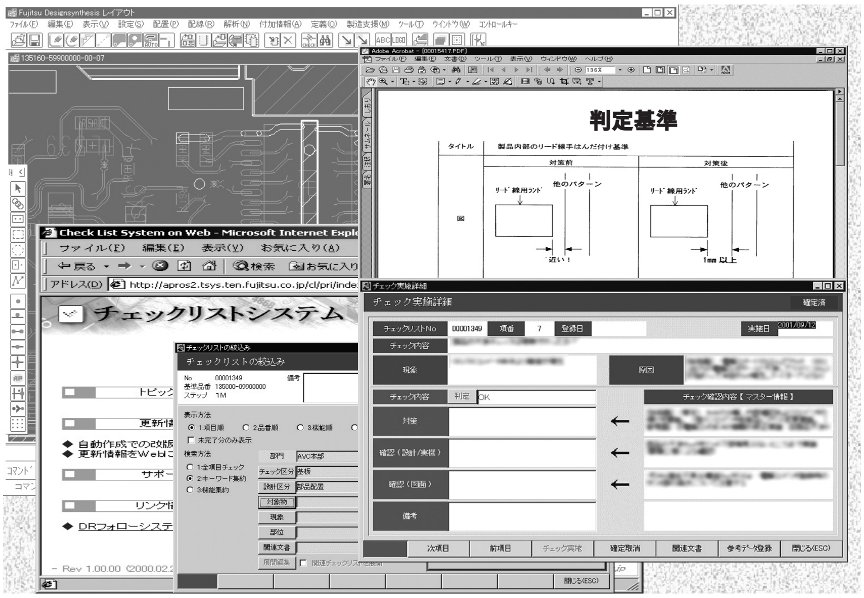
Quality Checklist System

Takeshi Moriyama
Kazutaka Yamaguchi



Abstract

One of the most frequently used phrases in modern information strategy is "knowledge management". We are introducing knowledge management in our design reviews, to help personnel at the working level ensure the quality of a product in the design stage as early as possible and prevent quality concerns.

The Quality Checklist System we have developed is not merely an electronic checklist. It is a solution for the tradeoff requirement inherent in a checklist system, "checking as many items as possible with greater efficiency".

The system allows us to automatically prepare an adequate amount of items for a checklist for each product at the design concept stage, and provides engineers with optimum check items as well as reference information for quality judgment at every point of the design process. Thus, our design check operations have improved in efficiency and reliability.

The text here introduces the functions and effects of the Quality Checklist System, mainly discussing our focus on problem-solving in the development of the system.

1 Introduction

The 21st century is an age of knowledge. Under such circumstances, "Intelligence sharing" by utilization of IT (information technology) is the most critical factor for a company to enhance its business power. Every company is now striving to computerize its employees' individual know-how and the accumulated data of the past experiments so that every relevant member in the company can access the necessary information. These approaches are called "knowledge management".

However, successful knowledge management requires solutions of the following two inherent problems.

One is the problem of input efficiency. Individual know-how and knowledge (implicit knowledge), before being registered in a computer system, must be transformed in a communicable form (explicit knowledge) as efficiently as possible.

The other is the problem of output efficiency. The registered information must be retrieved efficiently and applied appropriately whenever it is required.

We have implemented this knowledge management concept in our design quality control system. The result is our new Quality Checklist System (called "checklist system" internally), which helps accelerate design quality development and prevent quality concerns.

The text here describes the development of the Quality Checklist System mainly for the focus points in the problem solution as well as the system functions and effectiveness.

2 Backgrounds and intent

Figure-1 shows a model of our checklist.

The most important point for product quality is intensive and persistent consideration for quality in the design process. Any market concerns and manufacturing line problems must be thoroughly analyzed and completely solved so that no similar problems will occur in the future. Our checklists define appropriate preventive measures that can be utilized in the design stage to eliminate any possibility of concern repetition. This is an example of conversion from implicit knowledge to explicit knowledge, a key issue in knowledge management.

In other words, the checklist items for guarantee of quality are our intellectual properties organized in an explicit form, and the checklists are a demonstration of the contents of our guarantee of quality. However, this model contains a serious tradeoff. The more the checklist items are added for better quality control, the more time and effort the engineers must consume for completion of the checklists.

The Quality Checklist System is an attempt to solve this tradeoff. We have developed a system that allows engineers to check more items with greater efficiency and thus achieve the above mentioned "output efficiency".

