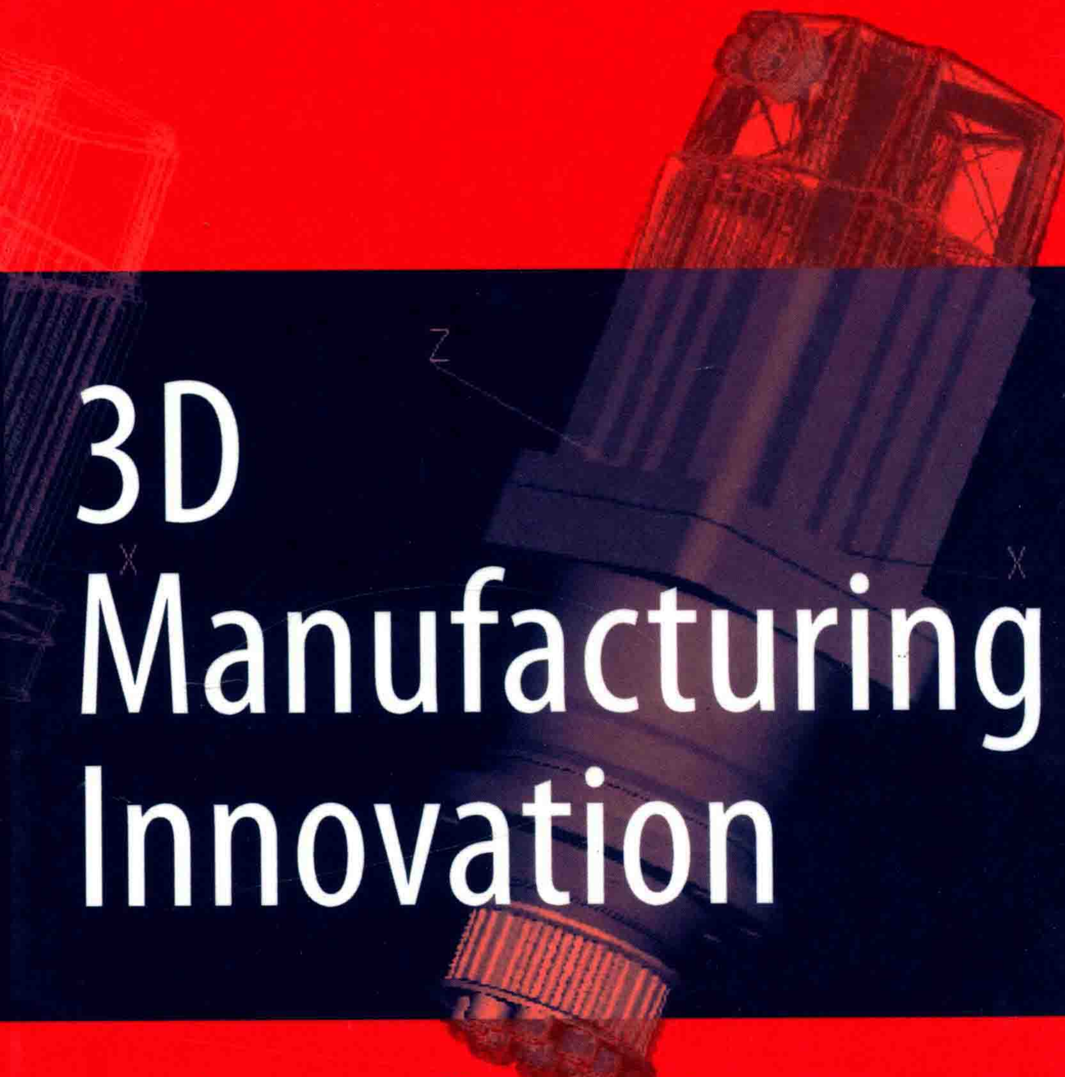
Hiroshi Toriya



3D Manufacturing Innovation

Revolutionary Change in Japanese Manufacturing with Digital Data

Springer

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Revolutionary Change in Japanese Manufacturing with Digital Data

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Foreword

Mr. Kentaro Kizaki
Nikkei Monozukuri Editor, Nikkei Business Publications, Inc.

Amidst the intensifying competition revolving beyond national borders in the manufacturing industry, what is the competitive edge required for manufacturers to survive? Competitive edge can be visible and invisible. "Visible competitive edge" means it is visible to customers, such as new mechanisms of products, materials, machining technologies, *etc.* It can also be called product innovation. In contrast, "invisible competitive edge" is competitive edge in the business process, in other words, competitive edge created by innovation of design and production processes, or by the establishment of mechanisms for manufacturing quality products quickly and inexpensively by the introduction of IT or human resource development.

