

With the addition of conceptual or industrial design, Autodesk now offers a unique digital prototyping solution for SMB manufacturers that are seeking success through innovation, quality, and style. However, several other vendors compete with Autodesk in the overall SMB product development space.

SolidWorks

First and foremost is SolidWorks, which vies for leadership against Autodesk Inventor. SolidWorks practically invented the 3D CAD modeling space for the desktop and over the years has grown into a $345.6 million (2007) firm with high name recognition and an excellent reputation for end-user support. The company expanded its original 3D MCAD offering through acquisitions and in-house developments and now includes integrated CAE and product data management (PDM) capabilities. SolidWorks' parent, Dassault Systemes, also offers a high-end engineering solution for PLM, with Catia and Simulia for design and engineering and Enovia for product information management. SolidWorks is selling through a global VAR channel.

Solid Edge

Another competitor in this space is Solid Edge, as of 2007 a division of Siemens PLM Software after the acquisition of parent UGS by German industrial giant Siemens. In 2005, Solid Edge introduced its integrated Velocity Series for the SMB manufacturing market. Velocity includes 2D/3D Solid Edge for MCAD, plus NX CAM Express for computer-aided manufacturing, Teamcenter Express for product data management, and Femap for computer-aided engineering. However, the solution does not include tools for conceptual or industrial design. Solid Edge is selling through a global VAR channel.

PTC

PTC started out in 1986 introducing a new parametric modeling technology. Over the years, it has grown its Pro/ENGINEER product line into a full-fledged PLM solution. The company is now offering its design and engineering products in five packaged solutions, scalable from the most basic Pro/ENGINEER Foundation XE for 3D CAD design to its highest-end Pro/ENGINEER Enterprise XE, which also includes product content management, simulation, and collaboration. PTC is selling to named accounts through its direct sales force, but during the past few years, it has also substantially expanded its global VAR channel.

CONCLUSION

IDC believes that with its new definition of digital prototyping, Autodesk is offering a product development solution to SMBs that will strengthen their competitiveness and give them the functional tools and processes required to achieve product excellence and profitability for years to come. Considering Autodesk's financial strength, its global market presence, and its commitment to the worldwide manufacturing midmarket, customers will not have to be concerned about continuing application development and support. As Autodesk's manufacturing solutions product line matures, the company will be able to support its customers as they expand their operations globally and increase the complexity of their product offerings.

For its future in digital prototyping, Autodesk can rely on a satisfied user base, as attested to by end-user quotes from Bosch Rexroth and HTC.

> Jim Lambert of Bosch Rexroth summed up his experience with Autodesk's digital prototyping solution as follows: "Our relationship with Autodesk is a great example of what a manufacturer and software vendor working relationship should be: They provide opportunities to test the software and provide feedback. I have a voice concerning the information and developments I need, and I have direct access to Autodesk programmers and their product support teams. They are taking the time to listen to their customers and are always looking for ways to improve their product. With Inventor, Autodesk has a superior product for digital prototyping, and adopting their technology in our design workflow has been a real success story. The future has never looked brighter."
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> Karl Thysell: "For HTC, Autodesk is ahead of its competitors in physical prototyping because it has a solution where the functions are integrated — CAD, Productstream, AutoCAD Electrical, all the software we need. With this integrated suite of applications, HTC has been able to reduce the number of physical prototypes from five to one. HTC is also able to share product files with its vendors and to coordinate all product data via Productstream."

CASE STUDIES

Bosch Rexroth Canada Corporation

Bosch Rexroth Canada (Rexroth) is a partner company of Bosch Rexroth AG, a worldwide leader in drive and control solutions. In 2007, the company had a total of 375 employees, with about 185 working at the Industrial Hydraulics business unit in Welland, Ontario. Its total 2007 sales amounted to $130.9 million. The Canadian subsidiary provides drive and control solutions in the major technology areas of Industrial Hydraulics, Electric Drives and Controls, Linear Motion and Assembly Technologies, Pneumatics, Service, and Mobile Hydraulics. In mid-2008, IDC conducted an in-depth interview with Jim Lambert, design manager at Rexroth's Industrial Hydraulics business unit. The discussion centered around Rexroth's strategic challenges in this rapidly changing and highly competitive market place and around Rexroth's initiatives to achieve increasing innovation, efficiency, and quality as well as closer collaboration within its internal departments and external business networks. Lambert ranked his company's top strategic imperatives as, first and foremost, innovation, followed by competitive advantage, faster time to market, key process improvements, and increased productivity.