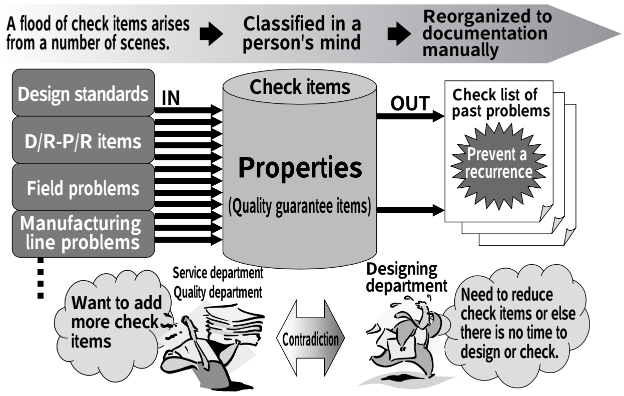


Fig.1 Conceptual model of a checklist

3 Issues for checklists

The issues included in conventional paper checklists are discussed below from three aspects: preparation, practice, and management.

3.1 Issues in preparation of checklists

In the past, the checklist sources (input) such as design standards, recurrence risk items were collected from paper documents (specifications, Engineering request forms, engineering standards, etc.) or oral information. These pieces of information were then reorganized in paper checklists. This was a time-consuming task.

Recent computerization has accelerated communication speed in the business world. For example, we share checklists on our Intranet. For our main purposes, however, computerization alone is not expect to provide enough effect. To address "more checklist items", new items must be registered promptly. To achieve "greater efficiency", any shortage or duplications must be eliminated from the checklists and the quality guarantee items must be established within the design concept stage. These are the key issues in the preparation of checklists.

Taking the above arguments into account, we have extracted the following two requirements for successful development of checklists.

①Adoption of database architecture

(Easy to modify and add check items, quick to propagate information)

②Dynamic and automatic development of a checklist for each product

(A suitable checklist for the product functions is available at the design concept stage.)

3.2 Issues in conducting a check

To conduct a quality check efficiently, the checklists should clearly define which items must be checked at which timing or which design phase.

On the other hand, in order to make the check operations more efficient and reliable, only the relevant check items should be presented to the checking personnel at each point of the design process. In addition, any human errors such as judgement dispersions across individual personnel, careless mistakes and omissions should be minimized.

Taking the above arguments into account, we have extracted the following three requirements for successful performance of the quality check.

③Check instructions optimized to the relevant design phase

(The engineer only has to check the items automatically provided at a given timing. This improves the working efficiency, optimally distributes the necessary workload over the design process, and thus reduces the heavy burden that the engineer may suffer.)

④Prompt supply of appropriate knowledge

(The engineer can easily retrieve necessary data for the check. The provided data supports his correct judgment based on clear grounds.)

⑤Automatic check function

(A computer system automatically checks some items and thus reduces the workload of the engineers and prevents human errors.)

3.3 Issues in management

The supervisors should be able to track the preparation and performance of the quality check operations on a real-time basis. Any problems should be found out easily so that they can instruct appropriate corrective actions.

Moreover, if any non-conforming items are found, they should support the working level personnel to solve the causal problems correctly.

Taking the above arguments into account, we have extracted the following two requirements as the management key points.

⑥Comprehensive management system based on real time performance monitor

(Allows the supervisors to identify the progress and result of a given check operation easily)

⑦Mechanism incorporating non-compliance problems and solutions into the comprehensive management system

(Allows the supervisors to easily identify whether a non-comforting item is surely addressed)

These 7 issues were the start point of our checklist system. The following paragraphs will provide the details of the checklist system, mainly discussing the focus points we have selected for the solution of these issues.

4 Solution in preparation of checklists

4.1 Development of checklist database

The purpose of this approach is to develop a database system with quicker and more flexible modification/registration functions to save the operator's effort. To achieve this purpose, we adopt the following important concept as our guideline.

Conventionally, system engineers were apt to adopt a process oriented approach (POA), giving the highest priority to how the specification requirements would be fulfilled. In this approach of system engineering, data is merely a supplementary object for the processes. Consequently, data duplication was likely to occur across multiple specifications and an increasing number of interface processes were required.

As an alternative to prevent such complex problems, there is the data oriented approach (DOA). In this approach, the target business data is accurately modeled and organized in an appropriate database where data duplications are eliminated. Thus, multiple application programs that have been developed individually can work together in a harmonious manner.