Indispensable to this "invisible competitive edge" is no doubt the use of 3D for the design and manufacturing processes. With the growing use of 3D CAD in design departments, 3D data-based manufacturing is becoming more and more common. In design departments, 3D data is used as the material for verifying design, and in manufacturing departments, 3D data is used for machining and automatic assembly. 3D data is also used for enhancing the manufacturing process to facilitate the work of assembly operators. Procurement and marketing departments can also use 3D data for their procurement, sales, and logistics activities as predictors. In whichever case, 3D data is a tool which supports in ways invisible to customers of the manufacturing industry. The full and thorough use of 3D data will reinforce invisible competitive edge. According to Professor Takahiro Fujimoto of the University of Tokyo (Graduate School of Economics), "MONOZUKURI" (manufacturing or making in Japanese) is the transcription of design information onto media. He says, for example, an automobile is the transcription of design concepts of a vehicle onto a 0.8-mm-thick metal sheet. Important here is the fact that satisfying the customer is not the medium of metal sheet but the design information itself. And the means of conveying this design information from designers to production engineers are drawings or 3D data, *etc.*

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Japanese Drawings: Designed to Facilitate Production Technology Plans

At the moment (2007), most 3D CAD software products used in design departments are from Europe or the USA. The use of 3D CAD enables designers to define 3D models precisely as well as convey shapes accurately to those applying production technologies. 3D CAD is very clear-cut, nothing is vague, so it tries to provide all the information required in the downstream process. This was why CAD was developed in Europe and the USA. On the other hand, the aim of drawings used in Japan has been for designers to relay design details to production engineers. The process of preparing these drawings consisted only of reconstructing design information so that production engineers can understand the information better. So the production engineers would look at the drawings, try to understand the intent of designers, and work on the production process. This creativity at the production side is what strengthens the foundations of the Japanese manufacturing industry.

In manufacturing, 3D CAD data is, needless to say, very useful. There are very keen efforts to realize "drawing-less" manufacturing by digitizing information transmission and abolishing drawings. However, it is risky to simply replace drawings with 3D CAD data. This is because the meanings of drawings and 3D data are totally different in production engineering.

If the strengths of the manufacturing industry to date are to be made use of, it is necessary to use 3D CAD data but, at the same time, apply a method which will reliably convey designer intent such as tolerance and important details to the production process. Such a reliable method would be lightweight 3D data as represented by XVL. Lightweight 3D data should not be taken as the simplified version of CAD data, because not only production engineering departments but also various departments can access this lightweight 3D data to learn about design intent. For this, large-scale assembly data must be viewable and easily accessed by virtually anyone.

Japan Leads the World in Use of 3D Data

Japan clearly leads the world in the use of 3D data. Lightweight 3D data XVL was developed by the Japanese company Lattice Technology (hereafter referred to as Lattice) and is growing more and more popular. Other lightweight 3D data software include Fujitsu's VPS and Digital Process' VridgeR. Though differing in the functions provided, Japan has pioneered the use of 3D data software. This can probably be attributed to the sophisticated skills of users of XVL and 3D tools, in other words, production engineering departments of Japanese companies.

It is natural for Japanese industry to reinforce its manufacturing strengths through IT. As European and American CAD software have already penetrated deeply into the Japanese market, there is not much value in developing Japanese CAD systems now. So in order to strengthen the Japanese manufacturing industry, we need software that matches Japan's manufacturing culture. One such software would be software enhancing collaboration between design departments and manufacturing departments such as production engineering. In order for Japan to carry out concurrent engineering the Japanese way, it will need mechanisms for production-related staff to participate in the design process from an early stage. This would be design review using 3D data as a tool for communication between different departments.

From the perspective of the partnership between design and manufacturing, design reviews embody the bottom-up approach where optimization proceeds by trial and error. In contrast, European and American software vendors propose the concept of realizing overall optimization all at once, called Product Lifecycle Management (PLM). PLM is a top-down approach where attempts are made to manage and use information in the product lifecycle from upstream to downstream to enhance the competitive edge. In reality, this approach for overnight reforms is sometimes difficult. When attempts are made to resolve a big problem, it is usually difficult to decide where to start from. It is therefore more realistic to start by accumulating CAD data and lightweight 3D data in the company's common database so that people requiring information can access it. Once more and more people are using the data, then it is time to enhance software and hardware. The fact that lightweight 3D data such as XVL allows such a bottom-up approach makes it advantageous in reinforcing Japan's strengths.

