

Development of Engineering BOM Data Management System

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ABSTRACT

A new engineering bill of material (BOM) system was developed in order to shorten the development cycle and improve BOM accuracy. This BOM can perform integrated management of basic product information of all vehicle models, all types, and combinations of frame, engine, transmission, and so on. It also improves drawing release efficiency and facilitates connection with other systems. Based on a commercially available product data management package, this system has a three-tier system architecture for easier data linkage, and it runs on the sophisticated Windows NT Server for improved operation performance. This not only allows management of basic product information for all vehicle models, but also makes it possible to centrally manage information sharing and drawing data from the initial development stage through to mass production. Significant improvements have been made in the efficiency of design drawing release and reception work flow as a result.

1. Introduction

From 1980 through the mid 1990's, the System Department at the Tochigi R&D Center carried out extensive system development, including that of the engineering-BOM — the Honda Structure System (HSS hereafter) — in order to shorten the period of drawing issue and to improve the accuracy of BOM information. Examples include a part application indication processing system that made it possible to automatically calculate feature application indications for part data and product variation application (the Honda Feature System; HFS hereafter), a drawing release support system that carries out checks of application, of drawing history, and of configuration from CATIA drawing data, and a drawing distribution system that distributes drawings to suppliers and plants. In the development of the HSS, there was one development facility, five manufacturing facilities, 8 models, and approximately 400 product variations, and the system incorporated all of their needs. However, as the scale of development has grown in recent years, the number of models now is almost four times that of when the system was developed, and the number of product variations is now approximately 10 times what it had been. With the existing system capacity, it is now difficult to carry out processing. In addition to this capacity problem, because it is necessary for the system to adapt to the new style of development of recent

years, a new engineering-BOM system (The New Engineering-BOM Worldwide System, referred to as NEWS hereafter) was constructed. It can manage vehicle product basic information in an integrated manner, is more efficient in drawing processing work, and can easily cooperate with other systems.

This BOM was developed by building unique Honda technology on the base of a commercially available software package, the first in the world as a mass production automobile supplier. Conventionally, this area of development has been “untouchable” and no technological evolution has been expected. However, with this NEWS it is much easier to introduce rapidly evolving technological innovations, in areas such as data communication or the IT field, into system development in this area. In addition, it is possible to communicate with other systems, without using copies of data. As for system configuration, conventional systems are built to work on a host computer, but this system utilizes a high speed PC in the business logic calculation domain, and so performance is improved. Even thinking about a stable system utilization rate, which can be a problem with this kind of system, by having multiple hardware configuration and development of independent control programs, stable utilization like that of a host computer was achieved.

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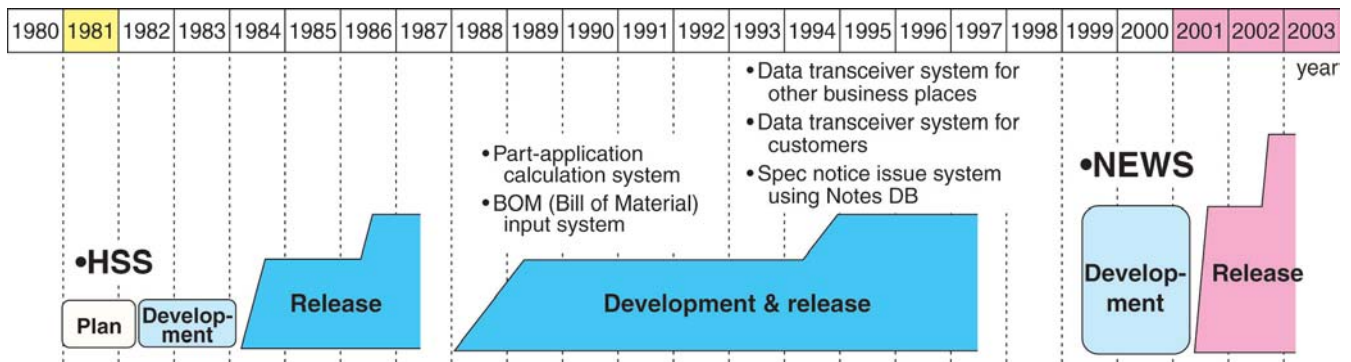


Fig. 1 The history of system development

2. Aims of Development

2.1. Concerns with the Conventional BOM System

2.1.1. Inefficient parts application method

With the conventional system, although there is the frame, engine, and transmission, data was managed in frame family units, and so when there was a spec change, it affected everything in the family. For example, when there was a change to a frame variation, it meant that engine and transmission family engineering change work had to be stopped simultaneously. In addition, associated data linked to engine or transmission data applied to a frame did not exist as BOM data.

