
Development of Lifecycle Management System for Racing Parts

Hidetada TANIGUCHI*
Shigeo MIYAJIMA*

Katsunori TAGUCHI*
Osamu WATANABE**

Masataka NODA*

ABSTRACT

In racing operations, parts development and supply must be constantly reviewed in a short time with regards to changing circumstances in order to simultaneously promote upgrading and supplying of parts with the aim of maintaining competitiveness relative to other teams. For this reason, a part lifecycle management system was constructed to increase development speed and effectively utilize resources. This system aimed for centralized management of part plans and results data for all stages, from investigation of part design specifications to drawing issue, production plans, arrangement and purchasing, procurement and manufacturing, receiving inspection, inventory control, assembly, usage history, and disposal. Centralized data management enabled instant sharing of information across the Racing Division, and provided prospects for creating an environment that enables accurate and prompt decision making even at racing sites.

1. Introduction

The Racing Division of Honda's Automobile R&D Center (Tochigi) developed, assembled and supplied engines, developed advanced chassis technologies, and also developed and supplied internal gears and gear shifting parts for the gear box to the Honda Racing Formula One Team (HRF1). Engines were also assembled and supplied by Honda Racing Development Ltd. (HRD) in England, and in addition to parts development and supply to race sites from Tochigi, locally procured parts were supplied from HRD.

In racing operations, development speed is demanded to maintain competitiveness, and this assumes a unique operations flow (Fig. 1). Parts with multiple specifications are constantly designed, arranged and tested, then just before assembly the test results are reviewed to select the optimum specifications from among the current inventory and parts scheduled for delivery, and the selected parts are assembled into products and supplied. In addition, arrangements must be made concurrently for development parts and racing supply parts, and assembly specifications also change frequently. This means that a diverse and large volume of inventory is essential in securing a constant stock of parts that might be used.

Assembly specifications and inventory conditions change constantly, including support for races that are held every other week, and it is also necessary to accurately record part assembly results and usage

histories to provide feedback on trouble information. Parts shifting and plan changes based on tests and race results also had to be shared between Tochigi and HRD, so speed and accuracy of information were also demanded.

In addition, the recent application of regulations limiting engine usage had tended to increase the need to manage parts with the same part number by quality rank, and to perform individual part lifecycle management.

The system constructed for production car development operations was also used to manage racing parts until recently, but no fundamental changes had been made to suit the environmental changes and operation contents unique to racing operations.

In the operational flow of production car development, the prototype assembly specifications and assembly schedule are determined, and then the parts resources needed for assembly are secured before purchasing (Fig. 2). For this reason, the constructed conventional system lacked the flexibility required by racing operations, and constantly changing information could not be accurately reflected.

To overcome this issue, the information needed by each department was provided separately using other system ledgers and tools, and had to be collated manually based on experience or by using large numbers of people. In addition, when the need for coordination arose between Japan and England, which are separated by both physical distance and time difference, atypical