In DOA, systematic data identification and analysis come first instead of process considerations. This procedure is based on the theory that correctly analyzed and designed data structures are less changeable than processes.

To make the most of the benefits from the DOA concept, we have adopted a data analysis method by T character type ER figure (Note 1) for database design, as shown in Figure 2.

Note 1: Data analysis method by T-shaped ER figure
Data analysis methodology proposed by Mr. Hiromi Sato in SDI Co. Functionally improved compared to the conventional ER methodology.
The methodology consists of four basic techniques. Of them, we have chosen the technique called "comparison table". To give a brief explanation, the technique clearly defines the identities of the information resources and provides accurate relationships between the information resources.
We used this technique to develop a real time and flexible database.

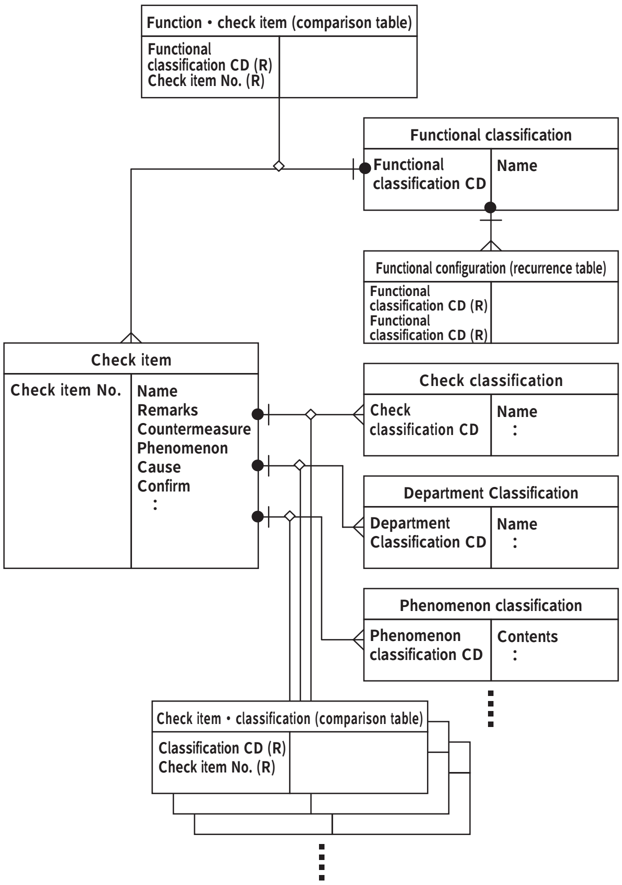


Fig.2 Check item-related T-shaped ER figure

4.2 Dynamic and automatic development of a checklist for each product

Dynamic development of a dedicated checklist for each product, with necessary check items determined from the product's functional configuration, serves as a quality guarantee list reflecting the product features and allows us to confirm the population of the quality assurance items (check items). The dedicated checklist, which is prepared in the design concept stage, will provide the targets for our quality management. Furthermore, with an automatic checklist development system, we can ensure that any one can develop a checklist with the same functionality and reliability.

To realize such an automatic checklist development system, we have placed our focus on the following points.

A: A product configuration is expressed by parent-child relationships between individual part numbers. (This is called a "parts list" in general.)

B: The product functionality, which belongs to the interim parent number of the part number (completed unit), is confirmed at the design concept stage.

C: The check items can be categorized by product functionality.

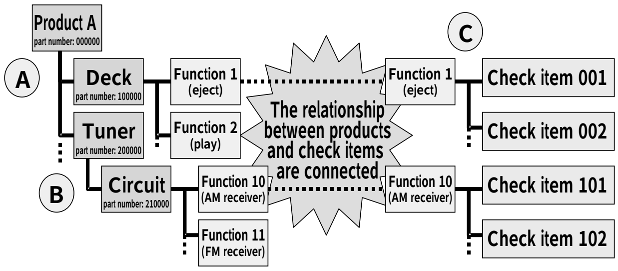


Fig.3 Part number / function / check item related figure

Figure 3 shows the correlation of these three points.

Here, the product functionality is a common keyword to identify the relationships between a product and the check items through the relations between the part numbers and the functionality. By introducing this concept, we have established a rule set required for automatic development of a product-unique checklist (automatic extraction of check items).

The automatic extraction system developed on the above rule set allows us to prepare a product-dedicated checklist with only the necessary items extracted at the time of functionality confirmation (design concept stage) (Figure 4). We have adopted the comparison table for the development of this system, as described in the previous paragraph.