2.1.2. Management of incomplete parts data

With the HSS, searches were made together for parts that are applied as standard parts and all parts that are applied as optional parts. Therefore, it was not possible to extract only parts data applied to a certain optional feature vehicle.

2.1.3. Data that was not shared

With the conventional system, data that was prepared by a design engineer prior to drawing issue (drawing release schedules, etc.) was not well managed. In addition, because there was no timely sharing of data between departments, parallel work in each process was dependent on personal communication, and this was an obstacle in truly shortening the development cycle.

2.1.4. Scattered system

The development history of the BOM and related systems is shown in Fig. 1. After the introduction of the HSS, a number of peripheral systems were developed to meet various needs. Because the direction of data flow in the system developed so far was one-way, there was no linking in the sense of mutual utilization of data. Therefore, in linking with other systems, the work of copying data between systems was generated. In addition, in the process of development, the design engineers had to call up many display screens, and manually input the same data into different formats. This meant a lot of duplicate work, and so an increase in design workload.

2.1.5. Low reliability in drawing delivery system

In the distribution of drawing data, the conventional system carried out only transmission management, and so

reliability was low with a reception error rate of 10%. Furthermore, when passing data to the supplier, there was the work of investigating each time the situation surrounding customer receiving environment and processing it by hand.

2.1.6. Limits to system capacity

An increase in the number of variations, too, greatly affects system performance. At the start of system development, the number of model variations was about 400, and while the system was expanded to be able to process 3,000 variations, practical development was carried. However, the current variation count exceeds system processing capacity at 4,000, and processing takes time after system trouble occurs (Fig. 2).

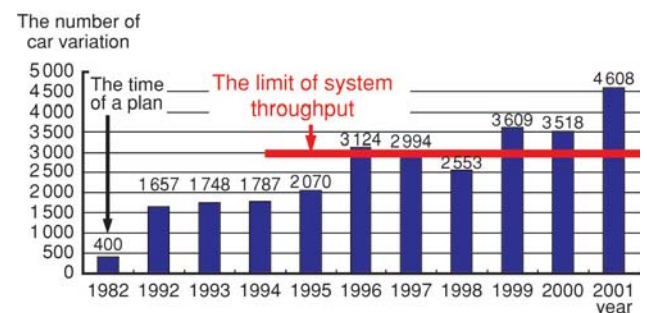


Fig. 2 Transition of the number of car variations

2.2. Aims of Development

The following aims were established in the construction of a new system, in order to resolve the issues set forth above.

- (1) Complete data management of parts for one vehicle.
- (2) Make possible simultaneous, parallel development through information sharing.
- (3) Make possible centralized management of data flow through system integration.
- (4) Contribute to shortening the development cycle by building the new system as a system that is unlimited in terms of processing data amounts.
- (5) Actualize easy linking between various systems.

3. Details of Development

3.1. Functions Developed

With NEWS, function utilized by conventional multiple systems were improved in line with the development aims, and packaged. Explanations of the function developed are as follows.

3.1.1 Parts data management for a single whole vehicle

(1) Feature-application List (referred to as F-List hereafter)

Feature-applications are defined against variations in grade. Fig. 3 gives an example of this. In the table, an “0” means that it is applied, and a “-” means that it is not applied.