* Automobile R&D Center

** FUJITSU LIMITED

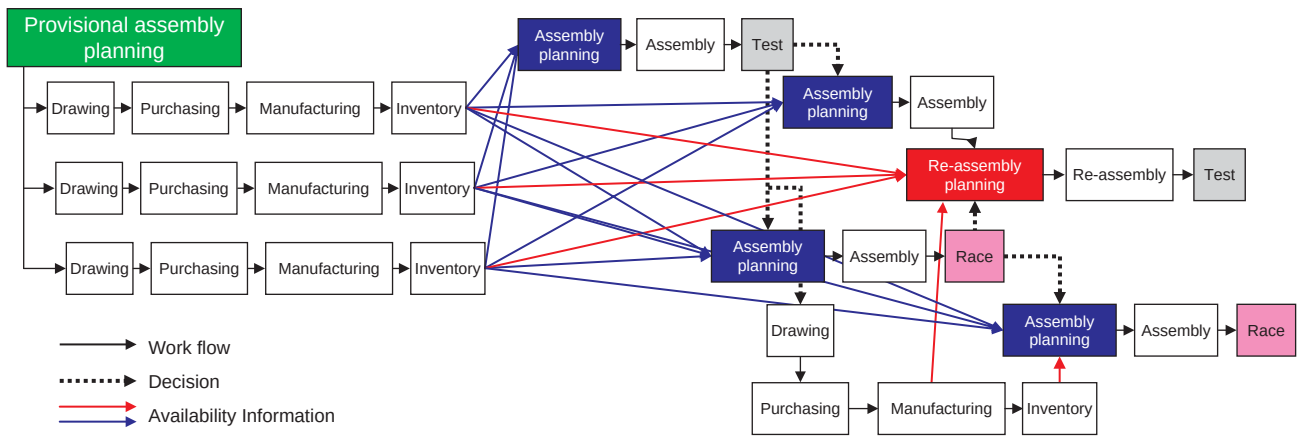


Fig. 1 Racing operations

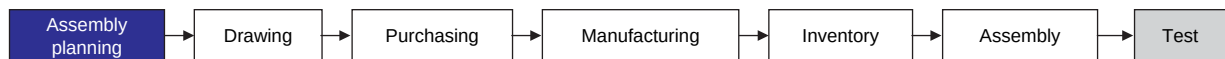


Fig. 2 Production car development

and detailed exchanges via telephone or e-mail consumed much time and manpower.

As a result of the above, it was sometimes difficult to make optimum decisions promptly, finding replacements for lacking parts took time and effort, and excess inventory sometimes occurred, all of which were factors hindering the effective use of development resources.

2. Development Policy

The newly developed system aimed to share accurate parts management information to enable the timely and accurate decisions needed for racing operations. In addition, construction of an environment enabling the maximum utilization of development resources was also expected as a result.

To achieve this, the target was set as centralized management of constantly up-to-date plans and results for all stages, from the investigation of part design specifications to drawing issue, production plans, arrangement and purchasing, procurement and manufacturing, receiving inspection, inventory control, assembly, usage history, and disposal.

The specific development indexes were determined as follows.

- (1) Faster verification of assembly plan feasibility
- (2) Increased purchase order speed
- (3) Enhanced parts management information

Construction of the new system required that the operations flow be restructured, so members selected from all related departments thoroughly verified the work flow, and reviewed operational roles to achieve the optimum overall balance.

Due to the nature of racing operations, speed and flexibility are demanded, so the division between contents that should be decided by humans and areas that can be left to the system was thoroughly discussed, and

the specifications were determined.

In addition, measures were taken to promote accuracy and maintain up-to-date information, including systems that provide tangible effects, such as letting not only people make decisions based on centrally managed information, but also letting people in charge of entering information view the necessary information.

An advance project was commenced in Spring 2006, and work began to understand the current status of all operational issues involving racing parts management at Tochigi. Based on these results, operational roles were redefined starting from Spring 2007, and construction of the new system began from the start of 2008.

3. Function for Verifying Assembly Plan Feasibility

An integrated system was constructed that links and verifies the control number (unit number) information assigned to each assembled product (A), assembly schedule (B), assembly part configuration sheet (C), arrangement, purchasing and delivery information for each part (D), inventory information (E), assembly results (F), and usage history (G) (Fig. 3).

The system uses alert displays to automatically indicate which part impedes the assembly flow when the assembly plan for each unit number is changed, and all related persons can share information instantly. This lets people make comprehensive judgments regarding responses to various issues, and these decision results are reflected to the system, enabling the latest plan information to be shared.

The individual functions that comprise this system are described below.

3.1. Assembly Part Configuration Management for Each Completed Product

An assembly part configuration sheet function was

developed as a core function for verifying plan feasibility. This function was created by extracting the plan management know-how accumulated by the Racing Division, and managed the parts configuration for each completed product. This function generates the original data that is the basis for instructions to all subsequent processes, and features the ability to change the configuration even after parts are purchased and manufacturing starts.

Assembly part configuration management for each unit number was achieved by linking data such as noted below (Fig. 4).

(1) Registration of parts by each specification

Multiple specifications are defined for each function unit, and the components used in each specification are registered. This enabled the selection and use of arbitrary parts (selected parts) from among multiple types.

