［Original Paper］

Case Report on Introducing a Production Management System in Small and Medium Enterprises: JIS Bolt Production

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Abstract

In small and medium enterprises that have not fully introduced production management systems, business achievements may depend on the knowledge, skills, or habits of a specific individual. When business data and other documents are prepared in longhand or when data is decentralized, it takes time to accumulate such records. For such organizational operations of small and medium enterprises, it is clear that a production management system should be introduced for purposes of efficiency because there are many reports. On the other hand, there can be several accompanying problems: deficient knowledge on the part of the software engineer, the difficulty of using a system, and a mismatch between the business and a system. The purpose of this research is to provide useful information for small and medium enterprises that are considering production management systems. Concretely, this article describes a production management system that was jointly developed with a JIS (Japanese industrial standards) hex-head bolt manufacturer. The process is described from development to use, and the improvement in operating efficiency after its introduction is quantitatively detailed.

1 Introduction

Planning production for greater efficiency is crucial in the manufacturing industry. Therefore, high precision is necessary for managing orders, stocks, materials, and product information, as well as the state of production lines. However, in some small and medium enterprises without production management systems, operating data may be dispersed among a number of persons; consequently, the quick acquisition of desired operating data becomes difficult. Moreover, when a firm is greatly dependent on a specific authoritative and experienced person, it becomes difficult to conduct business when this person is absent. Accordingly, some computerizing of the business management and introducing a production management system based on integrated data processing are required to improve operating efficiency.

There are many reports of business improvement through introducing production management systems, and their usefulness has been described [1, 2, 3].

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Computerizing a business effectively increases two kinds of competitive power: that linked to external evaluation from the customers, such as prices and delivery times, and that relating to internal evaluation with such matters as productivity [4]. Nonetheless, other problems arise, and the following have been reported in the development, introduction, and use of a system.

(1-1) Deficient knowledge of the SE (Software Engineer)

This problem may be particularly manifest in the development phase of a system [5,6]. In relation to this problem, it was considered whether conventional systems' development techniques could compensate for the deficient knowledge of the SE [7].

(1-2) Difficulty in using the system

A software package called ERP (Enterprise Resource Planning) is an example of a development tool for a system. This kind of software is advantageous because it can be upgraded easily and can strengthen business functions. However, if not designed to accommodate the peculiarities of a specific business, the system may not be user-friendly [8,9].

(1-3) A mismatch between a business and the chosen system

The introduction of a production management system may go wrong. As one of the factors behind failure, it has been demonstrated [10] that a mismatch can occur when an organization with decentralized administration changes to a concentrated or centralized information system.

This paper introduces an example of a production management system that was developed for a small-to-medium manufacturing enterprise to avoid the problems described above.

Concretely, this paper describes a production management system jointly developed with a JIS hex-head bolt maker (henceforth written as H Inc.), whose production items change frequently each day. The entire process from development to use of the system is described and the improved operating efficiency quantitatively shown.

2 The production system of H Inc.

Makers that produce bolts for such vehicles as cars and motorcycles usually get an unofficial estimate from automakers of their annual output quantity; then the manufacturers often use a build-to-order system for production. The production system of H Inc. incorporates the ability to add urgent orders to its fundamentally make-to-stock production method. Since the bolts that H Inc. produces are JIS compliant for general circulation, neither H Inc. itself nor the direct sales trading company is able to anticipate end-user needs with complete accuracy. Therefore, it is difficult to predict when a bolt of a certain size is needed. In order to make timely deliveries, after the plan for make-to-stock production is completed, actual production accommodates urgent orders. Therefore, changes in production items arise frequently each day. Furthermore, because of competition with cheap imports, the delivery time for urgent orders is very short, usually one or two days.

With regard to introducing a new production management system at H Inc., the problems described in (1-1), (1-2), and

(1-3) arose in terms of the following points.

Because a manufacturing system for inventory reduction was under consideration at H Inc., special knowledge was required to avoid problem (1-1).

H Inc. needed a production system that could accommodate a very short lead time compared to that of other companies in the same trade. Since this point is closely related to the basis of the production system at H Inc., eliminating problem (1-2) had to be done by means of designing a system that would suit this specific business.

At H Inc., because previous documentation for the business had been paper based, it was possible that introducing a production management system could result in problem (1-3). For all of the above reasons, H Inc. was eminently suitable as a candidate introducing a system that would avoid each of these problems.

3 The development team and the design policy for the proposed system

In order to ascertain the potential problems that a manufacturing industry of small and medium scale might face in introducing a new managerial system, we investigated the existing difficulties facing H Inc. when we started the project. We found that because the SE did not really understand the business, the resulting software was not user friendly. Because of this initial lack of understanding, the software specifications had repeatedly been changed, resulting in unnecessary expenses for each change.

The results of our investigation agreed with the problems outlined in (1-1) to (1-3). Therefore, we needed to develop a careful plan for eliminating these problems as we designed the new managerial system. It was especially important for problem (1-1) to be completely solved and eliminated because of the cost involved. A five-person development team was then assembled and the design plan defined.

3.1 The development team

To avoid problems (1-1) and (1-3), the development team was composed of people having the following technical knowledge and experience.

