Mixed Production System of High-mix Low-volume Products

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The Mechatronics Systems Plant produces ATMs, cash-handling equipment and information terminals. Mono-zukuri innovations are promoted daily at the plant in an aim to become the "world's No. 1" mechatronics plant of high-mix low-volume products. Since the percentage of continuous production products as typified by ATMs was high in the past, production efficiency was improved through the implementation of dedicated lines. However, in recent years, the percentage of cash-handling equipment and information terminals whose production is irregular has been increasing.

In respond to such changes in the production environment, the entire plant worked together to develop a "Mixed Production System of High-mix Low-volume Products," which is introduced here in this article.

Conventional Production Line System

As shown in **Table 1**, each conventional production line was dedicated to a single product and carried out integrated production from sub-assembly to shipment (**Figure 1**).

Table 1. Conventional Production Line

Item	Conventional Line
Line Type	Line dedicated for each product
Product Type	Continuously produced product
Parts Placement	Dedicated parts shelves positioned near assembly line
Job Cart	Used dedicated cart matched to product size
Work Range	Same worker performs work from parts collection to assembly

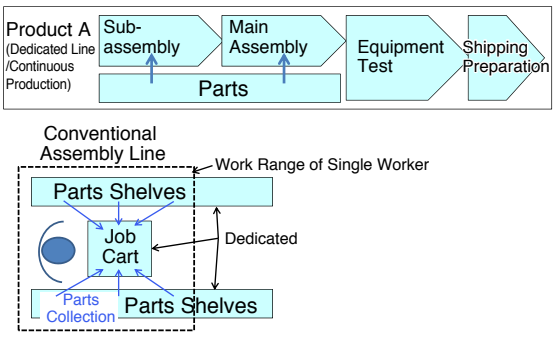

Figure 1. Conventional Production Line System (Dedicated Line)

Problems with Conventional Production Lines

As irregular production of intermittent products increased, two problems with the conventional production lines became known. The problems were poor production and space efficiencies.

(1) Poor production efficiency

Due to limited floor space, production line was once disassembled and rebuilt when production resumed. For this reason, the man-hours required to prepare the line's restoration/restart becomes enormous and lowers production efficiency. Furthermore, because of the large number of dedicated lines, the number of lines the production innovators needed to handle increased, thus requiring more time to improve production efficiency.

Even if a certain work was experienced in the past, every time the products are switched the workers' tendency to forget reverts their work proficiency back to normal and became the cause of the drop in working time itself.

(2) Poor space efficiency

Since a dedicated line is laid out for each product, the operation rate is low. During a non-busy period, 50% of the lines are inactive compared with a busy period (**Figure 2**).

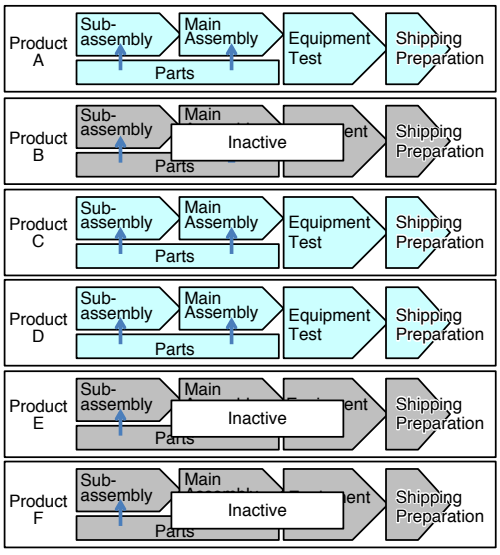

Figure 2. Dedicated Line Status during Non-busy Period

New Line using Mixed Production System

In order to solve the problems of the conventional lines, the specification was repeatedly studied to halve the number of current production lines. Eventually, the notion of dedicated lines was discarded in favor of a mixed production system that produces multiple products on a single production line (**Figure 3**).