(2) Registration of specifications applied to unit numbers

The combination of specifications to be applied to each function unit is registered for each unit number.

(3) Assembly part configuration sheet

The data from (1) and (2) above are linked to create a list of all parts required to assemble each unit number.

3.2. Delivery Management of Purchased Parts

Functions enabling the swift provision of delivery date information were strengthened based on split delivery and delivery date changes according to the supply capability of suppliers, which is common in racing operations.

(1) Multiple delivery date response management

The system that links suppliers and purchase order information was modified and a function was developed so that multiple delivery date responses can be registered

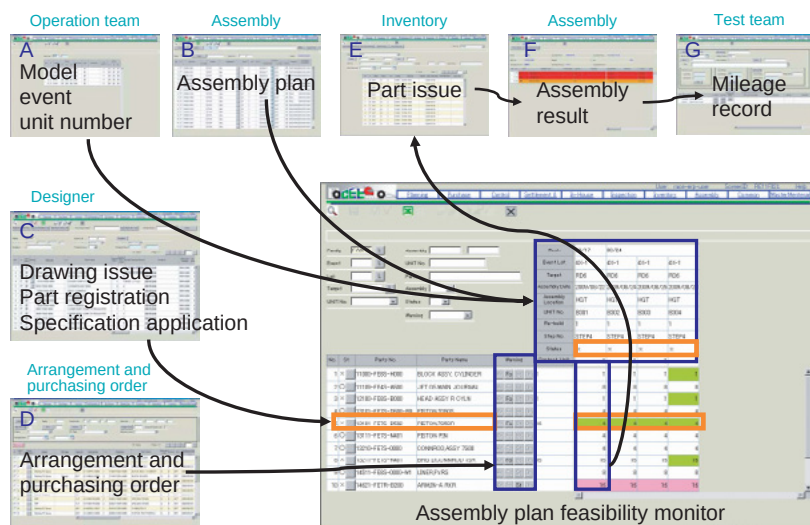


Fig. 3 Assembly plan feasibility monitoring

Part registration for specifications

Part	Quantity	Common	Piston				Funnel	
			L1	N5	M	S		
A	4		○					
B	3	○						
C	2			○				
D	2				○			
X	1	○						
E1	4	○						
E2	4					○		
F1	4							○
F2	4	○						

Specification application for unit No.

Region	Round1		Bench
	R001	R002	
Quantity	1	1	5
Piston			
L1	○	○	10
N5		○	20
Funnel			
M		○	10
S	△		10
memo			

Assembly part configuration sheet

		Assembly date	2007 06/01	2007 06/02	2007 06/10	Quantity
		Unit No.	R001	R002	Performance	
Part	Quantity					
Piston L1	A	4	4		10	14
Piston N5	B	2		2	20	22
	D			2		2
Common	C	3	2	2		4
Common	X	1	1	1	5	7
Common	E1	4	4	4	20	28
Funnel M	E2	4		4	10	14
Funnel S	F1	4	4		10	14
Common	F2	4	4	4	20	28

Fig. 4 Assembly part configuration sheet

for a single purchase order.

(2) Confirmation of delivery date response statuses

Various supplier delivery schedule statuses can be confirmed, such as delivery date responses not yet received, delivery date delay responses, or changes to delivery date responses. In addition, information concerning delivery dates (fixed delivery dates) agreed upon between the person making the purchasing order and the supplier can be shared.

3.3. Process Progress Management for Manufactured Products

When manufactured parts are completed by machining materials that pass between the in-house Manufacturing Division and multiple suppliers, unfinished parts may be transferred directly between suppliers to shorten the schedule. Process progress management formerly relied on the experience of the person in charge, and was performed by understanding the status of only representative priority management parts. Therefore, management was systematized and the following functions were developed to increase information accuracy and enable the sharing of information.

(1) Process progress management

Process design and machining process schedules and results can be displayed for all parts.

(2) Understanding progress using receipts

Unfinished parts do not necessarily move in purchasing order units. Therefore, progress status was understood by creating receipts and loading the receipt information to the system when unfinished parts are received by the next process.