Developer (a), a person experienced in production technology and in guaranteeing quality in a major domestic semiconductor manufacturing company, had a comprehensive knowledge of management, such as corporate management or factory management.

Developer (b) was experienced in production control in a major domestic automaker. Car production is highly dependent on small-to-medium scale subcontractors; therefore, (b) has abundant experience in instructing subcontractors on improving their production activity.

Because it was assumed that, in developing a new system, changes would be required in the H Inc. manufacturing system, the knowledge from (a) was needed for a thorough examination of the new system. The knowledge from the experience of (b) was indispensable for implementing the changes. Developer (c) was a programmer with knowledge of estimation theory because the need for optimization of scheduling was also assumed.

Developers (d) and (e) were both current employees at H Inc. In order to understand the production system of H Inc. and to uncover the problems, we had frequent meetings with (d), the senior executive director. We also obtained feedback from (e), the person in charge of scheduling production at H Inc., by introducing a prototype of the proposed system.

3.2 The design policy

If maintenance, which is frequently needed in a managerial system, cannot be performed easily, problem (1-2) arises. If packaged software is employed, the person in charge must be extremely knowledgeable about the software. If, however, the software is especially designed to suit the business, the maintenance becomes much less demanding so that any user can maintain it easily. For example, if there is a change in the master data or in the output layout of documents, a user can easily effect the change with MS-Excel or MS-Access. Therefore, we thought that system maintenance would be simplified if the system were developed using Visual Basic rather than packaged software.

Following a meeting at H Inc., four agreements were reached concerning the development of the system.

(3-1) The requirements of the proposed system

The primary demand from H Inc. was “to be able to estimate the quantity of output with high precision.”

Moreover, the proposed system needed to be able to handle frequent changes in item production. The final requirement was that “the proposed system should have a function in which the order of manufacture can be determined flexibly.”

(3-2) The development tool for the proposed system

The person who would be responsible for maintaining the proposed system after its introduction is not at H Inc.; thus, if packaged software were to be used as a systems development tool, problem (1-2) would likely arise. Therefore, a user-friendly production management system that could respond to the specific needs of H Inc. was developed using Microsoft Visual Basic as the programming language.

(3-3) Database

The database was created using Microsoft Access and controlled by Visual Basic using DAO (Data Access Object). With regard to the master data, an interface for the data updated for exclusive use was not developed; however, because MS Access is used, the data can be updated directly. A stand-alone computer was used to introduce the proposed system. Therefore, access to the database is not restricted. The data is backed up when a user periodically copies the data folder from the proposed system to a removable medium.

(3-4) The development model of the proposed system

The proposed system was developed using a spiral model. That is, the business of H Inc. was classified into six subsystems, and design and implementation were advanced in order per subsystem. This development approach meets the demands of H Inc. and, at the same time, prevents deviation from the function that the proposed system provides, thus preventing the mismatch described in problem (1-3).

4 The problems in the business flow

of H Inc.

4.1 The business flow of H Inc.

Effective display designs must provide all the necessary data in the proper sequence to carry out a task [11]. Thus, the business flow of H Inc. was first clarified.

A meeting was held at H Inc. to understand the kind and flow of operating data. The senior executive director of H Inc. explained the production system, and the office worker in charge of scheduling demonstrated how the documents are managed from the time an order is received until it is shipped. The information acquired at this meeting was arranged and the business flow of H Inc. clarified in Fig. 1.

This process can be summarized as follows:

(1) A customer order is received and the product stock checked.
(2) When the product is in stock, the order is delivered to the customer.
(3) When it is not in stock, the status of the product is checked.
(4) When the product is in progress, the date of delivery of the product is provided to the customer.
(5) When the product is not in progress, the existence of the material to produce it is checked.
(6) When the material exists, a manufacturing schedule is planned, a production order is given, and the date of delivery is processed.