Family TNAEF									
Model			S02A						
Destination			J						
Sec	Idx	Grade	EL	ML	ML-2	MT-A	MT-B	VT	VT-A
Vertical Set									
A00		ABS							
	1	ABS	0	0	0	0	0	0	0
A00		DR SRS							
	1	DR SRS	0	0	0	0	0	0	0
A00		MISSION							
	1	MT	0	0	0	0	0	0	0
	2	AT	0	0	0	-	-	-	-
	3	CVT	-	-	-	0	0	0	0
A00		SUNROOF							

Fig. 3 F-List

(2) Part-application List (referred to as P-List hereafter)

By indicating part-application against feature combinations calculated automatically, part application against product can be automatically calculated. Fig. 4 gives an example. Rows having an “0” at the top right give the feature spec differences, and by inputting the part number at the bottom left, it is possible to indicate part-application for spec differences. In addition, the numbers on the bottom right express the number of parts applied.

An explanation of the part application indication process is as follows. First, the model development team and the spec management team establish feature specifications for a model, and the F-List is created. On the system side, when the spec has been decided, from the feature combinations the necessary product variations are calculated, and variation codes are created. The design engineer utilizes the F-List data, and creates the P-List. In creation of the P-List, first of all, the features that determine part spec differences are selected from the F-List data. Then the feature combinations are calculated, and the design engineer inputs part numbers for the resulting pattern. When it is saved, on the system side, the product variations that are integrated with the calculated feature combinations are automatically searched, and part-

application determined. With this process, it is no longer necessary for the design engineers to manually indicate part-application for each and every variation (Fig. 5). This process was actualized in HFS, but its function was enhanced as part of NEWS functions.

1		2 DOOR							
2		3 DOOR							
3		4 DOOR							
A00		SUNROOF							
1		NO SUNROOF	0	0	0				
2		SUNROOF						0	
F44		SPOT LIGHT							
1		NO SPOT LIGHT	0					0	
2		SPOT LIGHT				0	0		
F32		RR WASHER							
1		NO RR WASHER	0	0	0	0			
2		RR WASHER							
1	62100-S02	-A000-H1	1						
2	62100-S02	-J100-H1		1					
3	62100-S02	-J100-H1				1			
4	62100-S02	-A100-H1						1	
5	62100-S02	-A100-H1							
6	62100-S00	-A000-H1							

Fig. 4 P-List

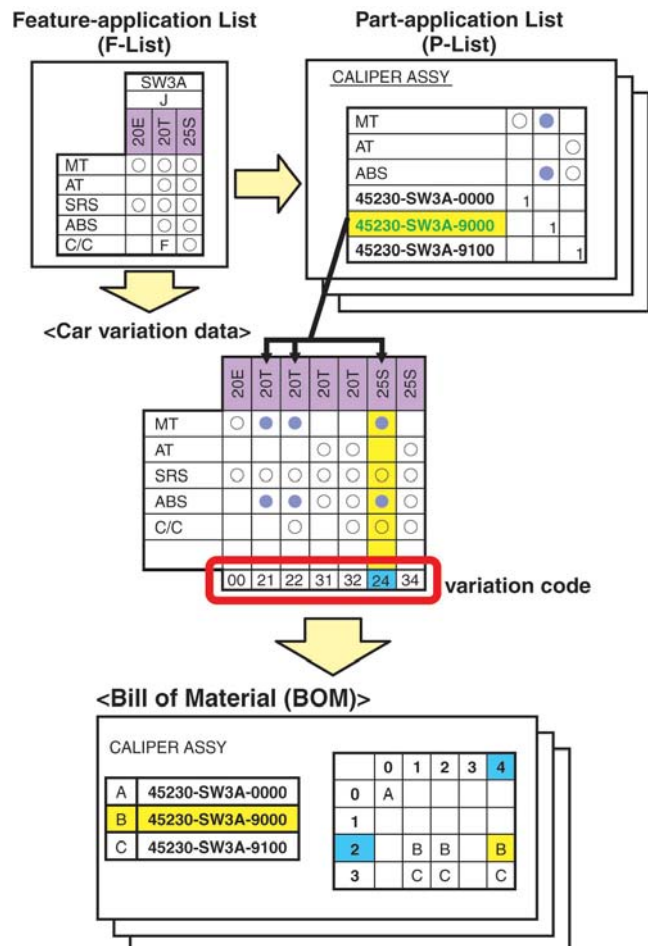


Fig. 5 Result of part-application calculation

(3) Joint List

Independently managing all variations in frame, engine, and transmission using the F-List, the various variation combinations are defined on the joint list, as data for one vehicle.