3.4. Reserves Used to Calculate Arranged Quantities

To calculate the proper amount of parts required (arranged quantity) amidst frequently changing circumstances, it is necessary to compare the quantity required by the assembly plan with the quantity remaining to be ordered, current inventory, the quantity scheduled for assembly, and other factors. Therefore, a reserves function was developed to obtain the proper arranged quantity.

First, the free inventory is obtained using Eq. (1) (Fig. 5).

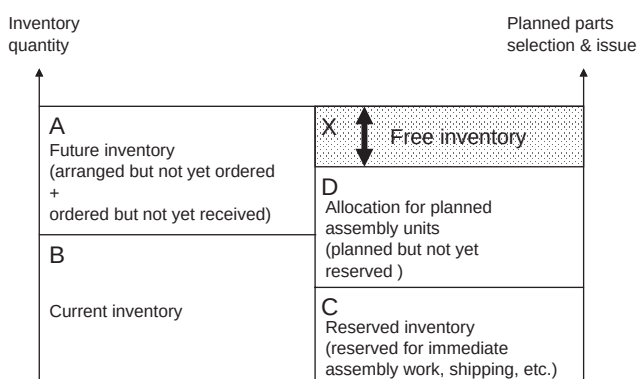


Fig. 5 Free inventory

$$X=(B+A)-C-D \quad (1)$$

X: Free inventory

B: Current inventory in parts warehouse

A: Future inventory (Sum of quantity arranged but not yet ordered and quantity ordered but not yet received)

C: Reserved inventory (Quantity ready and awaiting issue from inventory)

D: Allocation for planned unit numbers not yet reserved (Quantity required by unit number plans but not yet reserved for issue from inventory)

The final arranged quantity can be determined by experienced personnel by taking into account irregular factors such as the feasibility of reusing old parts based on the shared part management information described hereafter, and the number of race events remaining in the season, and then adjusting the quantity with respect to the free inventory obtained in the manner described above. This enabled more accurate arrangements.

3.5. Inventory Sorting

Labels noting the unit number information based on the assembly plan at the time of purchasing order placement were formerly affixed to parts, but this was not useful for racing part management in which assembly plans undergo frequent changes. Therefore, an inventory sorting function was developed to increase the sorting speed and accuracy.

This function automatically creates prioritized sorting proposals for available inventory based on the latest assembly parts configuration sheets, assembly dates, unit number purposes, applied specifications, and quality rank. Humans then make a comprehensive decision to determine the final sorting destination. This enabled highly flexible operation.

4. Purchasing Order Related Functions

Various pieces of information are required when ordering parts, and the links between this information affect the actual speed required to place purchasing orders. The speed required to place purchasing orders was increased by strengthening and enhancing the functions and processes described below.

4.1. Information Entry Prior to Drawing Issue

In the conventional system, determination of the arranged quantity, supplier, tentative price and other purchasing order operations were performed successively after drawing registration (hereafter, "drawing issue"). Centralizing information enabled more accurate advance information to be shared, which made it possible for these operations to proceed concurrently prior to drawing issue (Fig. 6).

(1) Registration of drawing issue schedule

Various pieces of information concerning parts scheduled for drawing issue are managed. The scheduled drawing issue date, material quality, base parts and other information that affects purchasing orders is entered.