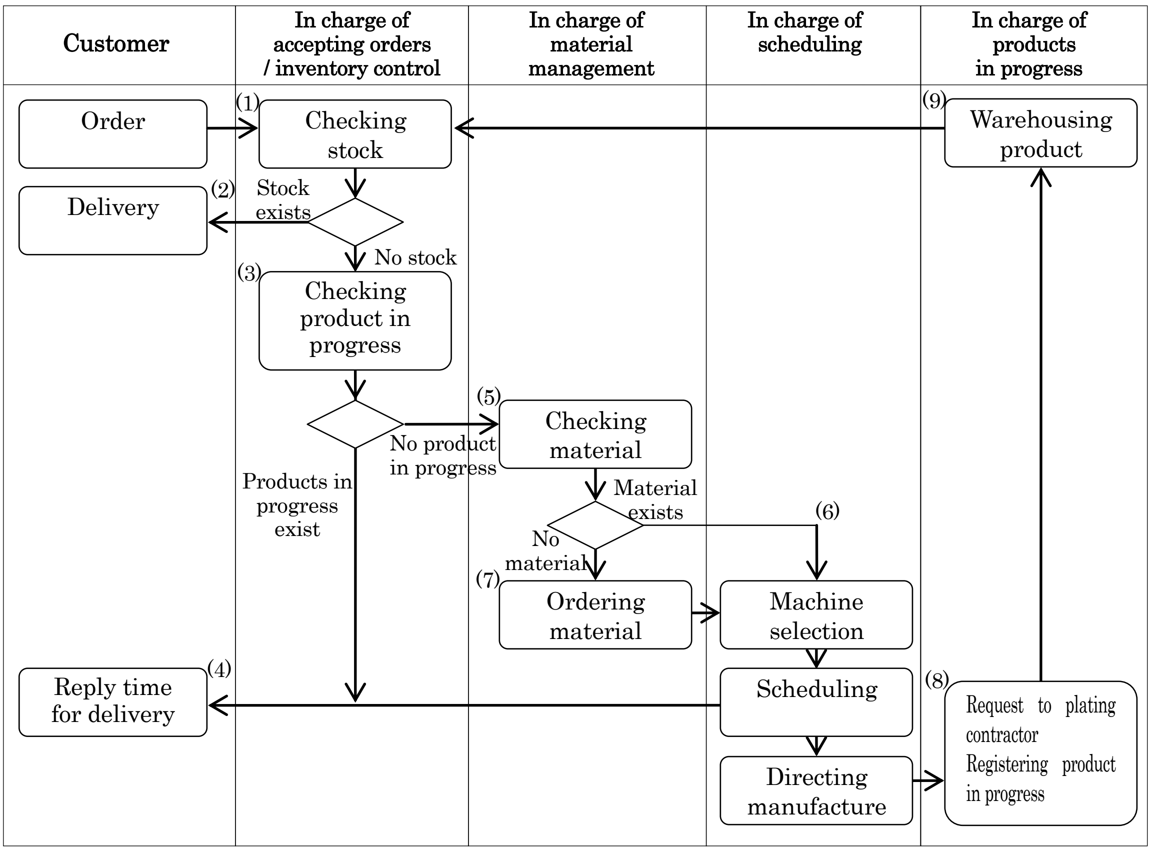

Figure 1. Business flow

(7) When no material exists, an order is sent to a material supplier.
(8) The plating processing of manufactured bolts is requested of a contractor, and those bolts are registered as products in progress.
(9) After the plating process, these bolts are stocked as products and delivered to the customer.

4.2 Problems in the business flow

In the business flow shown in Fig. 1, H Inc. had the following problems prior to the introduction of the system developed in this research.

(4-1) The stock of finished goods stagnated over a long period

Manufacturing efficiency and cost were considered top priorities in the conventional production control of H Inc. Since the number of shipped products changed sharply every month, this production method often resulted in a stagnant stock of finished goods. In one case, for example, a product requiring only a few shipments piled up over a year because of orders for manufacture that were not really needed.

(4-2) Inconsistent data

Although some of the operating data on orders, stock, materials, and scheduling were in an electronic format, they were decentralized. In addition, because many data were still managed in a paper medium, data inconsistencies might occur.

(4-3) The office wall was taken up by whiteboards

The shipping schedules of the products in progress and the warehousing schedules for completed products from the plating contractor were managed on two inefficient whiteboards (1.8 m long and 0.9 m wide), which occupied an office wall.

5 Improvement plan for the production system of H Inc.

In the meeting, the improvement of problems (4-1), (4-2), and (4-3) was discussed. In order to solve problem (4-1) with stagnant stock, the company's first demand, (3-1), had to be satisfied.

To improve problem (4-1), a precise investigation was conducted into the monthly number of product shipments. The investigation revealed that from an inventory list of about 1500 items for about 40% of the items, fewer than five cases were shipped monthly. Furthermore, fewer than ten cases were shipped monthly for about 60% of the items.

Based on this result, the company began to consider a method for reducing the finished goods inventory for those items of which fewer than ten cases were shipped monthly. It was decided to include in the proposed system the information on the products for which the number of shipments changes every season, and according to the production time and quantity shown by the proposed system, H Inc. would be able to shift to a system in which the quantity of items produced would be more strictly controlled.

The solutions for problems (4-2) and (4-3) proved to be related. It was decided to solve problem (4-2) through constructing a database for each process and linking them to each other.

A new database was created to manage the number and the completion data for products in progress and was linked with the inventory control databases. As a result, the system embodies all the data required for scheduling. Thus, it was decided to remove the two whiteboards on the office wall after implementation of the proposed system.

6 The proposed production management system

The composition of the proposed system is shown in Fig. 2. It consists of subsystems that permit controlling inventory and managing delivery times, materials, production, scheduling, and products in progress. Since the databases of these subsystems are linked, information on stock, received orders still unresolved, and stock after shipment can be simultaneously displayed, as shown in Fig. 3. At that time, for a product in which the volume of inventories after shipment is less than the safety stock quantity set up by Fig. 4, a warning system was developed whereby the inventory volume after shipment of the suitable product turns red on the display shown in Fig. 3. For example, Fig. 3 shows that 77 cases of M10 (30 mm) are in stock and 50 cases are on order. In this case, 27 cases of stock will remain after shipment. However, the numerical values are red, which is a warning that stocks are low. The safety stock quantity of this product is 80 cases, according to the display shown in Fig. 4; thus, 53 or more cases need to be manufactured. Therefore, using the information from Figs. 3 and 4 together, information can be derived that satisfies the company's number one demand (3-1).