Preface

It is said that good users are essential to the birth of good software, because it is the discerning users who help foster software quality. This book discusses the uses of 3D data mainly in the Japanese manufacturing industry. Originally, 3D CAD, CAM, and CAE data was used exclusively for product design. However, in recent years, the Japanese manufacturing industry has used 3D data to revolutionize manufacturing processes. By using lightweight 3D formats such as XVL, Lattice Technology's eXtensible Virtual world description Language, Japanese manufacturers have improved production and laid the groundwork for innovative new methods of corporate communication.

This book discusses how leading Japanese manufacturers use 3D data in downstream processes, how the IT infrastructure required for this has been built, and some of the trial and error behind these developments. Each of the companies introduced as case studies are leaders in Japanese industry. It should be particularly interesting to European and American manufacturers to learn how their counterparts in Japan make use of IT to gain competitive strength. In fact, European and American manufacturers are starting to use 3D in downstream processes; this book includes examples from three leading manufacturers. It is interesting to note that the software described in this book, which supports manufacturing, a forte of Japan, was also developed in Japan, demonstrating that outstanding software is indeed nurtured by outstanding users.

We sometimes hear people talk about the CRIC cycle, which stands for crisis, response, improvement, and complacency. When faced with a crisis, people respond and try to fix the problem. The conditions improve, and then complacency sets in. But what happens if the solution is a "quick fix" that does not solve the underlying problem? People are complacent, but the risk remains – a trap we are all apt to fall into.

The CRIC cycle can sometimes be seen in the manufacturing industry. Manufacturers constantly strive to enhance quality, cut costs, and shorten delivery times. 3D CAD/CAM/CAE has been embraced as a solution to these challenges.

In the 1990s, Boeing started using 3D CAD to design its 777 family of aircraft. This endeavor, which involved intense collaboration with partner companies, demonstrated clearly the advantages of concurrent engineering using 3D design.

At the same time, China was seen to rapidly adopt 3D design, skipping the 2D CAD drawing step that other nations had gone through. Japanese industry experienced a sense of crisis and rushed to start using 3D CAD as well. This was how applications of 3D design in Japan started to shift into full swing. It is now expected that Japanese manufacturers will be able to innovate their production processes using the 3D CAD data that has accumulated in design departments. However, in reality, many companies do not seem to be fully utilizing the 3D CAD software which they have procured. In addition, many companies that have embraced 3D design are using 3D data only for checking simple 3D shapes and drawing illustrations very limited applications. It looks like these companies have fallen into the trap of the CRIC cycle. It is said that if the path from crisis to complacency is long, the path that follows is also long. This means that if the cycle prolongs, it becomes difficult to break away from the crisis. These companies therefore need to ask if they are content to just have installed CAD, or to just be using the 3D data for limited purposes, and if the improvement measures they have implemented are not simply quick fix solutions.

Adoption of 3D CAD incurs huge costs for procuring and installing expensive hardware and software, training costs for designers and engineers, and costs for changing business processes. However, often the 3D CAD data generated at such high costs is used only in design and manufacturing, which make up less than 10% of the whole IT domain. The other 90% sees no benefit from this data. Often this is blamed on the large size and complexity of 3D data which makes it difficult to use. However, things are changing with the emergence of lightweight 3D data formats and viewers in recent years, which is increasing the use of 3D data not only inside the company but also outside. This is a natural development because 3D data can be understood intuitively and is an optimum tool for communication. Even Microsoft Windows Vista is equipped with a 3D viewer function, which is expected to increase the visibility and importance of 3D data.

This book introduces methods of using 3D data to enhance competitive strength in manufacturing. Chapter 1 explains the current situation of 3D design in Japan, a source of competitive strength of the Japanese manufacturing industry. Chapter 2 describes the background of lightweight 3D data. Chapter 3 introduces the pioneering case study of SONY which describes how to build an information infrastructure for 3D data. Chapter 4 discusses the advantages of using general lightweight 3D data, and Chapters 5–13 are case studies of leading manufacturers that have innovated business processes using 3D data. The lessons learned from their efforts are summarized in Chapter 14, and the lightweight 3D tools that these companies used are explained in the two appendices.

This book hopes to capture the essence of using 3D by examining leading edge efforts in 3D data applications. Though 3D can be beneficial for limited applications, such an approach fails to capitalize on the benefits of 3D data. Only by standardizing 3D use across the enterprise can companies fully realize the value of 3D data and break the CRIC cycle.