3.1.2 Simultaneous parallel development through information sharing

• PLUI (Parts List User Interface)

The PLUI makes it possible to input or reference the BOM using the same graphical user interface (GUI hereafter) from the memo state at the planning and concept stage through engineering changes after mass production. From the PLUI screen, it is possible to carry out operations such as referencing CAD drawings, displaying cost and mass, inputting drawing schedules, etc. (Fig. 6). At present, design engineers create and maintain the planning and concept stage parts lists on Microsoft Excel, etc., but data linking with the engineering-BOM created after drawing release is not possible in terms of the system. In addition, management of the data that accompanies the parts list depends on each individual. This is a cause of poor accuracy in cost and mass totals. With PLUI, at the planning and concept stage parts list and the engineering-BOM can be maintained with the same GUI on the same database, and an information sharing process is actualized. Through these measures, it is possible to have the following.

- Prevention of parts omissions in work by design engineer
- Provision of highly accurate BOM information to layout or cost and mass calculation systems, etc.

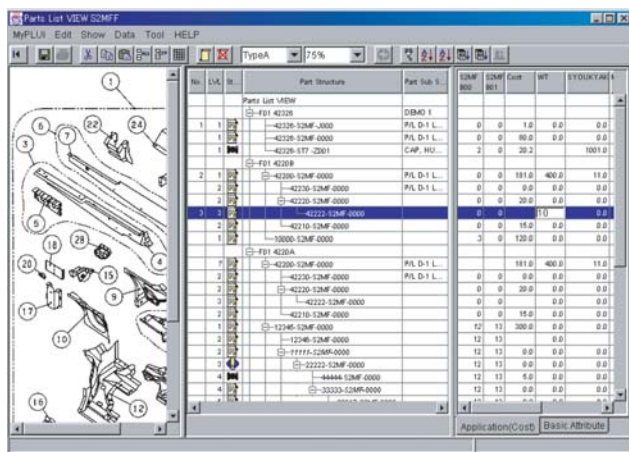


Fig. 6 PLUI display

3.1.3. Centralized management of data flow

In order to centrally manage drawing data flow from drawing release processing by designing engineer through distribution to plants and suppliers, the following processing functions were developed in NEWS.

(1) EC Data Reception

Check, using a bar code, to ensure uniformity between the CATIA data and the paper drawing with approval signatures.

(2) Total Check

Check feasibility of part application and drawing history, configuration.

(3) Obtaining Revision No.

Revision notification numbers are obtained in order of engineering change, so that there is no duplication.

(4) Calculation of EC Data Distribution Site

The worldwide facility distribution site for drawings or notifications is automatically calculated from part-application.

(5) Writing Revision No. on Drawings

The revision number is automatically written in the history column in CATIA drawing data.

(6) Scanning

Information drawn on paper is scanned, and stored in the database.

(7) English Translation

English translation of the notifications is carried out through data exchange with an outside translation company.

(8) Moving to Master Drawing File

CATIA drawing data is stored in the master drawing file.

(9) Distribution

Based on data distribution site calculation results, drawings and notification data are automatically distributed.

(10) Interface for manufacturing BOM

Engineering-BOM data is automatically distributed to the manufacturing-BOM, in notification order.

(11) BOM Search

BOM information, drawing and notification information, and CATIA data can be searched from a variety of angles. Fig. 7 shows the screen.

(12) Conversion to Mass Production

Prototype part numbers in CATIA drawing data are automatically converted to mass production part numbers, and moved to the manufacturing-BOM.

The above is a simple explanation of functions developed. These functions were developed as the basis for system application technology explained below.