The production control subsystem is shown in Fig. 5. In this part of the system, the user selects a product and then specifies the machine that will make it, the quantity that will be produced, and the urgency of its completion. Furthermore, when a manufacture warning for a product is shown, as in Fig. 3, the number needed for manufacture can be added here so that it exceeds the safety stock quantity. Thus, it is possible to control the quantity of production appropriately. The production order check sheet in Fig. 6 is published at the end of this process; it specifies a manufacturing machine and the quantity of the product produced on it.

In order to satisfy the latter part of demand (3-1)—that the proposed system should have a function by which the order of manufacture can be flexibly determined—it is necessary to be able to easily adjust the order of product manufacture. The schedule management subsystem shown in Fig. 7 indicates the product that must be considered for production and its priority. The production schedule of Fig. 8 is derived from setting up the order of manufacture. As in Fig. 8, the production schedule can be displayed. This part of the process thus satisfies the latter part of demand (3-1).

The management of the products in the progress subsystem shown in Fig. 9 can supervise the quantities of unfinished products in plate processing and schedule their completion. Finally, the material control subsystem shown in Fig. 10 manages the stock and schedules the arrival of material.

7 The initial effects of the proposed system

The proposed system, which was completed in 2008, is now in use at H Inc. An initial improvement report was created to demonstrate its operating effectiveness.

