

INVESTIGATION OF ACTUAL SITUATION OF COMPANIES CONCERNING USE OF THREE-DIMENSIONAL COMPUTER-AIDED DESIGN SYSTEM

Shigeo HIRANO ^{1,2} Susumu KISE ² Sozo SEKIGUCHI ² Kazuya OKUSAKA ²
and Takashi IMAGAWA ²

¹Tokyo City University, Japan ² Artner Co. Ltd, Japan

ABSTRACT: To improve product development efficiency, a more sophisticated design process has been sought in various fields. In particular, in the fields of transportation and electrical equipment, three-dimensional computer-aided design (3D CAD) serves as an important tool in product development. A few years ago, onsite operators said, “3D CAD takes a lot of effort and is useless;” however, recently, it has been considered that we are now in the 3D CAD era. In this research, the actual situation of companies concerning the use of 3D CAD was investigated and each aspect related to its use was examined.

Keywords: Three-dimensional design, Creative design, Increase in efficiency of the design

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1. INTRODUCTION

Searching after how does an unknown thing the plan and design and make how it is the translation that must support the design power that makes present actually. To put it differently, we make the caricature that expresses each source, mechanism of the design on the basis of specification with the early period stage of the design. Furthermore we grope the demand that thinks and would like you to design this sort of thing of the visitor tip continually and search the hint and make the request caricature. This process is the starting point of a design and will said that 60% of the designs ended with this stage. In recent years, because of improvements in 3D CAD software, the development of 3D CAD with many functions, and the miniaturization of computers, tools for design are shifting from 2D CAD to 3D CAD in many industries and educational organizations. The practical use of 3D CAD has been promoted to increase the efficiency of 3D CAD through the use by concurrent engineering (CE) of consistent

processes from product development to disposal. However, regarding improvements in the quality of design skills, the uses of 3D CAD are accompanied by various problems because there are neither clear rules nor manuals available. Using 3D CAD only to create models is not sufficient to enable desirable designing. A few years ago, onsite operators said, “3D CAD takes a lot of effort and is useless;” however, recently, it has been considered that we are now in the 3D CAD era. The shortening of the design and development periods, namely, the spread of 3D CAD, has become a mainstream phenomenon. On the other hand, many results that deviate from the original purpose because of local optimization using the modeling function alone have been reported. In this study, the actual situation of companies concerning the use of 3D CAD was investigated and each aspect related to its use was examined. In this paper, the contents of the survey on how 3D CAD is used in general and in the design process, as well as the results

of the survey, are discussed and explained.

2. SURVEY OVERVIEW

2.1 Target companies (Total of 50 companies)

machinery industry companies:20.
electricale quipment companies:8.
transportation equipment companies: 7.
precision equipment companies:4, and other industries: 11.

2.2 Survey period

From 20 September to 20 November 2012.

2.3 Investigation method

Collecting responses to a survey conducted by e-mail.

3. CHANGES IN ENVIRONMENT OF DESIGN

It is necessary for companies to continuously create innovative and original products that cannot be copied by third parties in order to survive in the 21st century, in which high-quality and rapidly producible products are desired. The most important task in realizing this is strategic training to produce truly experienced design engineers. Until a few years ago, there were questions on whether 3D CAD is really useful for machine designing, and thus, 3D CAD was rarely adopted by companies. One of the reasons behind the slow spread of 3D CAD is the temporary decrease in the pace of designing, because many parts are reused during machine designing and this requires a huge amount of paper drawings. However, with the strengthening of the competitiveness of Japanese manufacturing businesses in the international market, competition has increased; therefore, the strengthening of overseas production sites, the shortening of product life cycles, and the production of various products in small lots have been carried out. Because Japan came to play the main role in planning and designing, Japanese companies inevitably started to use 3D CAD.

Furthermore, although we begin using 3D CAD, two-dimensional drawings are still necessary. The drawing tasks such as inputting attribute information still remain. The work of producing orthographic projection can be carried out using 3D CAD; however, the work that is dependent on the designer's qualifications, such as functional and effective designing, should be carried out and structured by designers according to their judgment.

4. SURVEY ITEM, SURVEY RESULTS AND DISCUSSION

4.1 Survey content 1

The method by which overall 3D CAD data is used has changed; in particular, the way of thinking toward the system and the implementation method in product designing has improved. Work in which concurrent 3D shape data are utilized was investigated.

Survey results

It has not performed concurrent practical use.:33 companies.

machinery industry companies:11
electricale quipment companies:6
transportation equipment companies: 6
precision equipment companies:3
other industries: 7

Discussion

(1) Insufficient spread of use of 3D shape data in machine design departments.