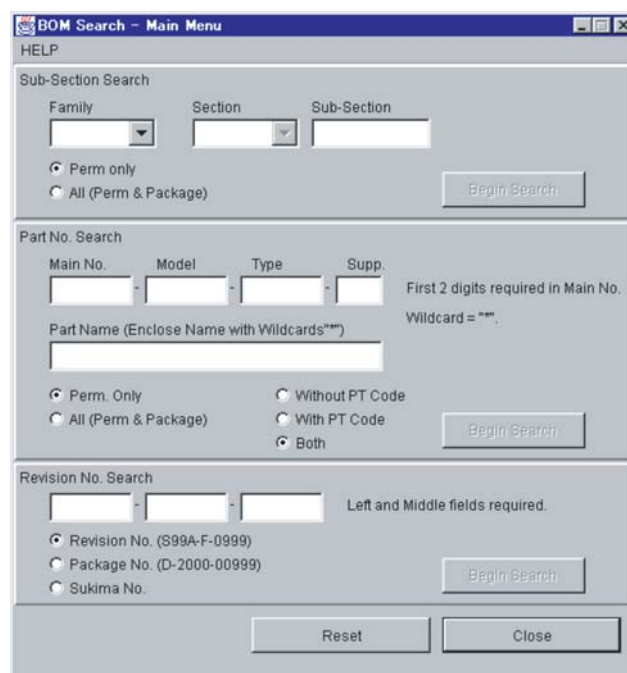


Fig. 7 BOM search screen

3.2. Detail of System Application Technology

In order to continue system evolution and to improve ease of system maintenance and application efficiency, this system is based on the data management software package eMatrix (MatrixOne, Ltd.), and with a three-tier system architecture (Fig. 8). On the client side, a GUI screen was developed in Java, so the users can easily input and reference parts information. In addition, an interface with CATIA was developed, strengthening data linking. The application servers are composed of UNIX and Windows NT, with the business logic created in TCL installed. In the database, Oracle was adopted from the point of view of performance and expandability.

The following technologies were adopted in a hierarchy.

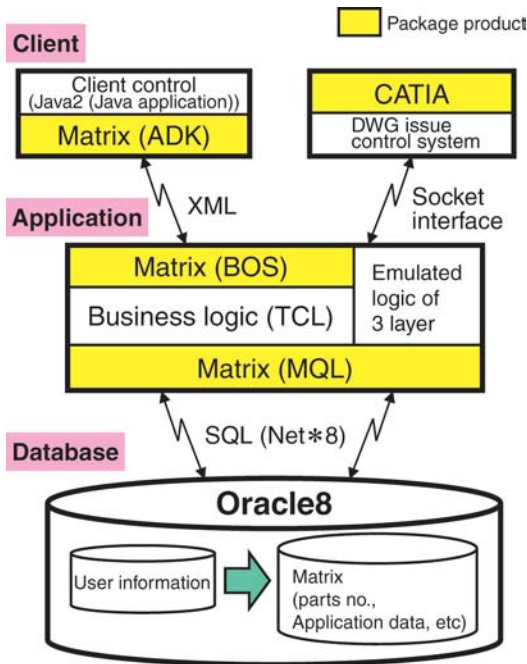


Fig. 8 3-tier architecture

3.2.1. Client layer

(1) Multi-Platform and Multilingual Measures

In order to maintain the same level of ease of operation among the workstations by IBM, SGI, and HP used as CAD terminals and Windows PCs used as OA stations, the same GUI was adopted. In addition, in order to ensure there is no effect due to differences in OS features, an integrated common function was created and adopted, relating to (1) automatic switching between similar fonts, (2) printing control, and (3) file path name control, etc.

Furthermore, the scheme outlined in Fig. 9 was adopted, to deal with other languages.

(2) A User-Friendly GUI

In order to improve ease of operation by the user, various GUI were actualized, including tree views, icons, pop-up menus, etc. Fig. 10 gives an example. With today's applications, it is ordinary technology, but conventionally, data is dispersed between the subsystems, and data storage formats were various, so it was difficult to actualize this flexible GUI.