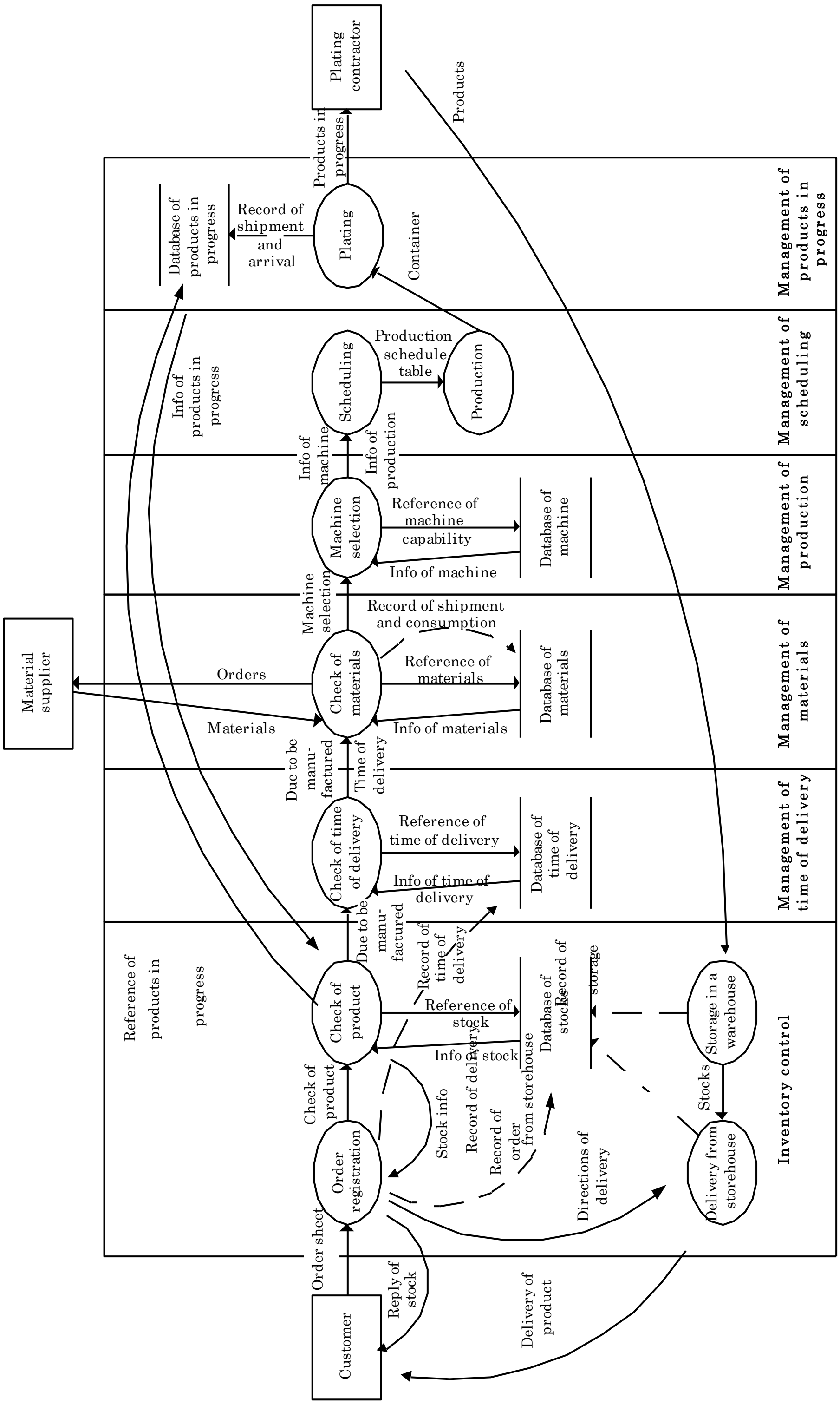

Figure 2. Production management system

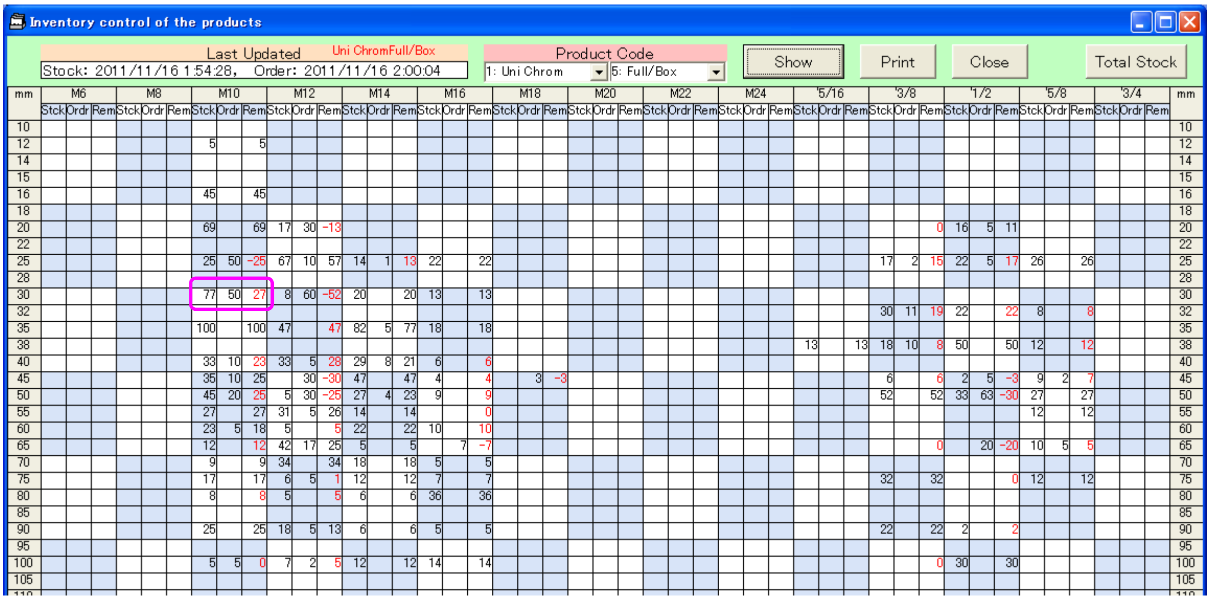

Figure 3. A comparison display of stocked products, unresolved received orders, and stocked products after shipment

The report showed that the inventory figures had been reduced by 30% and that the time for each business process had been shortened by about 2 hours each day. The details are as follows.

7.1 Inventory control of products

As shown in problem (4-1), too many products with few shipments were manufactured.

With the new manufacturing system, which was based on the proper inventory amount for every season, the manufacture of unnecessary products was stopped, and production was shifted to making only the required quantity. As a result, the total amount of stock was reduced by about 30%. In addition, with the introduction of the proposed production management system, the operating data could be managed with much greater precision. This system contributed to accurate estimates of the optimal inventory quantity based on exact data.

7.2 Management of production schedule

Prior to system installation, the production schedule data were transcribed by hand. Drawing up these documents took about 50 minutes each day because the production items, the quantity of production, machine capabilities, and their set-up/change-over times had to be investigated and recorded. The new system, with its ability to clarify the production items and their quantities, has permitted easy creation of production schedules by rearranging the production order of the items. Thus, the creation time for the documents has been reduced by about 30 minutes each day, from 50 to 20.

7.3 Production order documents

Before the system was introduced, production order documents were written by hand. Since the arrangement of the information on paper was complicated, this work had taken about 80 minutes each day. With the new system, it is unnecessary to