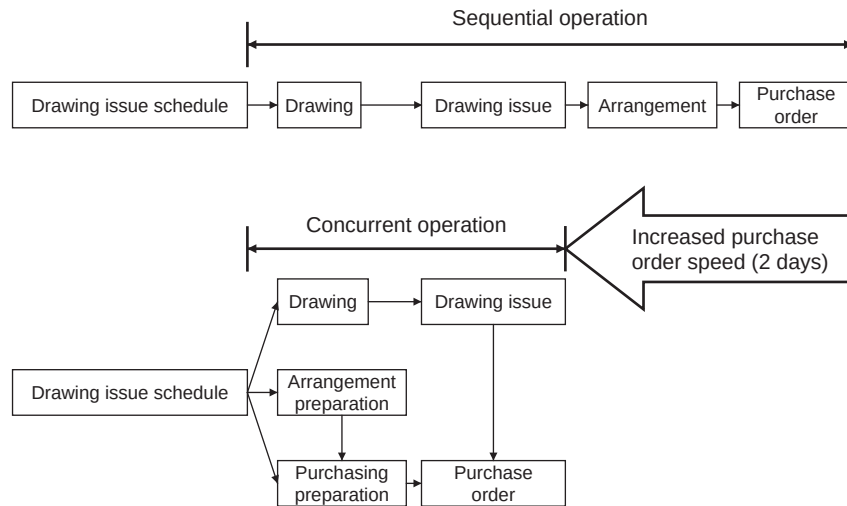


Fig. 6 Revised process of purchasing

Coordination issues are prevented by enabling part numbers to be entered only from the drawing issue schedule, which is the initial source of information, and then sharing that information with subsequent drawings creation and issue.

(2) Arrangement preparation

Information on the arranged quantity based on the assembly plan, and the department requiring the parts, is entered.

(3) Purchasing preparation

Suppliers and procurement methods for supplies are investigated based on the drawing issue schedule information, and the results are entered.

4.2. Enhancement of Drawing Issue Process

In the conventional drawing issue process, information sometimes stalled partway through the information transfer and other processes that relied on paper-based approval and distribution. In contrast, the newly developed system enabled instantaneous information transfer using the following functions.

(1) Compatibility check when issuing drawings

The conventional system had a downstream process whereby drawings were checked and revised by humans, but the check function was strengthened so that part configuration and part history compatibility checks can be completed in the drawing issue stage.

(2) Specification change notices

Specification change notices can be automatically created by extracting data from the drawing issue schedules and advance information.

(3) Issue of specification change notice numbers

Specification change notice numbers are issued immediately after a drawing issue is approved in order to strengthen compatibility check functions when drawings are issued.

5. Enhanced Parts Management Information

5.1. Inventory Control

Separate ledgers kept outside the system thus far and

information managed by other systems without data links were integrated to realize the following functions.

(1) Individual part management

Individual part management was enabled by assigning a unique ID number to each part during the receiving inspection, and printing or laser-marking a 2D barcode on the label or directly on the part.

(2) Management by quality rank

This function enabled better inventory control by ranking parts based on actual measurement results, and grouping parts into ranks.

(3) Reserved and allocated inventory part list

This corresponds to C + D in Eq. (1), and is a list of existing parts not yet issued from the inventory, from among the parts required for assembly of each unit number according to the assembly part configuration sheet. When a design change occurs, it is automatically reflected in this reserved and allocated inventory part list.

(4) Usage history management

Managing the part usage history enabled a more detailed understanding of part replacement periods based on lifecycle.

(5) Management of inventory outside the part management warehouse

Total part quantities and locations can be clarified by centrally managing the storage location and inventory in each department, from the time parts are issued from the part management warehouse until the parts are discarded.

(6) Management by assembly and unit number

Parts can be managed not only by part number, but also by the arbitrary groupings of assembly and unit numbers, which are used during storage and transfer (Fig. 7).

5.2. Assembly Results Management

Part assembly results were formerly managed by a separate system that is not linked with the inventory control system, and entering the results took time. However, the newly developed system enabled accurate recording in a short time. Engines in particular are composed of approximately 1000 parts, so methods were devised to efficiently and accurately record the results for each unit.

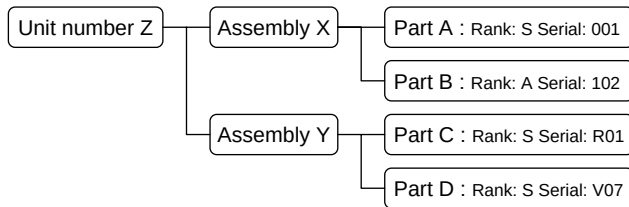


Fig. 7 Unit number and assembly

(1) Increased assembly results in entry efficiency

The new system enabled quick and accurate entry of assembly results in a semi-automatic manner instead of manually, by scanning a 2D barcode of the individual part ID number. In addition, automatic carryover of inventory issue information for each part prevented entry errors and at the same time reduced the data entry workload.

