Association of CAD Data with Parts List System on Host through Development of PDM System

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Working toward three-dimensional development with CATIA, Koyo planned to build a PDM (Product Data Management) system in order to make effective use of CAD data. The purpose was setting up the total system which could support the whole business of design sections; response to inquiries of new products, prototyping, mass-production and design change. One of the PDM softwares on the market was applied with some customized functions so that the structure information of CAD data could be systematically managed. And the association of CAD data with the parts list system on the host computer was realized.

Key Words: product data management, 3D CAD, parts structure table, design change

1. Introduction

In order to satisfy the requirements from various automakers to shorten the development period, Koyo has been performing various actions for each step ranging from the business inquiry to the mass production. These actions, however, still leave many problems such as technical or quality ones at the start of the manufacture. It is also required that all makers including cooperators strive for improving the efficiency of development and design at the preparation of the manufacture. Under such circumstances, three-dimensional (hereinafter referred to as 3D) CAD techniques have been rapidly used and more customers require their business partners to use 3D data. Thus, Koyo has promoted the use of 3D data for the purpose of providing shorter development period, reduced number of prototyping, improved design quality, and association with CAM and CAE techniques. In accordance with the introduction of the 3D CAD system, Koyo Steering System Operations Headquarters decided to establish the Product Data Management system (PDM) for the purpose of effectively using the CAD data. This PDM system realizes the systematic management of the information included in CAD data, thereby allowing the information to be associated with the parts list system managed by the host computer. This association system are introduced as follows.

2. Analysis of Current Status and Development Policy

2.1 Problems in Current Design Flow and Tasks

In order to establish the PDM system, the current status of the design system in Koyo was investigated to find the problems and tasks based on Customer Planning Session (CPS) method. As a result, about 120 problems and tasks were found. Some examples of the problems will be specifically described below.

① Information is not effectively used.
   · In Koyo, the CAD system and the parts list are independently managed and thus an interface of them is managed by humans.
   · In issuing the design change notification (hereinafter referred to as ECA, Engineering Change Authority), there is no supporting system.
   · Files are managed on a project basis and thus desired information cannot be searched immediately.

② Location of information is unclear.
   · Related documents are not systematically organized.

③ Information cannot be certainly communicated.
   · Design change of common parts cannot be incorporated into the prototype drawing in a timely manner.
   · Same defects as in the past sometimes happened again.

④ CAD data is not correctly maintained.
   · As the paper drawing is used as the formal drawing, the drawing sometimes has a conflict with the corresponding CAD data.
   · There is a concern with regards to how to manage the access authority and the exclusive access control.

2.2 Solutions for Tasks and Basic Policy for System Development

With regards to the above problems and tasks, facts and causes were investigated. As a result, it was found that these problems could be solved by the measures classified as follows.

· Digitalization
· Appropriate management of CAD data
· Integrated management of information
· Use of groupware (e.g., Notes)
· Efficient preparation of parts list
· Work flow
· Expansion of the function of the host computer
· Improvement of business flow
Thus, Koyo has decided to develop the PDM system based on the policy as described below.

The following design policy was determined for the work flow used by design departments including the steps ranging from the business inquiry for a new product through prototyping and mass production to a design change.

- Management of CAD data
- Efficient preparation of the parts list (i.e., association between the host computer and the parts list)
- Management of technical documents (digitalized and integrated management of information)

Koyo plans to establish a comprehensive supporting system by focusing on the above policy.

3. Structure of PDM System and Flow of Information

In order to establish the PDM system incorporating the above policy, the PDM software called Enovia VPM (hereinafter referred to as VPM) having superior affinity with CATIA was introduced. **Figure 1** schematically shows this new system. In this system, a conventional IBM host computer is used and what newly introduced are CATIA, VPM, and a groupware software (Notes) application. In this system, part No. information entered to the host computer is transferred to the VPM via Notes. Then, the model of the part No. is prepared in CATIA while completing the parts list in VPM, and then the parts list is sent to the parts list system in the host computer. Notes side receives information for the part No. (design change) from the host computer to semi-automatically prepares an ECA, and distributes it to related departments in an electronic manner.

4. Standard and Basic Functions of VPM

Outlines of the standard functions of the VPM used for establishing the association between the CAD data and the host computer are described here.

4.1 Integrated Management of CAD Data

In this system, PART (basic object used in VPM) and CAD models are managed to be structurally linked to each other. By associating the PART, having parts No. including each attributed information, with 3D-models and 2D-drawings, the integrated management of CAD data becomes possible (**Fig. 2**).
4.2 Product Structure Navigator (PSN)
The PSN structurally represents the relations among PARTs. By the PSN, a model according to an assembly drawing is prepared by selecting necessary components to combine the components at appropriate positions. While the model is prepared, the PSN prepares a parent-child relation between higher-level part No. and individual components. This parent-child relation is directly used as the information for the parts list. In other words, when the assembly model is completed, the parts list with regards to the model is completed at the same time (Fig. 3).

4.3 Management of Ongoing Status with Maturity
In this system, the ongoing status of the preparation of drawings or other works is managed by maturity. In the current system, a PART for which the drawings are now being prepared is set by designers as having maturity of 10% to 70%; a PART for which the drawings already have received approvals from responsible persons is set as having 80% maturity; a PART for which the drawings are waiting for the issue is automatically set as having 90% maturity; and a PART for which the drawings have been already issued is automatically set as having 100% maturity. Those drawings having maturity of 80% or more are locked so that designers cannot update such drawings (Fig. 4).