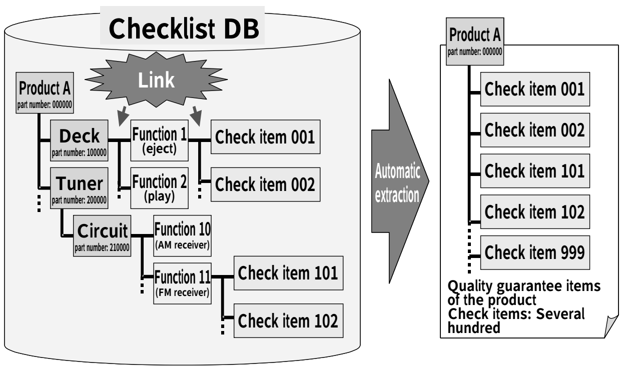


Fig.4 Automatic extraction function

5 Solution in conducting a check

5.1 Check instruction according to each engineering phase

We have developed a system that provides an optimum checklist for each engineering phase as shown in Figure 6 by associating the respective design phases to the relevant check items (Figure 5).

Because the system provides an optimum checklist for each design phase, engineers are released from the troublesome tasks of selecting appropriate check items.

To the checklists, supplementary information such as the check personnel and due date can be added. This allows us to perform task control for the check opera-

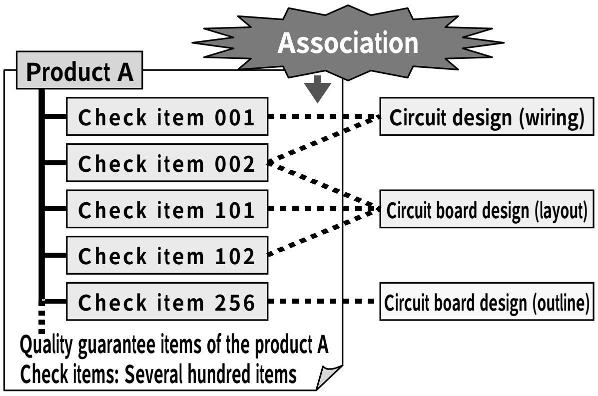


Fig.5 Check item and design process related figure

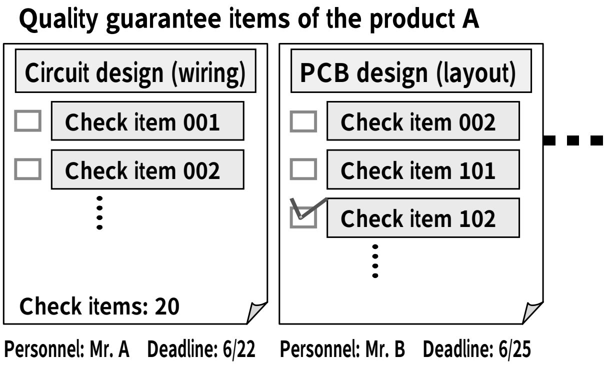


Fig.6 Checklist according to design process

tions and thus helps achieve the due date and progress management as described later.

With the automatic checklist development function and check instruction function, the system has realized one of our purposes, "more check items with greater efficiency", and provides a solution for the tradeoff. The next step for check quality improvement is to provide necessary knowledge and automate the check operations.

5.2 Provision of knowledge

We have developed a system that efficiently accumulates the necessary knowledge and allows engineers to make use of that knowledge. More specifically, the system associates the accumulated knowledge, such as past examples, technical standards, and calculation tools, with check items. When the engineer demands necessary knowledge by clicking the mouse button, the system provides all associated knowledge (Figure 7).

The system reduces judgment dispersions across different checkers and thus improves the reliability of the check results.

In the future, we will enrich the knowledge base by adding more past examples and technical standards, and evolve the current Pull type system (WANT), which provides knowledge when demanded, to a Push type