Concurrent structure of the design process in the machine industry has not become widespread because of the popularity of designs based on conventional know-how and on similar designs used in machine design. As a consequence, the introduction of 3D CAD into machine design has been delayed, which also affects the insufficient spread of the use of 3D shape data. However, it has been confirmed that the use of 3D shape data has prevailed in other industries.

(2) Realizing communication by exchanging digital information.

3D CAD should realize an effective

environment for communication among those who require accurate and complete data regarding production and techniques, whenever and wherever data are needed, by a suitable means and at a low cost. In other words, 3D CAD should help to realize accurate and speedy communication. The most important factor in realizing such communication is product data management (PDM), which enables integrated management and real-time responses on the basis of digital information.

(3) Concept from the point of view of customer satisfaction.

In product development, it is necessary to understand the diverse needs of users and to create a concept from the point of view of customer satisfaction. Therefore, it is crucial to ensure quality while decreasing the time, the number, and the cost of manufacturing processes in product development.

(4) Innovation in design tasks.

Changes in, accommodation to, and acceptance of tools, technologies, and techniques by designers who confront these new trends are always required in every design process.

4.2 Survey content 2

The phases wherein 3D CAD is used, from among the processes of planning conceptual design basic design, and detail design, were investigated.

a: Planning

Determine specifications, Calculate the cost.

b: Conceptual Design

A: Determine Rough shape

B: Examination using punch drawings

c: Basic Design

Plan drawing (Realization of concept, Performance investigation)

d: Detail Design

Part drawing, Assembling drawing-Develop

Grant of Material characteristics

Survey results

All types of industry: 50 number of companies.

a: Planning:8

b: Conceptual Design:26

A: Determine Rough shape:8

B: Examination using punch drawings:6

A+B:12

c: Basic Design:9

d: Detail Design:1

e: Other c+d:4 All stages except :4

Discussion

(1) From planning / concept design

When we receive an order from a customer, the requested specifications are presented by the customer. We then aim to manufacture and realize products with functions that meet these specifications within a budget. This is the goal of design. As design efficiency and cost performance are sought, the adoption of familiar designs that use existing techniques rather than techniques that require tests of new elements is frequently observed. As a result, in recent years, fewer trial and error methods have been carried out in the process of design, and priority has been given to design efficiency.

(2) Examination using punch drawings.

The imaging of an idea, namely, the representation of an idea using pictures and characters, is the most suitable method for maximizing the possibilities of designing at operating branches and for simply explaining information. In designing, the designer focuses on a blank sheet of paper, lets the mind wander, and draws a component. Creating an idea for a design probably means incorporating new ideas into the shape while considering the shape of new products by imaging the shape of products that are already known, that is, the products the designer had previously seen and touched. We think that 3D CAD is unnecessary up to this stage of designing.

(3) Acquisition of 3D CAD skills.

It takes a relatively long time to become familiar with 3D CAD, because of its complexity. When we use 3D CAD to produce a model of several machine components, the designers may experience

real difficulties in performing operations and modeling. Even if the designer succeeds in modeling, he or she will face questions about how to actually design the model afterward. Currently, young designers who undergo CAD training focus mainly on the operation of CAD software, which causes various problems, as frequently pointed out by more experienced designers. A method to solve this problem immediately is desired.

4.3 Survey content 3

The manner in which drawings are handed to the manufacturing department or external contractors was investigated.

- a: Two dimension drawing
- b: Three dimension drawing
- c: Three dimension drawing + Aribute information
- d: Two dimension drawing + Three dimension drawing
- e: Two dimension drawing + Three dimension drawing + Aribute information
- f: Other

Survey results

- a: Two dimension drawing:19
- b: Three dimension drawing:15
- c: Three dimension drawing + Aribute information:4
- d: Two dimension drawing + Three dimension drawing:7
- e: Two dimension drawing + Three dimension drawing + Aribute information:5
- f: Other:7

Discussion

- (1) Rarity of communication through 3D drawing alone. Ho

Even after a 3D shape model has been produced, a 2D drawing of a model is still necessary in many cases. Therefore, the work load for designers is continuing to increase because the culture of 3D CAD is not widespread in manufacturing departments; thus, manufacturing systems based on conventional 2D drawings remain. No standardized method of conveying data for a model of a 3D shape to manufacturing

departments has yet been established. In order to shorten the time required for design, it is important to reform existing organizations so that a manufacturing system that makes full use of 3D CAD data is established.

- (2) Illustration and indication of attribute information.

In most industries, information about machine components is conveyed not only using 3D shape models but also with 2D drawings. If there are no 2D drawings, all the information on the machine components must be clearly illustrated and presented on the models generated by 3D CAD. The information on machine components themselves is sometimes included in the 3D models; however, it is difficult to convey 3D information to the next process without any modifications, and thus 2D drawings are still used to support the conveyance of information.