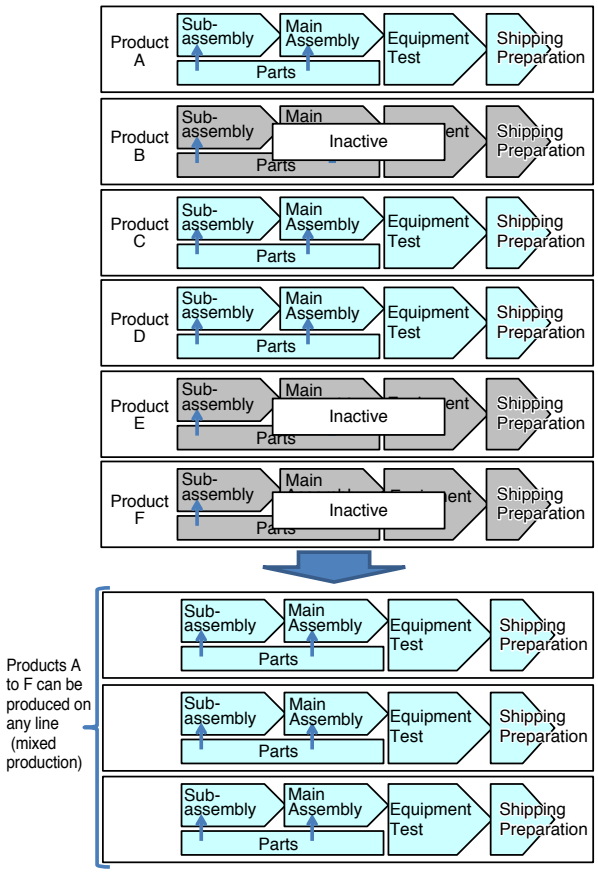

Figure 3. Mixed Production System

In mixed production, frequent product switching of the production lines will be necessary.

Since the number of production lines is halved, there is a possibility that a product that needs shipping cannot be produced. Therefore, a more precise production priority management is required.

Moreover, the configuration of cash-handling equipment completely differs by model with no commonality in parts. Therefore, with the collaboration of the production department, a new method of supplying parts to the assembly lines needed to be devised (**Figure 4**).

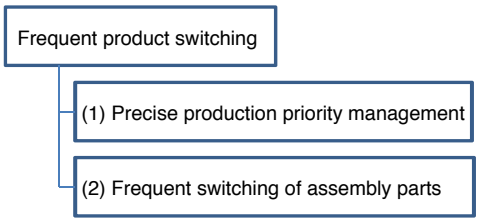

Figure 4. Points to Consider with Mixed Production System

(1) Precise production priority management through coordination with production plans

In order to make effective use of the limited lines, a production simulation system was created to reserve lines and verify loads one month before actual production (**Figure 5(a)**). This enabled desktop simulation of the required line length and man-hours (**Figure 5(b)**). Simulation results were fed back to the production plan, so that even with limited number of lines, production can be completed by the required delivery date.

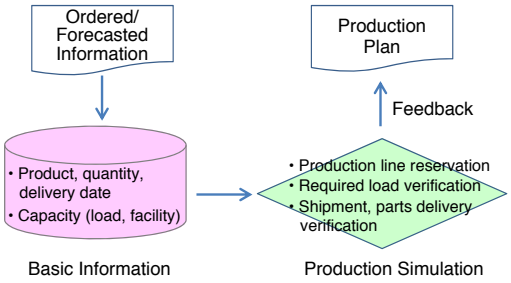

Figure 5(a). Simulation System

Figure 5(b). Simulation Display

Additionally, since it is necessary to supply parts in conjunction with the production plan, a parts status system was created (**Figure 6**). Through the control of parts supply, the line switching time was minimized and production efficiency was improved.

Figure 6. Display of Parts Status

(2) Establishment of parts switching system

To enable the frequent switching of supplied parts to the assembly line, different approaches were used for the small and large parts. Furthermore, the system was configured to link the data change in assembly guidance system with the change in supplied parts (**Figure 7**).

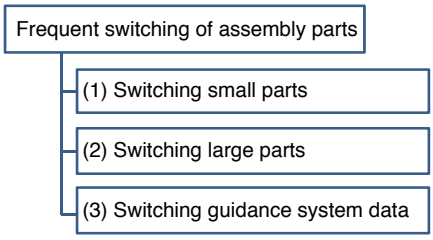

Figure 7. Establishment of Parts Switching Methods

1) Switching small parts

For small parts, a shelving unit capable of holding parts on the front and back for two products was developed and introduced. At the time of product switchover, the shelving unit is rotated to switch to the parts for next product making for a simple switchover (**Figure 8**).

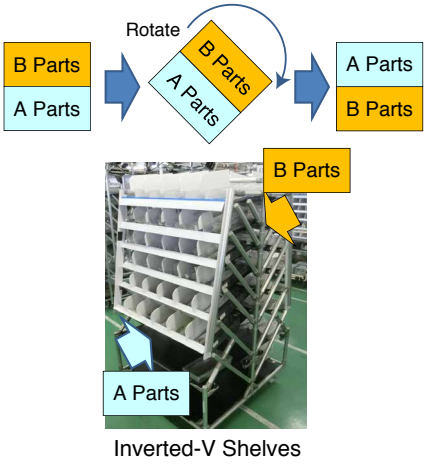

Figure 8. Switchover of Small Parts Shelves

2) Switching large parts

When large parts are switched within a line, the line slows down and assembling efficiency is drastically reduced. Therefore, large parts shelves were separated from the assembly line. Additionally, the supplied parts were served as a kit, which made it possible to cope with frequent product switchovers (**Figure 9**).