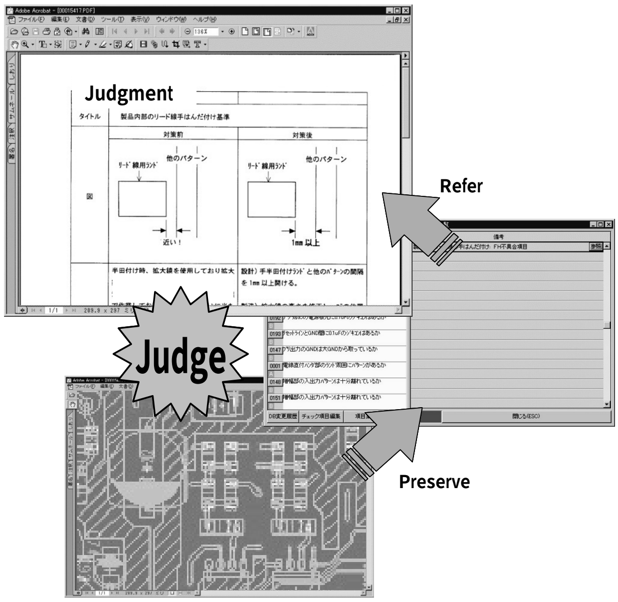


Fig.7 Reference for judgment standards and storage of results

system (MUST) that automatically offers necessary knowledge at due timing.

Another benefit of the system is to store the judgment results of each check operation in its knowledge base by linking them to the relevant check items. Thus, ongoing check operations are also utilized as referential knowledge for upcoming check operations.

5.3 Automatic check function

The knowledge base system offering relevant past examples and technical standards has improved the productivity and quality of our check operations. Further improvement can be achieved in significant reduction of workload and human errors by automating the check operations.

Our existing CAD systems and design review support systems have automatic check functions. We have utilized these functions as components of our comprehensive automatic check management system.

Once again, we have adopted the method of association. We have provided a code to each of the existing automatic check functions and established clear links between these functions and the check items (Figure 8).

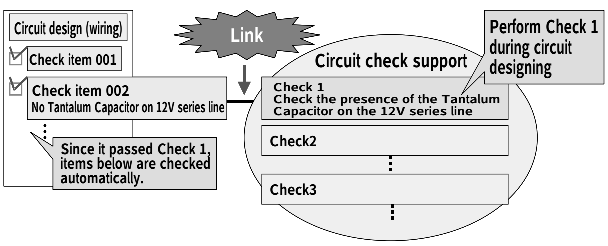


Fig.8 Automation outline figure

As a result; if the automatic check functions in the existing computer design systems are performed, the corresponding check items in the checklists are also checked without any human intervention.

This system has reduced the check workload significantly and prevents human error.

6 Solution in management

6.1 Real-time status monitor

To monitor the overall status of the checklist operations, a real-time totaling process is needed, which updates the monitor status whenever a check operation is performed.

We have developed an automatic totaling system that does not require any additional effort from the users other than routine check operations.

Fig.9 Progress total screen (matrix)

The system shows the check progress and results in numerical terms (Figure 9) and thus allows the supervisor to grasp the overall progress of the check operations easily. In addition, it provides a keyword totaling function that totals the check progress by a user-specified category such as function and design phase. This allows the supervisor to analyze the check progress from various angles as well as identify any abnormal status and take appropriate management actions.

Moreover, the system adopts a visual display system (Figure 10) for easier and quicker user operations.

Fig.10 Progress analysis screen (graph)

6.2 Sure follow-up

Non-conforming items found by the routine check operations must be followed up without failure. To meet this requirement, we have developed an additional data link function for our existing follow system. The function automatically registers non-conforming items in the follow system (Figure 11).

The function provides a smooth path from problem identification to problem solution as well as a feedback path from the follow system to the quality guarantee list system to update the overall status of the checklist operations.

The 2-way data link function enables us to perform sure follow-up for the routine checklist operations.

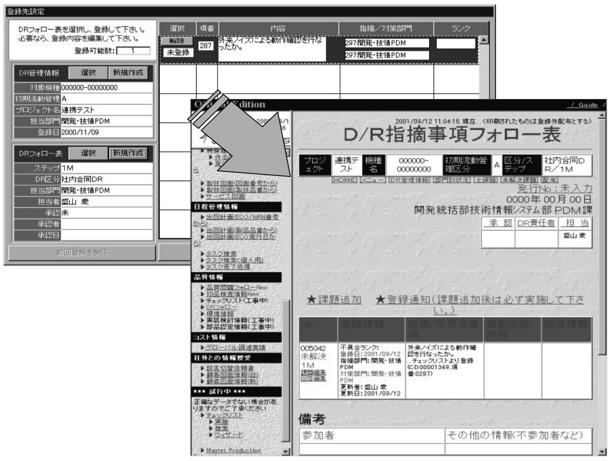


Fig.11 Automatic connection with a follow-up system

7 System configuration

The new system described above was originally installed in the user terminals (client) called "C/S type". Later, we also have introduced a Web-based system in consideration of business globalization.