4.4 Management of Security (People & Organization)
In this system, each user has to register his/her user ID so that the user can be appropriately allocated to a user group (Organization) depending on in what department the user is working and what kind of tasks the user is responsible for. It is also possible to group the roles (Role) of various users in order to allow one user to be allocated to more than one group. There are about 80 kinds of operation authorities available in this VPM system in order to classify users. These operation authorities are grouped into Process Groups. When a user registers his/her data, then the user is always allocated with Owner and Owner Group representing a user ID and in what organization the user is working (Data Group), respectively. When this user tries to access other organizations, then the user must go through this Data Group. A PART having 80% or more maturity are locked and thus cannot be updated, even if the Data Group and the Organization are the same (Fig. 5).

5. Design Change with VPM Function
Figure 6 shows the procedure for the design change. In the design change procedure, a PART, which needs to be changed, is selected and then "New Version" is used to prepare the new PART and MODEL containing changes in the design. At this time, the MODEL is copied and thus only the portions in the MODEL to be changed should be edited and redesigned. When the design change is finished, then the PART before change is "replaced" with the PART after change. In this replacement, higher-level PARTs before change are automatically searched so that all PARTs before change can be replaced with the PARTs after change.

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Fig. 3 Association among each PART

Fig. 4 Maturity

Fig. 5 Security management concept of VPM

Fig. 6 Design change process with VPM function
Fig. 7 Business flow of design change in mass-production

6. Work Flow after Obtaining Association between CAD Data and Parts List on Host Computer

The above-described standard VPM functions are added with uniquely customized functions and the conventional host computer system is also added with new menus, thereby developing a new structure for the association between the CAD system and the parts list on the host computer. The followings, based on Fig. 7, will explain the actual work flow after the association is obtained. Although the work flow is slightly different depending on each step for prototyping & design, mass production, and the design change during mass production, the following section will describe only the work flow for the design change during mass production.

1. Application for ECA No.
   As in the conventional system, application for ECA No. is issued by Notes.

2. Numbering and Transfer of Part No. after Design Change
   The on-line menu in the host computer is used for registering the information regarding a part No. and its attribute after the design change on a ECA No. basis. After being registered in the host computer, the information regarding the part No. and its attribute is transferred to the VPM system when the transmission key is pushed. As a result, when "New Version" is executed in CATIA and VPM, only the registered part Nos. are displayed as candidate part Nos., thereby preventing one part No. from being doubly inputted (Fig. 8).

3. The information transferred from the host computer is sent to a Notes server. This information is divided by the Notes server into a piece of information for the VPM and a piece of information for issuing an ECA.

4. The CATIA and the VPM generate "New Version" of each PART after the design change to prepare the model, to update the 2D-drawing, and to prepare a new structure of
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Preparation and Issue of ECA
The ECA database in Notes prepares and issues an ECA by using the information registered in the above step ② and by using the information of part Nos. which have been previously automatically prepared in "list of changing points" (Fig. 9).

Start of Processing after Approval of ECA
When the prepared ECA is approved thorough the work flow by Notes, then the CATIA and the VPM start "Process after ECA approved" (Fig. 10).

Then, the started program searches for all information applicable to the ECA No. to prepare a new structure including updated information regarding minor-changed part Nos., thereby preparing a new structure (Fig. 11). At the same time, the PART after the design change is updated to have a maturity of 90% (i.e., status waiting for an issue of the drawing). The parts list is further searched on an assembly part No. basis to transfer the result to the host computer. The host computer receives the result to register the result as a parts list for works in progress (Fig. 12).

Check of Details of Parts List and Input of Corrected Attribute
The information which can be transmitted from the CATIA and the VPM is limited to the information regarding the structure of a product. Thus, the on-line menu in the host computer must be used to check TS classification, selection classification, and auxiliary units so that any information requiring correction can be corrected. The above check-and-correct procedure eliminates the need for manually changing the parts list based on the ECA which has been conventionally performed by an engineering administration department. This procedure also provides an addition or deletion of exclusive auxiliary products such as an exclusive auxiliary kit.

Issue of Drawings
The parts list of works-in-progress is used on an ECA basis to prepare a formal parts list. Information for ECA is also electronically distributed by the Notes database to related departments. Paper drawings are distributed as in a conventional manner.

When the host computer performs the issue of drawings as described in the above ⑨, then the ECA No. is transferred to the CATIA and VPM so that applicable PARTs can be automatically searched. Thereafter, the maturity is updated to be 100% (which means that the drawing has been already issued).
7. Conclusion

By the combination of the CAD software (CATIA) and the PDM software (Enovia VPM), the following system has been established.

- A model according to an assembly drawing and the information regarding the structure of the model can be synchronized and the synchronized information can be associated with the parts list in the host computer used by a production department;
- CAD data can be managed in an integrated manner (e.g., the latest version can be appropriately managed and the information regarding the 3D model, the drawing, and the analysis result can be associated);
- Consistency among models can be secured and the design change of lower-level components is automatically incorporated into higher-level components; and
- A data security system can be established in which data, access, and operation authorities are protected.

However, the present PDM system still uses paper drawings as the formal and original drawing. Thus, the environment and the mechanism of such a PDM system must be improved to allow digital data of a drawing to be used as the formal and original drawing so that original paper drawings can be eliminated and digital drawings can be electronically distributed.

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