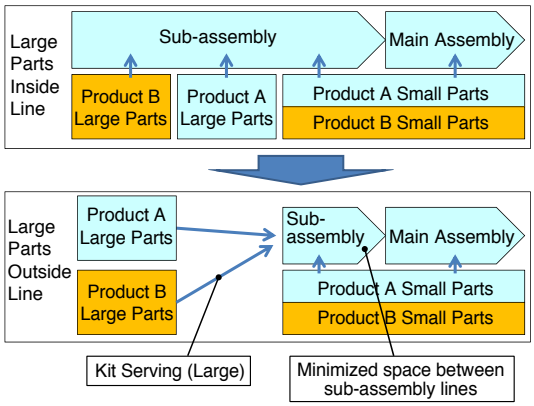

Figure 9. Modification of Large Parts Supply Method

3) Switching guidance system data

Products cannot be assembled just by switching parts if the assembly sequence is not known for each product. For this purpose, a guidance system that links the assembly sequences with the work instructions was developed[1].

Simply making a product selection on a tablet according to the production order decided by the mixed production system previously described, parts guidance and work instruction for the assembly can be provided. As a result, sixteen different products can be produced on the same line (**Figure 10**).

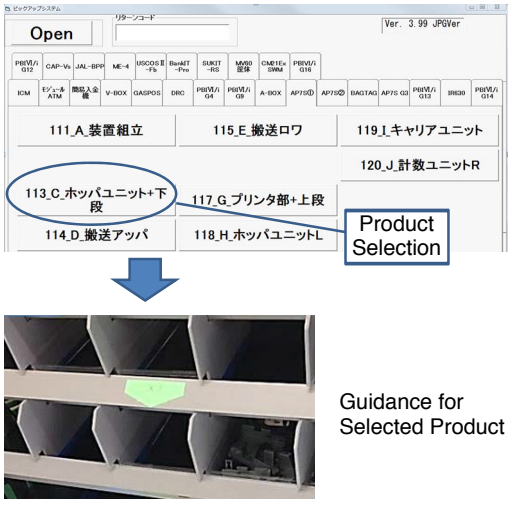

Figure 10. Data Switchover

The problem with the conventional lines in which the workers' proficiency drops back every time there is a product switchover, was minimized through the introduction of a guidance system. Converting the work instruction documents from paper to digital also reduced the need to flip pages.

New Line Problem and Innovation

A new line was constructed with the concept of improving production and space efficiencies, but a new problem has surfaced.

In the case of large parts, product switchover was realized through changes in the kitted parts. However, the separation of the large parts warehouse from the line has introduced the waste of walking (**Figure 11**). On a dedicated line, improvements were made to eliminate the waste of walking, but it was not realized for the mixed production line. In order to eliminate the waste of walking, an unmanned cart was developed and the transport of parts was automated (**Photo 1**).

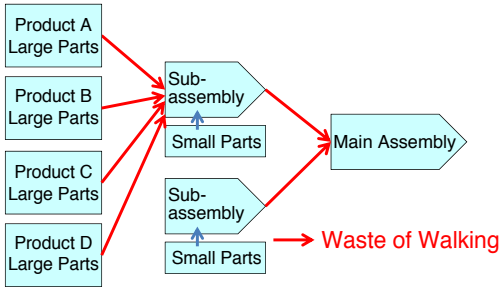

Figure 11. Waste of Walking

Photo 1. Unmanned Cart

Effectiveness of New Line

The new lines held down the cost of facility investments and produced great results. The "Mixed Production System of High-mix Low-volume Products" was constructed while inheriting the conventional quality mechanism. The introduction of the system reduced both the direct and indirect man-hours and provided a 1.5 time improvement in production efficiency compared with the conventional production system.

Moreover, space productivity (space efficiency) has also doubled (as of February 2018). Now, activities are continuing with plans for additional products.

Future Development

A base for mixed production has been built, and an environment where innovations and improvements can be readily carried out is in place. Handling of additional products, design changes, etc. will be incorporated into the system, and leveling up of the mixed production system will be promoted. ◆◆

References

1) Yutaka Kashiwakura, Jun Tada: New Assembly Navigation System to Improve Production Efficiency, OKI Technical Review Issue 228, Vol.83 No.2, pp54-57, December 2016

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