Rexroth considers design tools as the foremost enablers to reach these corporate goals. The company had started out using Computervision's Medusa tool for 2D drafting in the late 1980s but in 1999 transitioned to 2D AutoCAD. In 2002, due to pending extensive project opportunities, the company became interested in 3D digital prototyping and introduced Autodesk's Mechanical Desktop. It was soon found, however, that the system ran into hardware problems and could not operate reliably with more than 30 parts. Upon the advice of its reseller, the company decided to hold back on further investments in 3D applications until Autodesk was ready to introduce its new Inventor solution.

The final transition into 3D was initiated by Lambert, who was looking for suitable low-cost 3D tools as a natural migration as a result of the higher complexity of hydraulic systems being tendered in the motion control marketplace. The selection focused on functionality, price, and ease of use. Inventor and SolidWorks turned out to be the finalists, with SolidWorks at a slight advantage as the more mature tool. Nevertheless, the final purchasing decision favored Inventor. Lambert explained:

- "Local Canadian high schools and postsecondary schools largely train their engineering students on Inventor, so companies don't have to invest time and money getting their young new hires up to speed.
- Rexroth Canada had an excellent relationship with Autodesk's Manufacturing Solutions division, which included many of its suggestions for new features/functions in upcoming Inventor releases.
- Autodesk as a company was beginning to get an understanding of how to develop software that not only could handle a design department's requirements but also could leverage the 3D design intent into the working environment of other stakeholders in manufacturing and sales and at customer sites.

- Other Rexroth subsidiaries with similar application requirements strongly recommended Inventor to their Canadian colleagues.

- Inventor as Autodesk's flagship product for digital prototyping was sure to get the full support from corporate management, while SolidWorks was perceived as being overshadowed by parent Dassault Systemes' flagship Catia."

Rexroth Canada began its move into digital prototyping with Autodesk's Inventor solution by testing it for one year on a large civil engineering project, the St. Lawrence Seaway Management Corporation's modernization of the locks on the Welland Canal part of the St. Lawrence Seaway. As part of the five-year project, one designer and the computer-aided design administration were trained on Inventor 3D to create 3D drawings, renderings, and animations of the hydraulic systems for the canal, something that would have been quite difficult to do in 2D. The success of this experiment — greater speed, fewer errors, faster design changes, and clearer communication — convinced Rexroth that it was on the right track by opting for digital prototyping, not only for the remainder of the Seaway project but also as a standard in its business unit in Canada.

Rexroth now has 25 users of Autodesk applications, which include Autodesk Inventor, AutoCAD Electrical, Autodesk Productstream for data management, DWF Viewer and Design Review for visualization and collaboration, and computer-aided engineering applications by Autodesk's partner ANSYS. Beyond that, Rexroth is using MDTools by VEST Inc. to assist in the design of hydraulic manifolds. As of this writing, Rexroth no longer uses 2D for its hydraulic systems design except for hydraulic circuit schematics. In Lambert's words, "None of the Rexroth designers want to work in 2D anymore, and when they need to update old 2D legacy files, they draw straws; the loser gets the 2D assignment."

Lambert outlined the current use of Inventor for 3D digital prototyping and DWF Viewer and Design Review visualization and collaboration tools at Rexroth Canada three years after its introduction as follows:

- 14 engineering seats of Inventor and no plans for additional hires in spite of increasing workloads because of efficiency improvements

- 3 senior managers using Inventor to look at product information

- 20 salespeople using DWF Viewer and Design Review

- 150 clients using DWF Design Review to redline, mark up, and measure Rexroth's designs

- Marketing using Design Review to render hydraulic equipment for sales brochures, saving the cost of a photographer for its marketing collateral

- 5 users in service and support using Design Review to view their customers' equipment

Rexroth's manufacturing group also gains substantial benefits from Inventor's support for 3D digital prototyping. Technicians on the shop floor can now view 3D models rather than 2D drawings of the complex machines they are to assemble. Before starting their work on each of the custom-designed hydraulic systems, they can view a 3D model and see how it fits together. The final design sign-off is another process that has been accelerated and simplified a great deal. Before using Inventor for 3D, Rexroth designers would generate 2D drawings and circulate them for internal design review. Each department would open the files, review the 2D drawings, sign off on them, and then forward them to the next department. Said Lambert, "After a week, the drawings would eventually make it back to the design group. With Inventor for digital prototyping, I now book a meeting room for all participating departments when complex equipment must be visualized, put the 3D model on the projector, do the markup using 3D DWF Design Review, and we are done with the manufacturing sign-off in about an hour. No surprises."