(2) Easier assembly results verification

Assembly part configuration sheets and assembly results can be compared, enabling instant understanding of differences and easy comparison of different assembly results.

(3) Link with manufacturing quality information

Serial number information is received from a separate system that manages manufacturing quality information, and linked with individual part ID numbers. This enabled detailed information on manufacturing quality to be referenced from the assembly results.

6. System Application Technologies

The new system is not a customization of a commercially available package, but was constructed through dedicated development in consideration of maintainability, expandability and feasibility of the requirements unique to racing operations such as described thus far.

When developing a system, the policies and goals of systemization must be commonly held, or individuals will devise arbitrary requirements, making unification of specifications difficult. Conversely, excessive standardization may affect ease of use. An open application framework was used as the base for the system, but feasibility of operations was given priority, and construction aimed for a balance between standardization and individuality.

The technical contents applied to each level are described below.

6.1. Approach towards User Interface

Basic window configuration patterns such as search and lists were provided for the user interface, but the layout of each window was investigated thoroughly together with users to realize demands for operability that differs for each operation. As a result, the following window configuration patterns were created to match individual requests.

(1) Monitor panel type

The assembly plan feasibility verification window shown in Fig. 8 displays the arrangement status for each

part in unit number units, and enabled identification of up to eight different color-coded alerts for easy understanding of the status at a single glance. In addition, the layout provides launch buttons for each part to enable the necessary measures to be taken according to the alert type.

(2) Operation intensive type

The purchasing order information creation window is used constantly, so all necessary operations should be realized in a single window. Therefore, the layout was divided into three areas, with basic information displayed in the upper part, and the purchasing order form and