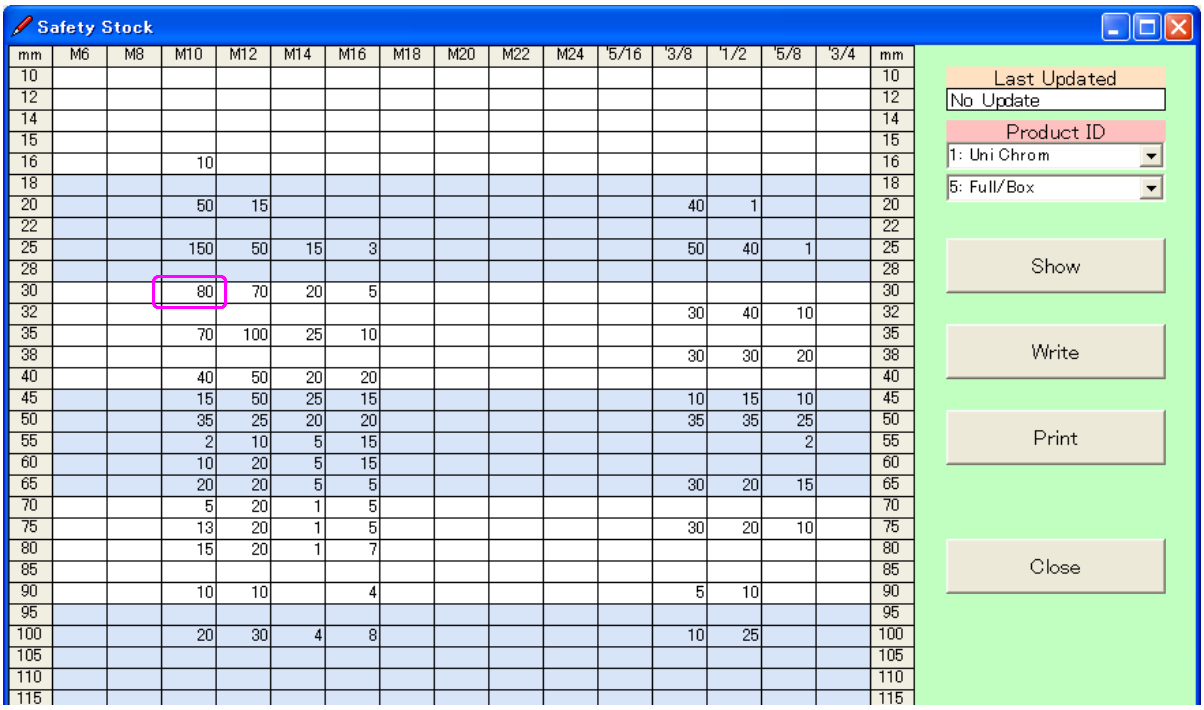

Figure 4. Setup of safety stock

search for order size information, and the time for issuing these documents has been reduced to about 20 minutes—a time savings of about an hour. Because documents are now printed, it is easier for workers to check them; thus, work efficiency has increased.

7.4 Management of products in progress

Before the system was introduced, products in progress were, as indicated, recorded by hand on two large whiteboards. Therefore, correcting writing errors and making other changes took time, and management of unfinished products had taken about 25 minutes each day. With the new system, mistakes have been eliminated and these two whiteboards have been removed. Moreover, the shipping data of products to contractors can now be easily obtained, and the administrative handling time has been reduced from 25 to about 5 minutes a day.

7.5 Management of delivery times

Since the system has made it possible to manage delivery times, stock products can be preferentially shipped to the customer who ordered first. As a result, the number of products shipped on the day the order is received has increased about 15%.

7.6 Management of material

Before the proposed system was introduced, the person in charge checked twice a week for materials in the warehouse, taking about 20 minutes each time. With the introduction of the new system, it is possible to check on material stocks and to schedule their arrival at a glance. Although the input data takes about 5 minutes each time, because the stock of materials can be seen in an instant, the time needed to count the inventory figures of materials has been shortened by about 30 minutes per week.

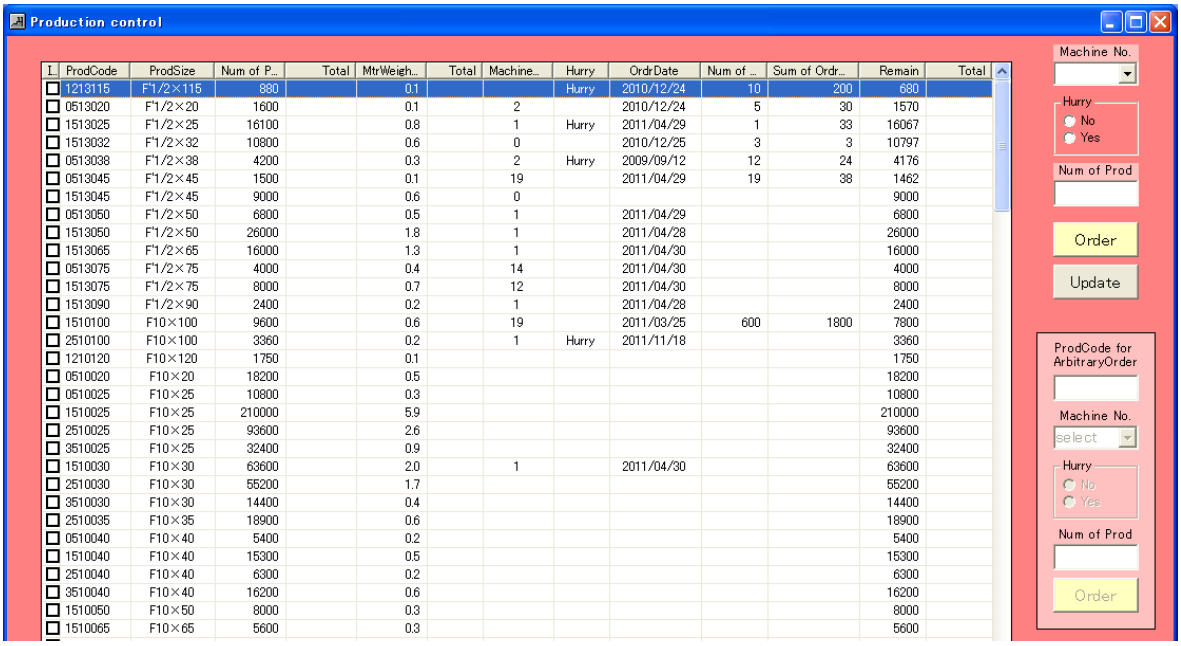

Figure 5. Production control

8 Conclusions

This article describes a production management system jointly developed with a JIS hex-head bolt manufacturer. The subsystem units were developed using a general-purpose personal computer and Visual Basic as the programming language.