The use of lightweight 3D data is an attempt to incorporate IT into manufacturing technologies. The goal of the use of 3D data is to eliminate all unnecessary work of designers and manufacturing staff so that they can concentrate on innovative work. In addition, by sharing knowledge from design and manufacturing with downstream departments, quality and productivity can be enhanced throughout the company. By taking readers through 3D data uses by pioneering companies, this book hopes to show how IT can be used to improve manufacturing not just in Japan, but all over the world.

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Chapter 1
Adoption of IT by Manufacturing Industry to Enhance Competitive Strength

The Japanese economy has finally started to gain back its strength after a prolonged recession which resulted in its so-called "ten lost years." From the lessons learned during the bubble economy, Japanese companies are now aiming at "lean," cost-efficient, and profitable businesses, and are developing a dislike for excess staff and facilities. On the other hand, the globalization of business is increasingly pressuring companies to replenish goods as soon as they have sold. To enhance brand value, it is also crucial for manufacturers to ensure high quality in their products. This has led to a situation where such goals as faster delivery time and quality enhancement need to be realized by a limited number of people in design and manufacturing. With the dwindling birthrate and aging population, there is a lack of trained labor. The training of employees with inadequate skills is a problem. People in design and manufacturing are starting to grow tired. It is in such times that companies/industry need to use Information Technology (IT), review the corporate business process, and have staff focus on creative work. The keywords of IT in manufacturing are process evolution by 3D design and use of 3D data. Successful use of 3D data throughout a company in the manufacturing industry has now become indispensable for building competitive strength.

1.1 Tasks in Manufacturing and Ideal Uses of IT

Most companies give, as their topmost priority, the creation of a high-speed development system to shorten the time from product planning to market release. This is a common task for all manufacturers, from digital home appliances which have short product lifecycle, to cars, their related parts, machines, and so on. Speed is the ultimate goal for companies engaged in the intense competition to survive. The aim of speedy development is to be first to market with products that are appealing to consumers. This requires quick discovery of new user needs and rapid production of appropriate products. A shorter development time often means lower development costs, which is a second reason why so many companies are working on speedy development. The introduction of 3D CAD in product development by manufacturing companies has therefore been largely motivated by the desire to increase development speed.

On the other hand, the adverse effects of speedy development are starting to stand out. The manufacturing site is too busy and personnel are exhausted. Few have enough time to think about next generation technologies. Also seen are growing problems such as lack of time for staff training and use of outsourcing which means that the accumulated knowledge does not remain inside the company. Recently, we read about the decline in manufacturing quality in Japan. It is at just such times that we need to build IT infrastructures and use IT to support those involved in design and manufacturing. Unfortunately, present 3D CAD is often found to make things much busier at the design site contrary to its initial aim. It is tough to actually make 3D CAD work in operations, and this process often imposes a burden on design engineers. It seems that despite the tremendous efforts to create 3D data, the resultant data can only be used for a narrow range of applications. In other words, the value of the data is not as great as the labor to create it.

At the same time, Japan is said to be a broadband internet superpower. According to the penetration rate of broadband internet per household by country at the end of 2005 as announced by France IDATE, Japan is fourth in the world, coming after Korea, The Netherlands, and Sweden. Japan owns some of the leading IT infrastructures in the world. Broadband internet networks mean high-speed access to the Internet.

There is, however, a serious problem. In March 2006, the World Economic Forum announced that Japan ranks 16th place in terms of response index to IT infrastructure. The response index to IT infrastructure indicates the degree of contribution by IT infrastructures to economic growth. This means that Japan is not putting its world-class IT infrastructure to full use. So the improvement of this response index is crucial.

Japan is in a very good position to increase its IT infrastructure index in the manufacturing industry, because Japan leads the world in the use of 3D data. In Japan, unique software that suits Japanese manufacturing practices and culture is being developed, and software which supports the Japanese style of manufacturing – basic design in Japan, production in Japanese plants, and release the products to the world – is readily available. The manufacturing industry in Japan can increase its competitive strength by effectively using 3D data on its world-leading IT infrastructure.

1.2 Current Situation of Use of IT in Manufacturing

Figure 1.1 shows how manufacturing companies invested in IT in 2004 and 2005. As you can see, the importance of 3D CAD/CAM/CAE is overwhelming. The importance of 3D design is well known and 3D design, manufacturing, and analysis has already been adopted by 70% of the companies. The next large growth can

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