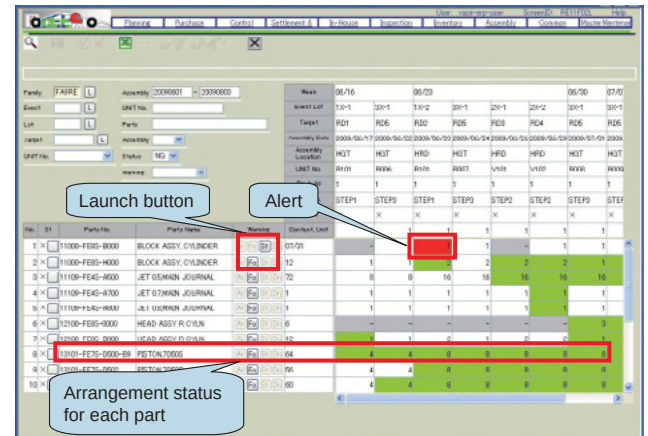


Fig. 8 Assembly plan feasibility monitor

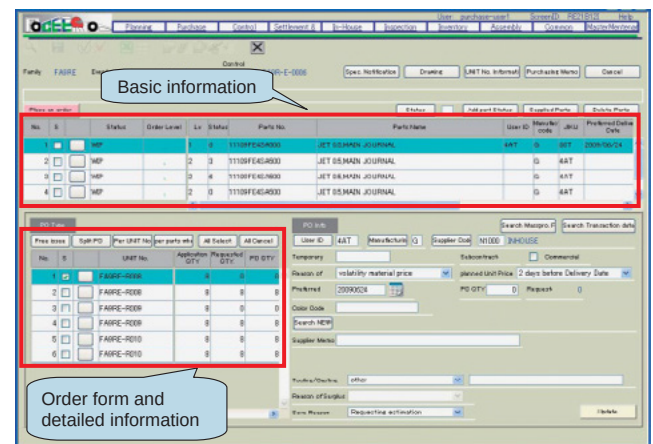


Fig. 9 Purchase order entry

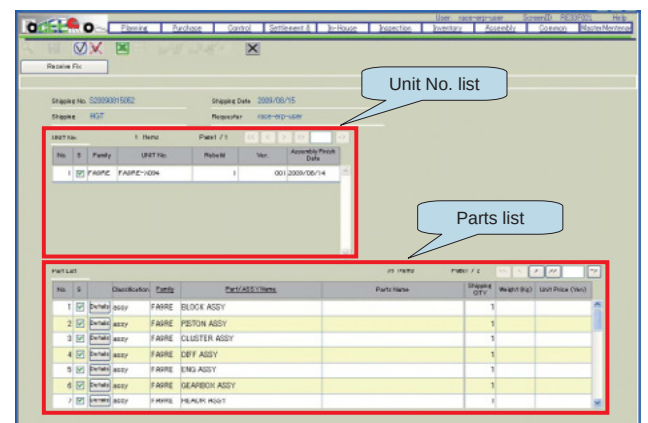


Fig. 10 Receiving confirmation

Table 1 Common functions

	Common functions	Explanation	Usage pattern
a. Display	- Table column customization - Structure expansion - Memo	Enable each user's preferred display, structure and additional information	Sorting or selecting data on user's demand
b. Multi location	- Multi language - Multi location	Switch displayed language for menus, drop-down lists, etc.	Usable by multiple offices, both domestic and overseas
c. External interface	- Excel input - Excel output	Bulk operation by using a spreadsheet is possible.	Mass data inputs and outputs essential for fast operations
d. Security	- Menu privilege - Data privilege	Can be set for each user based on their role and screen mode	Privileges control based on department and/or title

detailed information displayed in the lower part of the window (Fig. 9).

(3) Simultaneous list display type

Both the unit number list and the parts list must be checked at the same time, so two areas with separate page switching control were implemented in the upper and lower parts of the receiving confirmation window shown in Fig. 10.

6.2. Common Function Technologies

Common functions were split from the operations logic and implemented on the framework to increase user convenience and system development efficiency. Frequently-used functions were made into common functions that could be accessed from any window, and this enabled system developers to focus on the operations' logic design, which increased both quality

and development efficiency. Table 1 summarizes the common function technologies applied from the viewpoints of (a) display, (b) multi location, (c) external interface, and (d) security.

6.3. Approach towards Data Model

The data model did not use the data structure of the conventional system, and was instead newly designed to realize centralized management of information. Design departments create design drawings and part configurations in part number units, but the basic information unit for ordering departments is the purchasing order form. In addition, after parts are received, important parts must be identified and managed individually. Therefore, a database was constructed that links the assembly part configurations, purchasing order forms, and individual parts handled by each department