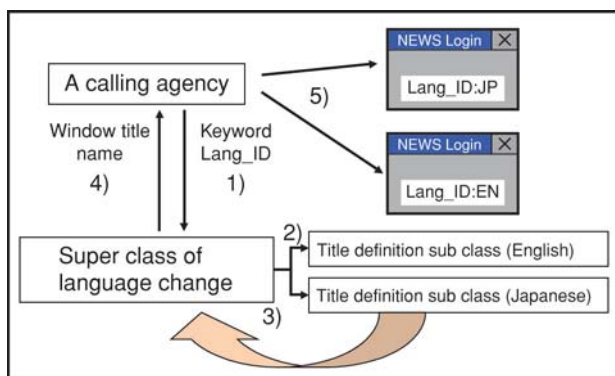


Fig. 9 Multi-language compatibility

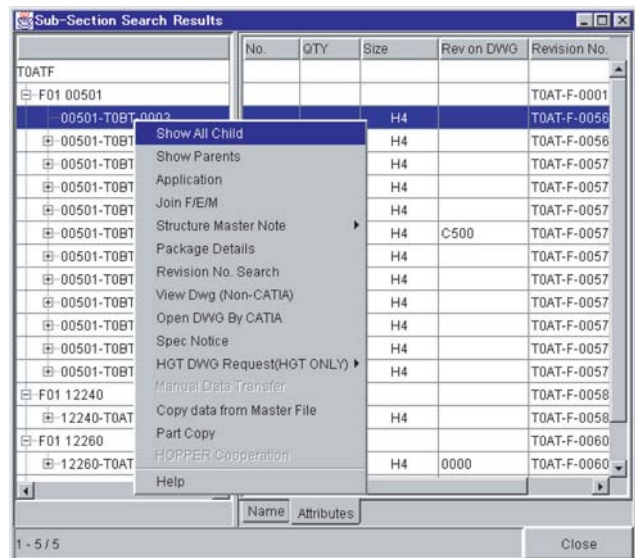


Fig. 10 Example of GUI

(3) Communication Method

With NEWS, the communication method adopted between clients and servers is the CORBA (Common Object Request Broker Architecture) IIOP (Internet Inter-ORB Protocol). In the future, studies will be made into a communication method that switches between communication within the application server using RMI (Remote Method Invocation) and external communication using XML (eXtensible Markup Language) (Fig. 11). With the communication method using XML, the elements handling communication are completely covered as a package, and without significant modifications to existing business applications, communication efficiency can be improved. Current testing confirms operation.

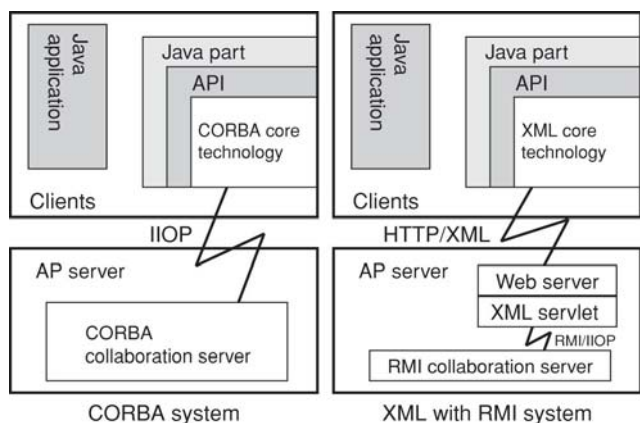


Fig. 11 Communication methods

3.2.2. Application server layers

With this system, as application servers, 2 UNIX servers and 36 Windows NT servers were introduced (Fig. 12). This gives the following benefits.

(1) High Speed

Because it is possible to use CPU so that each process can be independent, it is possible to introduce performance that exceeds that of a general-purpose computer. In addition, with future hardware evolution, it will be possible to actualize, at a low cost, even higher speeds.

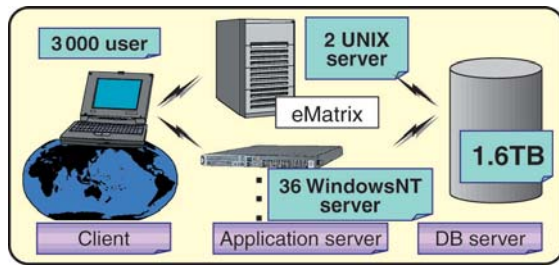


Fig. 12 System configuration

(2) Scalability

Even if the scope of business expands in the future and the number of users grows, it is easy to increase the number of servers, so ease of expansion as a system can be maintained.