- (3) Minimization of use of 2D drawings.

Once we remove 2D drawings, we will manufacture all products by incorporating processing technology information into 3D CAD data in the design phase, which is then read by a numerical control (NC) machine. In this way, it is possible to reduce the number of manufacturing processes, the cost, and the burden on the operators. In other words, the 3D CAD shape model data becomes the nucleus of the manufacturing process. Therefore, a rigorous verification of the 3D CAD data becomes necessary in the design phase.

4.4 Survey content 4

How design analysis is carried out in the design process was investigated.

Survey results

- a: Hand calculation:9
- b: Hand calculation and CAE:26
- c: CAE:8
- d: Other:7

Discussion

- (1) Environmental changes in computer-aided engineering (CAE) and its role. According to the results of our questionnaire,

only 16% of the respondents use only CAE for design calculation (design analysis); however, judging from the result that 68% of the respondents use a combination of hand calculations and CAE, it is possible to consider that the role of CAE has already shifted from a mere analytical tool to an effective design tool.

(2) CAE as a tool for designers.

Designers wish not only to simply request an analysis and wait for the result from a specialist but also perform analyses themselves and obtain the required result within a day so they may progress to the next step in the design. To realize this goal, we must perform several tasks, including (1) development of a CAD-CAE integrated system, (2) establishment of modeling and evaluation methods, and (3) development of a support system for design.

(3) Problems caused by decrease in the number of prototypes produced.

The decrease in the number of production of prototypes has led to a reduction in the opportunities to learn from manufacturing substantial products. In a design method, design skills for achieving mechanical requirements such as light weight and high stiffness, production technology that enables the timely provision of products in accordance with users' needs, and manufacturing technology that realizes the value of products at an appropriate cost, comprise the framework of manufacturing. However, full attention should be paid when these skills and technologies are applied.

(4) Results of CAE depend on experience and sense.

There is an obvious difference in the quality of design between designers, depending on their skill, even when the same tools are used. This can be regarded as a problem in training. In other words, designers are required, not only to learn how to use CAE, but also to have the ability to decide, in order to accurately examine the behavior of objects. Decisions are supported by experience and

sense, which can be gained from experiments and theoretical considerations.

5. COMPREHENSIVE DISCUSSION OF FUTURE INNOVATION AND DESIGN

Today is an era of specialization and designers must acquire their own special skills. However, to be a skilled designer, design should be understood not from the limited academic viewpoint but from the viewpoint of industrial problems. In addition, designers must always understand problems from a broad viewpoint and carefully analyze individual problems derived from their research. Furthermore, designers are required to make quick timely decisions. Also, cogitation that can shift from realistic thinking to abstract thinking is always necessary. This is because many inspirations occur as a result of abstract thinking. Designers become creative through such rigorous training and behavior guided by a trained mind. Design, which is the origin of all industries, is a world of devising and creating, in which new styles and the innovation of techniques are constantly demanded. Constant effort and diligent study are needed for designers to create designs that can appropriately meet the demands of the present age. It is also necessary to have flexible and unique ideas as well as a challenging spirit to realize such ideas. Young designers are expected to contribute to our society through their skills and ideas and to play an active role in various fields as machine design engineers who form the core of specialists in a technology-based country such as Japan.

6. CONCLUSIONS

Some people have stated that descriptions of machine components using 2D drawings will disappear within the next 5 years; however, we cannot easily imagine the nature of design without any 2D drawings. What is most important in design is how accurately product information can be conveyed to manufacturers. 3D CAD is merely a tool in the design process,

and produces no products in practice. It is expected that most of the design processes will be carried out automatically using computers through an innovative change in design business. However, a question arises whether it is acceptable to leave all the manufacturing-related work to computers. After all, we believe that people are still the most reliable, with the flair, experience and skills that they have cultivated for a long time. Innovation in design work is clearly necessary, but we should have good judgment in determining its direction.

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REFERENCES

- [1] Shigeo Hirano and Sozo Sekiguchi:
Creative Production Process
& Manufacture, Science, Published by
Corona, (2007).

ABOUT THE AUTHORS

1. Shigeo HIRANO, Tokyo City University, Tokyo, Japan. Ph.D., His research interests are Mechanical Design and Drawing, CAD, Design System Education and development of new products for Hman Spport Sience. He can be reached by e-mail:rs4775hirano@ybb.ne.jp
2. Sumu KISE, is a Ability Development Section Supervisor in the Artner Co. Ltd.
3. Sozo SEKIGUCHI, is a President in the Artner Co. Ltd.
4. Kazuya OKUSAKA, is a Ability Development Section General Manager in the Artner Co. Ltd.
5. Takashi IMAGAWA, is a Ability Development Section Supervisor in the Artner Co. Ltd.