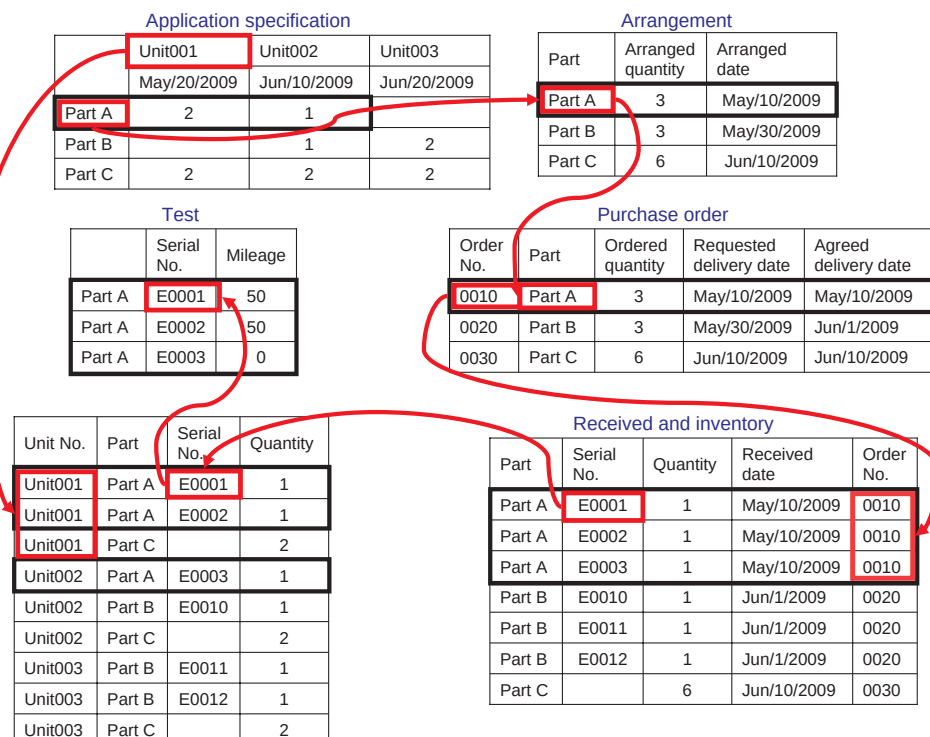


Fig. 11 Data model

in terms of arranged quantity, received quantity, and assembly results (Fig. 11). This enabled each department to handle information in the units suited to the operations performed by that department, and organically linking these units of information enabled information spanning the entire part lifecycle to be instantly understood.

7. Confirmation of the Effects of System Application

The decision to withdraw from Formula One was made immediately prior to application of this system, and the system has not been used for actual operations. However, the system was still completed and integrated tests were conducted. The results confirmed that each department could carry out operations under an environment in which all data related to part manufacturing and supply was centrally managed, and that timely and accurate decisions could be made, which was the goal of development.

7.1. Faster Verification of Assembly Plan Feasibility

Formerly, the feasibility of the overall assembly plan first became apparent when persons in each department compared the information held separately by each department. This made a process to investigate countermeasures essential, and checking the location of a quantity of specific parts for this sometimes took as much as two days. However, this system enabled instant identification and information sharing for the part which impedes the assembly flow. In addition, the latest information is centralized and can be easily referenced, which is thought to enable swift decisions even when coordinating between Japan and England.

7.2. Increased Purchase Order Speed

Accurate advance information enabled advance preparations to proceed concurrently, which together with enhancements to the drawing issue process, shortened the time required from drawing issue to place a purchase order by two days. In addition, centralization of information can also be expected to prevent confusion and duplicate work due to differences in information.

7.3. Enhanced Parts Management Information

Inventory control from the time parts are entered into the inventory until disposal can be performed not only in part number units, but also by individual parts themselves, assembly, unit number, or quality rank. This enabled an accurate understanding of inventory quantities as well as measures for part excesses and shortages according to the application. In addition, understanding part replacement periods based on individual part usage history information can also be expected to help understand the part quantities required and achieve proper inventory levels.

Assembly results records up to and including actual work such as at a racing circuit can also be shared in real time, simplifying the process of checking which of the selected parts have actually been used. In addition,

links with a separate system that manages manufacturing quality information enabled swift and accurate decisions to be made regarding defective parts and whether to exclude parts from the same manufacturing lot.

8. Conclusion

As of 2006, HRF1 was already collectively managing racing sites and factories for non-engine parts, using the part usage history management function and 2D barcodes with an originally developed system based on commercially available software known as the ERP (Enterprise Resource Planning) Package. The starting point for this system development project was the finding that HRF1 was able to respond immediately to inquiries from Tochigi regarding gear box parts, exhaust pipes, and other parts.

Centralizing part lifecycle management required wide-ranging investigations and reviews to optimize overall operations. Approximately 3 years were needed from the start of advance investigations in 2006, but the know-how generously provided by HRF1, thorough discussions by project members involved, and the clear sharing of goals and targets across the Racing Division enabled completion of the system.

This system was designed for direct application to both Tochigi and HRD, and aimed for centralized management of engine parts. This system was not applied directly to HRF1, but preparations were underway to enable links with chassis part and gear box part information, such as a part number read-as function and measures to avoid duplication of key management numbers, to enable future links with existing HRF1 systems.

The indexes of “faster plan feasibility verification, increased purchase order speed, and enhanced part management information” are themes that are also constantly pursued in the development of mass production cars. Application of this system to the development of production cars will be investigated in the future.

■ Author ■



Hidetada TANIGUCHI



Katsunori TAGUCHI



Masataka NODA



Shigeo MIYAJIMA



Osamu WATANABE