The project started in 2003. Development was carried out according to the spiral model by a team of five persons. The deficient knowledge on the part of the programmer was completely covered by the other members' knowledge and experience. The subsystems were developed and introduced gradually, with corrections and adjustments performed over time. All the subsystems were connected in 2008, and the proposed system was completed. No serious problems now remain, and the proposed system is working stably.

Because H Inc. has not requested any specification changes since the introduction of the proposed system, we believe that problems (1-1) to (1-3) were avoided in our development of the system. The introduction of this system has also reduced administrative time and excess stores of stock, and has improved the number of shipments. This project has demonstrated that for the introduction of satisfying executive software, the company needs to discuss the business with the software developers so that problems (1-1) to (1-3) may be avoided.

Highly precise production control became possible through this system. The result of shifting to the new production system, which orders product manufacture according to the information shown in the system, has been an inventory reduction of 30%. Most of the 30% in the inventory reduction would probably have occurred

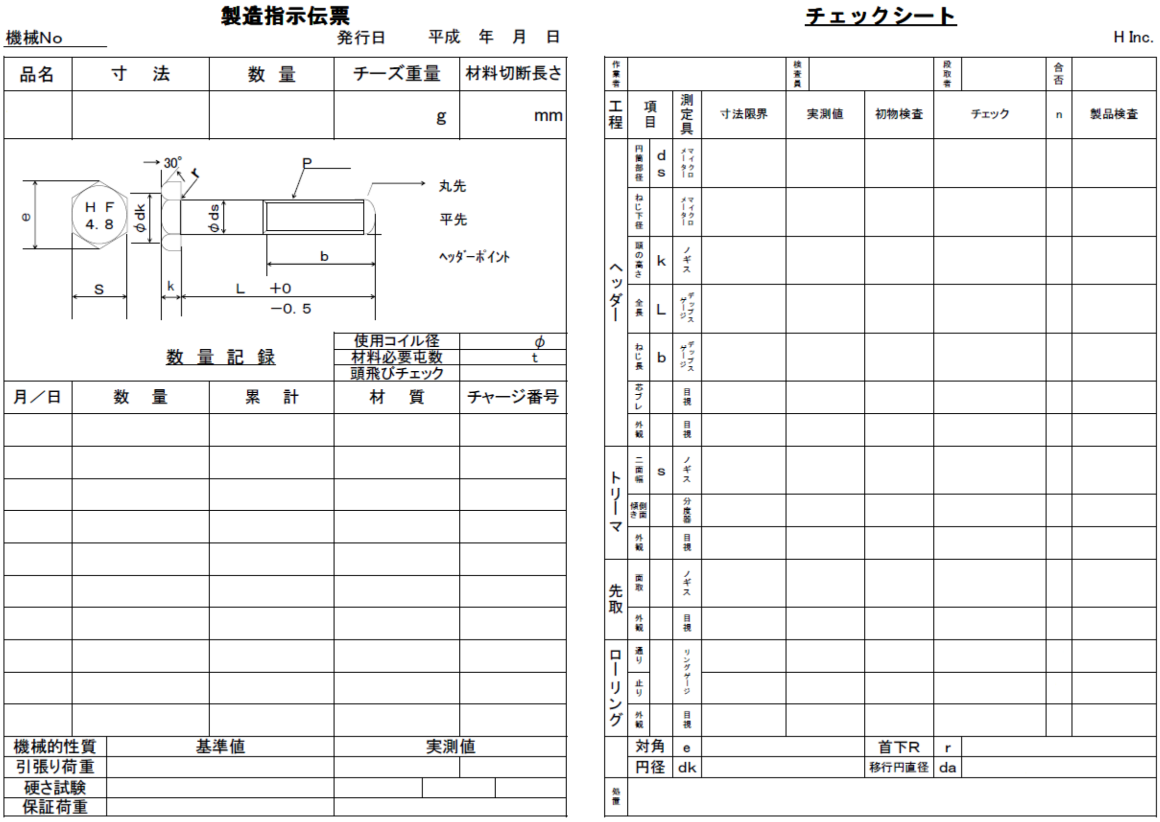

Figure 6. Production order check sheet

with any change in the manufacturing system, even if this exact system had not been introduced. However, we believe that this new system showed a strong introductory effect for the following reasons: because H Inc. normally has a very short lead time for its orders, it has to be able to determine the quantity of production quickly and correctly. Because this system was set up to show the proper value of the volume of inventories that changes in every season, it can show the optimal quantity of production for every season in an instant. Thus, we believe that this system contributed to instituting highly precise production control through the changes that were specifically tailored to the manufacturing system of H Inc.