The key is communication. Lambert said, "Especially for complex assemblies, clearly communicating full design intent with 2D drawings to manufacturing is difficult, and yet these are the very people who have to approve the design and build the equipment." He also pointed to breakdowns in communication "between what customers tell sales, what sales then tells engineering, what engineering tells designers. Sometimes the customer wants oranges and we supply bananas." Communication can also break down from ideation through manufacturing simply because of the wrong tools: "2D cannot communicate effectively, nor can it simulate real-world situations. The beauty of digital prototyping is that designs can be tested out before they go to manufacturing," he said.

There are two additional advantages Rexroth is now reaping from digital prototyping. In the past, due to the size and complexity of its machines, it used to design 80% in 2D and then finalize the remaining 20% on the shop floor in a trial-and-error approach. The problem was that no two machines were alike and many of the shop floor modifications could not be captured for documentation. Said Lambert: "Digital prototyping lets us capture 100% of the design intent and build identical units."

Rexroth's long-term goal of market leadership in hydraulic machinery depends on its successful response to its customers' increasingly complex projects. Lambert explained, "Digital prototyping definitely raises the bar of complexity we can handle. With digital prototyping we can bridge the gap that previously existed with 2D tools between conceptual design, engineering, and manufacturing." He ranked the overall value to Rexroth of Autodesk's digital prototyping solution benefits as follows:

1. Communication
2. Quality improvements thanks to engineering analysis — especially the selection of the right safety factors and the avoidance of overdesign or underdesign
3. Faster product development
4. Use of a single digital model between design applications

Asked how Autodesk could further improve its digital prototyping solution, Lambert mentioned a computational fluid dynamics (CFD) module as a logical next step.

Lambert summed up his experiences with Autodesk's digital prototyping solution as follows: "Rexroth's relationship with Autodesk is a great example of what a manufacturer and software vendor working relationship should be: They provide opportunities to test the software and provide feedback. I have a voice concerning the information and the developments I need, and I have direct access to Autodesk programmers and their product support teams. They are taking the time to listen to their customers and are always looking for ways to improve their product. With Inventor, Autodesk has a superior product for digital prototyping, and adopting their technology in our design workflow has been a real success story. The future has never looked brighter."

HTC Sweden

Privately held HTC Sweden AB produces and sells patented professional grinding and janitorial floor systems that make up machines for polishing and cleaning concrete, granite, natural stone, terrazzo, and wood. For the past 10 years, the company has been leading the market with diamond-based concrete grinding systems. The company was founded in 1987 in Soderkoping, Sweden, and has subsidiaries in the United States, Germany, England, and France. Since 2006, British venture capital company 3i holds 34% of the company's shares. HTC now has 185 employees and expects 2008 revenue of around $56 million, up from $7.5 million in 2001. Among HTC's customers are IKEA, Wal-Mart, Rolls-Royce, and Lufthansa.

In mid-2008, IDC conducted an in-depth interview with Karl Thysell, the company's chief technology officer and son of founder Hakan Thysell. The discussion centered around HTC's strategic challenges in the floor grinding market and around the company's initiatives to achieve market domination. Thysell ranked his company's top strategic imperatives as, first and foremost, faster growth, followed by cost control and competitive advantage.

HTC has been an Autodesk customer for many years. It started in 1996 using AutoCAD LT and transitioned from 2D to 3D in 1998 with Mechanical Desktop. However, Thysell found Mechanical Desktop hard to use and decided to replace it with the newly available Inventor Release 3 in 2000. Before opting for Inventor, he had compared it with PTC's Pro/ENGINEER and Dassault Systemes' SolidWorks and Catia. In spite of the fact that SolidWorks is easier to find in Sweden and that Pro/E is taught more frequently at Swedish schools and universities because they get it for free or at a good discount, he decided to stay with Autodesk and its new Inventor solution. He tried Inventor for a day for free at his reseller and loved it.

Thysell's most important reasons for the selection of Inventor for digital prototyping were ease of use, ease of integration, price, and functionality. For Thysell, price and functionality go hand in hand. He explained, "If software applications are hard to use, executing designs takes longer, and in our competitive world, time is money." In his experience, Inventor is one of the easiest design software applications to learn, and everyone in his office is now using it. In fact, he has no problem converting his new Pro/ENGINEER-trained hires to Inventor. "Inventor is developed in the 21st century; it is a very modern tool with a nice work environment, and it is easy to use," he told us.

Asked whether Inventor or its competitors are ahead in digital prototyping, Thysell said that it depends on the customers and how they use their software. For his purposes, Autodesk is ahead because it has a solution where the functions are integrated — design, data management, electrical, all the software applications he needs. On the other hand, he has found that Autodesk is weak in computer-aided engineering calculations. HTC itself uses SolidWorks' Cosmos for CAE rather than Inventor-embedded ANSYS. He finds ANSYS' DesignSpace hard to use, and in his opinion, he gets better value from Cosmos than from DesignSpace.