(3) Reliability

Generally, the utilization rate for NT servers is 97%-99%, but by implementing (1) parallel devices and doubling (normal utilization backup device) and (2) utilization monitoring and automatic switching (threshold value monitoring) measures, the utilization rate reached 99.98%. An infrastructure was built that could maintain a utilization rate on a par with a mainframe system.

3.2.3. Database server layer

With this system, theoretically object-orientated data management is carried out. However, physically, Oracle has been adopted, which is a relational database. Therefore, both system design flexibility and maintenance of execution performance are achieved. Accordingly, in data definition design, there are no limits due to performance or resource economy. Because of this, it is possible to substantially and freely increase the amount of each type of data, such as number of product variations, thereby actualizing the development target of limitless processing data.

3.2.4. Data transmission and receiving system, utilizing MQ

In order to improve drawing data distribution accuracy, this system adopted a data transmission and receiving structure utilizing MQ (Message Queuing). Fig. 13 shows an outline of the structure. MQ is a transmission and receiving monitoring software, and it automatically compares information transmitted and information received. If the information is insufficient, data is automatically resent. This has made it possible to maintain transmission and receiving at almost 100%.

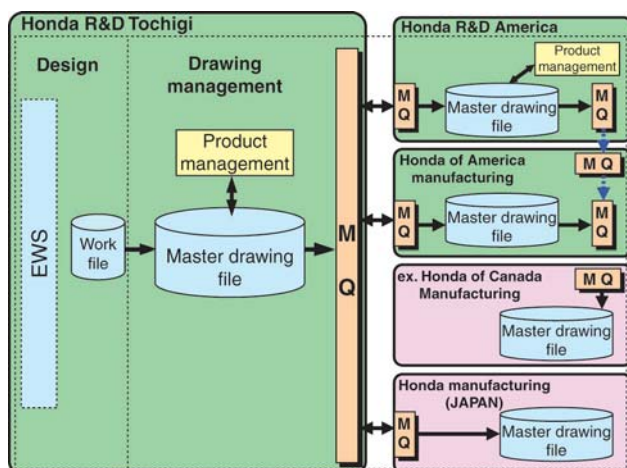


Fig. 13 Drawing transmission using MQ

4. Benefits

4.1. Benefits in Management of Parts Data for One Vehicle

With NEWS, it is possible to extract parts applied to option feature vehicles. That is to say, it is possible to manage all parts information from model to option. In addition, frame, engine and transmission data are managed in separate family F-Lists, and the combinations are defined in the joint list. This means that even when there is a change to a frame variation, there is no need to stop, at the same time, engine and transmission engineering change work, thereby improving efficiency.

4.2. Improved Work Efficiency with System Integration

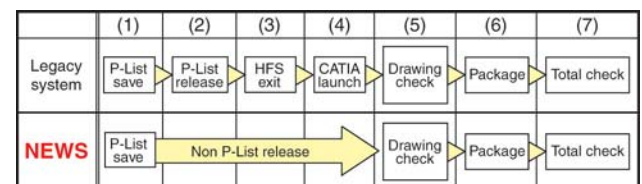
By integrating the system, the design engineers drawing release work efficiency is improved. Fig. 14-(a) compares the workflow carried out by design engineers with the conventional system and with NEWS, and Fig. 14-(b) compares operation time. With work simplification, design drawing release work efficiency can be improved by approximately 30%. Concerning BOM accuracy, too, parent check error (error which occurs where there are parts which are not related to parent part or model application), which conventionally occurs frequently, now have an occurrence rate nearly 0.

It is also possible to centrally manage data flow from drawing release through distribution. In line with this, the engineering change process can be efficiently carried out as a re-configuration process. Fig. 15 compares EC data reception time for an engineering change, with the conventional system and with NEWS. In comparison with conventional system processing, with NEWS, work is simplified and at a faster speed, resulting in a 40% or more improvement in work time.