Moreover, the time for each business function was shortened; overall, the same tasks take less time, about 2 hours less per day. Therefore, this system has been effective in reducing the workload of the person in charge of scheduling.

For further operating efficiency improvements, the automatic creation of a production schedule based on demand forecasting and an optimization theory [12] may be attempted. However, a person can operate the system by simply referring to the manual and training a few people. Overall, this system has improved the operating efficiency of this small-to-medium manufacturing firm.

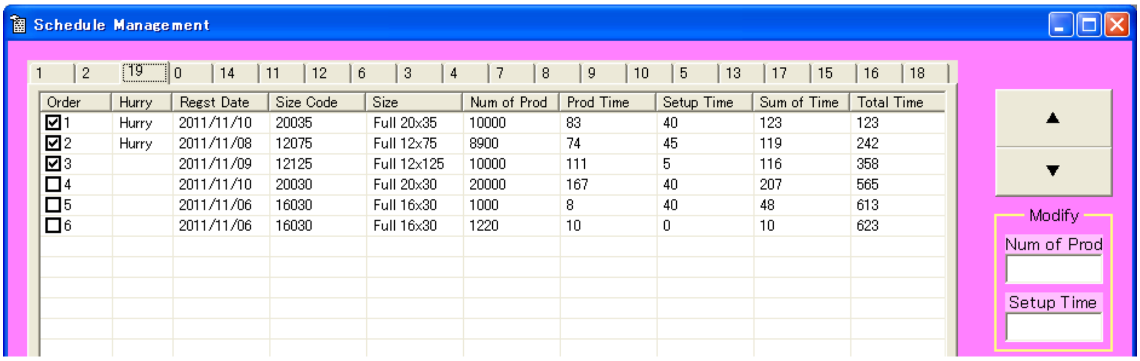

Figure 7. Management of scheduling

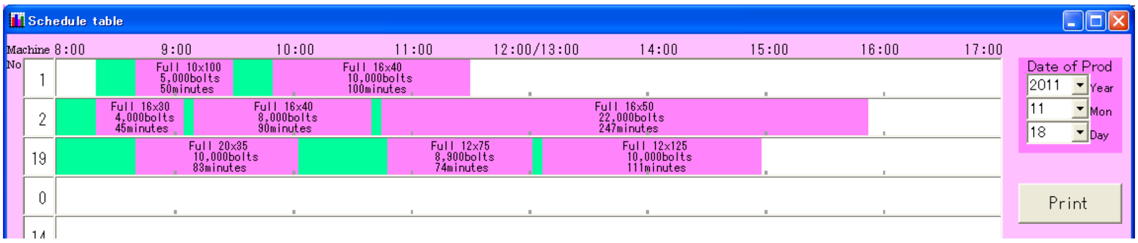

Figure 8. Table of production schedule

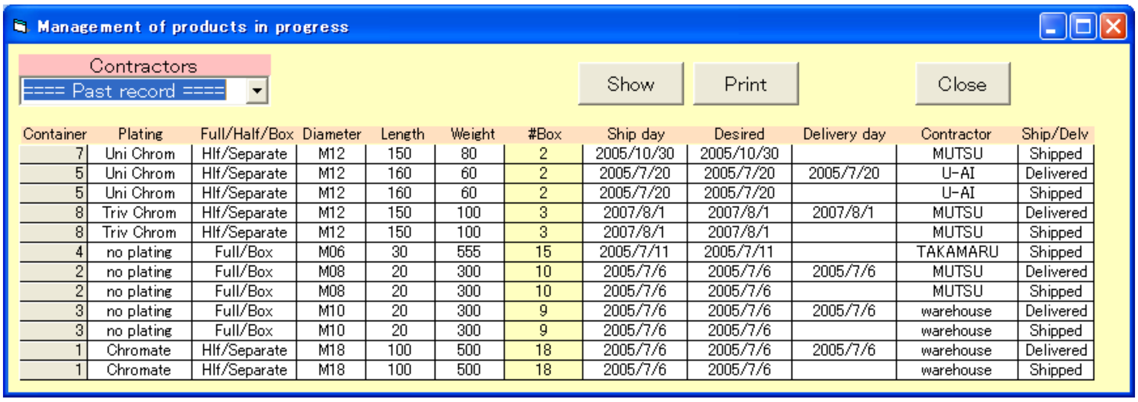

Figure 9. Management of products in progress

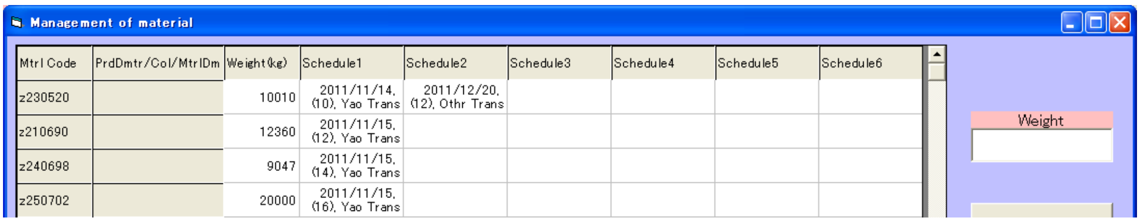

Figure 10. Management of material

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