HTC uses digital prototyping for the development of its grinding machines but also for its dies and tooling. The company's 15 Autodesk product users utilize Inventor 2009, Mechanical Desktop, AutoCAD Electrical, Autodesk Productstream for data management and change order handling, and Design Review, which is now part of Productstream. They also have a license for flow analysis for SolidWorks' Cosmos and for Autodesk 3D AliasStudio but currently rely on an outside design partner for the conceptual design of their machines. With this integrated suite of design and data management applications, HTC has been able to reduce the number of physical prototypes it creates from up to five sets to one per product, saving time as well as a substantial amount of money. Other advantages HTC is now garnering from its reliance on Autodesk's digital prototyping solution are the ability to share product files with its vendors and the ability to coordinate all product data via Productstream. At this point, Productstream is connected with the company's ERP system, Microsoft Dynamics NAV. The plan for the future is to connect all suppliers into an integrated Web-based supply chain with Productstream and Microsoft Dynamics NAV tied together. By doing this and utilizing the DWF format instead of the heavier Inventor files, it's not necessary for outside vendors to use the same software as HTC and upgrade to the next releases in accordance with HTC, an issue that HTC finds hard to enforce at times.

Marketing and sales rely on rendered images from Inventor or 3ds Max for marketing collateral. The same is true for developers of manuals for the service and support team. Thysell ranked the overall value to HTC of Autodesk's digital prototyping solution benefits as follows:

1. The use of a single digital model between design applications
2. Faster product development
3. Improved product styling
4. Design reviews with non-CAD users
5. Quality improvements thanks to engineering analysis — since HTC engineers frequently work on similar machines, this is not as important for them as for other companies that, for example, focus on developing customized machines
6. Integrated review with Autodesk design applications — this would rank higher if HTC didn't have in-house designers

Asked what he can do now that he could not do before digital prototyping, Thysell highlighted visualization — he can visualize a product on a scale of 1:1 on a big screen before it exists, and he can see how heavy it is.

How can Autodesk further improve its digital prototyping product? Thysell had the following suggestions:

- Better calculations and reuse of calculated data; for example, an engineer should be able to use the calculated value for pressure and then reuse that data and calculate the stress.
- Support for good technical paper drawings in vector format for end users on the shop floor who don't have access to a laptop or the Internet.
- Rendering of exploded views for high-quality images for printed manuals or even better in a vector format.
- Sharing of Inventor data with technical writers who use Adobe. When designers update 3D models, the updates don't go through to Adobe. For HTC, the aftermarket is very important.

In summary, Thysell has found Autodesk's digital prototyping solution one of the easiest software application suites to learn. It opens the door at HTC to design and manufacture innovative, high-quality products and to integrate its business partners into its digital pipeline.

DEFINITIONS

In IDC's definition, product development consists of two phases: the digital phase and the physical phase (e.g., product manufacturing, physical testing, and beyond). The digital phase consists of an increasing number of steps that can now be simulated digitally and that replace the need for dealing with the physical product. The most important steps of digital prototyping are conceptual or industrial design, detailed computer-aided design, computer-aided engineering, and product information management. IDC also includes collaboration as an enabler of team-based but dispersed product development.

Industrial/conceptual design. The goal of industrial design is at least threefold: to create a product that is aesthetically pleasing, that is functional, and that has a unique appearance to help manufacturers and retailers to develop brand recognition.

Computer-aided design. CAD applications allow product design engineers to draw the detailed engineering files for product manufacturing.

Computer-aided engineering. The goal of CAE is threefold: to test a product's ability to withstand long-term usage, to ensure product quality by digital simulation rather than by relying on overengineering, and to optimize the material selection for product costing, quality, and manufacturing. Digital simulation can include stress testing, thermal and fluid flow analysis, kinematics, and more.

Product information management. PIM serves as a repository for product intent, product structure, and development processes. It supports team collaboration within enterprises and across business partner networks, speeds time to market of innovative products, and opens the door to extensive reuse of parts, components, and procedures.

Collaboration. In the past, collaboration among developers was simple — most developers were collocated, spoke the same language, and used the same development processes. However, things are changing. Development teams are distributed across the globe, rely on input from a large number of sources, and have to satisfy demands from different global client constituencies. Without easy-to-use workflow and visualization tools worldwide, distribution of product development and manufacturing would be impracticable or even impossible.