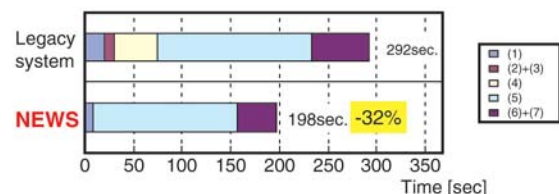
4.3. System Capacity Improvement

As explained in the previous section, with NEWS, a system was created that can handle an increase in the number of product variations.

In addition, with parallel devices, etc., system stability can be maintained.



(a)



(b)

Fig. 14 Work flow on drawing release process

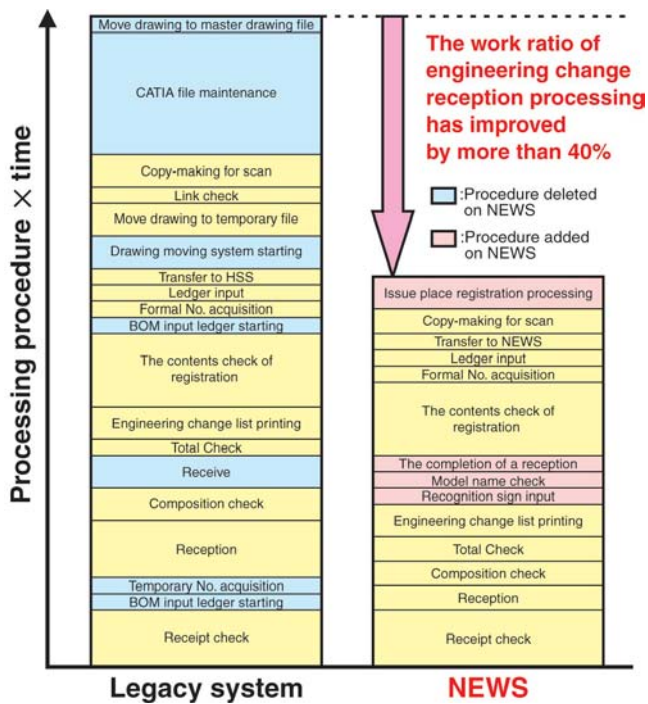


Fig. 15 Comparison of the throughput of NEWS and a legacy system

4.4. Ease of System Linking

In terms of linking with other systems, the NEWS part data is linked with the new cost system that automatically calculates, manages, and totals costs of parts for one vehicle. With this, it is possible to reduce the labor required for verification table input work.

5. Summary and Future Development

By creating NEWS that integrates the conventional BOM and related systems, and makes possible integrated management of vehicle parts basic information, improved drawing release processing efficiency, and links with other systems, the following results were achieved.

- (1) The introduction of an option part-application search function and an joint list make it possible to completely manage basic product information such as frame, engine and emission associations, etc., in addition to information on all vehicle models and all variations.
- (2) By integrating the drawing release and drawing distribution functions, drawing data can be centrally managed. In addition, by simplifying the work procedure, engineering change work efficiency is improved.
- (3) Problems due to limitations in the number of variations that can be processed for one model or in the number of part numbers were eliminated, and the system was created that can handle an increase in data. In addition, by doubling up each domain in terms of hardware, the system will not completely stop even if there is a failure.
- (4) As in the example of linking with the cost system, it is possible to see the benefits of easy linking with other systems and a reduction in processing labor.

In the future, with the adoption of XML, the communication method will evolve and system performance will improve. In addition, looking toward further integration of other development technological information, there will be

strengthening of links with layout information management and application to verifications using DMU (Digital Mock Up). With these measures, it is possible to shorten the verification preparation period and reduce labor. In addition, by sharing, in real time, layout information before drawing release, it is possible to greatly contribute to completed vehicle quality enhancements and a short development cycle. Working towards expanded information sharing with manufacturing, studies will be made into system creation and data construction for data that is not yet handled by NEWS, such as color charts and mass production package style, etc.

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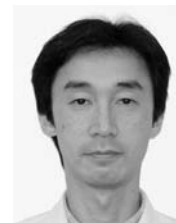
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