The system is running concurrently with the user terminal systems and is configured as shown in Figure 12. All the functions are distributed among the clients, Web server, MRB server, application server, and database. The MRB server automatically selects a suitable process route according to a process request from the

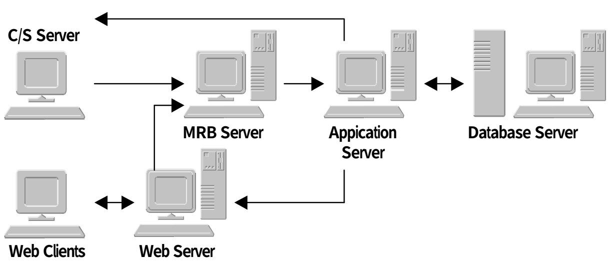


Fig.12 System configuration diagram

C/S or Web, and feeds back the required data to the request source. Both systems thus can operate in a harmonious manner.

This approach has also saved investment that might be duplicated between the C/S systems and the new Web system.

8 Summary

The system that we have developed for the purpose of "more check items with greater efficiency" provides solutions in the following areas.

①he necessary quality guarantee items (check items) and total workload are identified at the design concept stage.

②Appropriate checklists dedicated for each product are automatically provided. Thus, the workload for the checklist operations is optimized.

③The checklists can be grouped by a specified category such as design phase. This distributes the necessary workload optimally and improves the efficiency.

For the reliability of the check results,

①ppropriate knowledge is provided for each check operation, such as past examples and technical standards. This reduces judgment deviations across individual checkers.

②The automatic check function reduces the check workload significantly and eliminates human errors.

Moreover, in the area of management,

①he progress in the routine check operations is monitored on a real-time basis and any abnormal status can be found out immediately.

②Non-conforming items are followed up surely.

The Quality Checklist System has evolved beyond a mere electronic checklist. It is an integral component of our knowledge management concept.

As future technical development in knowledge management, we plan to construct a general portal site providing engineering know-how and expand automation of design check.

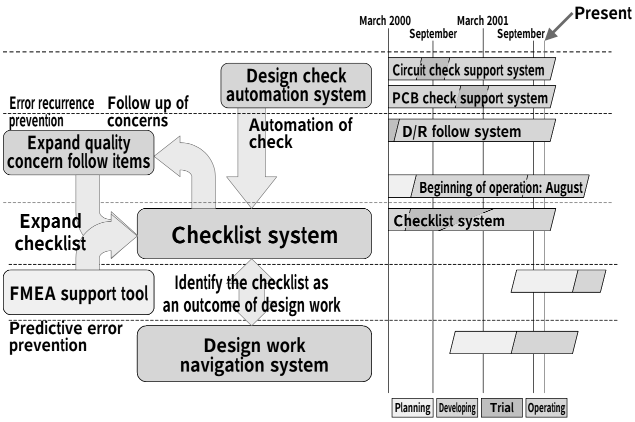


Fig.13 Future plan

For the comprehensive design support environment (Figure 13) including the Quality Checklist System, we plan to achieve further improvement in the two areas of the check item maintenance, error recurrence prevention and predictive error prevention. For the first, we are advancing the collaboration with our Quality Concern Follow System (in operation) that comprehensively manages critical concerns from the upstream design stage to the downstream market. For the latter, we are developing a collaborative link with a new design tool, the FMEA Support System (in planning).

On the other hand, to achieve better usability for engineers, we are developing an integrated design/quality control system, Design Work Navigation System (partially in test operation). It is a further improvement of the automatic checklist preparation for each design phase that we have completed, and is based on the process/outcome-oriented modeling of the entire design work.

Reference documents

1) T-shaped ER database design technique
Sato, Masami (Soft Research Center)

2) Database construction technique by RAD
Sato, Masami (Soft Research Center)

3) Article of Nikkei Newspaper about knowledge management

Profiles of Writers

Takeshi Moriyama

Joined Fujitsu TEN in 1989. Involved in the development of electronic CAD applications, and the development of technology information systems for design support. Currently in the Product Data Management Section of the Technical System Engineering Department at the Research & Development Division.

Kazutaka Yamaguchi

Joined Fujitsu TEN in 1983. Involved in the development of plant information systems, then transferred to the development of technological information systems in 1998. Currently the Manager of the Production Engineering Department of the FA System R & D Section at the Production Group, and Product Data Management Section Manager of the Technical System Engineering Department at the Research & Development Division.