Introduction of Toyota Production System to Promote Innovative Manufacturing

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Until recently, Fujitsu employed various strategies to improve productivity and efficiency at its plants and business units. In 2003, however, we introduced the Toyota Production System (TPS) throughout the company to promote innovative manufacturing. This system is intended to achieve company-wide innovation not only at the plant level, but also for product delivery processes from the sales sections to the customers and for processes upstream of design and development. The system is still under construction, and we are now addressing various problems posed at each plant and business unit. This system is also intended to bring innovation to the processes performed between the plants, suppliers, and customers by linking with upstream development sections. This paper examines the progress of introducing TPS, using its introduction at some of our Information and Communication Technology product plants as examples.

1. Introduction

To overcome the difficulties caused by the deteriorating business environment and to accomplish continuous improvement, Fujitsu has until recently employed various strategies to improve productivity at its plants and business units.

In 2003, in response to the need to further implement these activities throughout the whole company, Fujitsu announced a policy of introducing the Toyota Production System (TPS)[1),2)] as an extensive company-wide activity. First, the manufacturing sites were designated as the starting points, and we started activities that focused on returning to total supply chain management (SCM) of production activities and returning to the upstream design departments. To convert from the staff-led improvement activities approach that had been used to date, we focused on employee consciousness and instruction and started implementing TPS from zero at each plant and manufacturing subsidiary. To introduce TPS, we first sought guidance from well-informed outside consultants and then, in 2004, we stared developing full-scale activities with the ultimate goal of reforming the corporate structure and climate.

In this paper, we describe the TPS introduction policy we developed for our production innovation activities and look at its implementation at some of our Information and Communication Technology product plants . We then describe these activities and the results that were obtained. Finally, we describe our plans for future development.

2. Establishment of new manufacturing promotion division and innovation policy

2.1 Establishment of new manufacturing promotion division

To escape from the need to carry out structural reforms in response to the continuing depression of the electrical machinery and

appliances industry and to strengthen our global competitiveness even with products manufactured domestically, we established the Manufacturing Promotion Division in September 2003 to focus on our manufacturing activities in Japan.

Two new departments — the Distribution Infrastructure Servicing Department and the Manufacturing Plant Department — have been added to the departments that comprised the old division; namely, the Industry Engineering (IE) Department and departments related to production technology and facilities development. The roles of the new division are as follows:

1) Development of production innovation activities, overseeing the management of the progress of the activities, and training of the engineers designated to implement the activities
2) Construction of the priority plant for putting TPS into practice and human development of plant personnel
3) Introduction of TPS into the distribution departments (component procurement, product shipment) and strengthening of cooperation with the manufacturing plants
4) Development of low-cost production technology and nano production technology

One of the objectives of the new division is the promotion of innovative manufacturing centered on the following Information and Communication Technology product plants.

- Oyama Plant (photonics, light modules)
- Nasu Plant (mobile systems, mobile phones)
- Fujitsu Access Limited (transmission equipment)
- Fujitsu Wireless Systems Limited (multiplex radio equipment)
- Fujitsu I-Network Systems Limited (switching devices, other equipment)
- Fujitsu IT Products Limited (servers, storage systems, other equipment)
- Shin-Etsu Fujitsu Limited (magnetic tape libraries, other products)
- Fujitsu Isotech Limited (personal computers, IA servers, other products)
- Shimane Fujitsu Limited (notebook PCs)
- Fujitsu Peripherals Limited (displays, printers)
- Fujitsu Interconnect Technologies Limited (printed circuit boards)
- Fujitsu Frontech Limited (equipment for financial institutions)
- Fujitsu Kasei Limited (modules, light connectors, other products)

2.2 Innovative manufacturing policy

Fujitsu has established the following three points as its manufacturing policy.

1) Customer-focused
- Product manufacturing that provides value to the customer

2) The importance of customer values
- Needs (functions, performance, ease of use), quality, delivery (Time To Market), price

3) High value-added manufacturing that utilizes Fujitsu's strengths
- Providing products with the high reliability that was cultivated in the development of core products
- Providing products with the speed and cost priorities that were cultivated in the development of PCs and mobile phones

Based on this policy, and with the goals of implementing reforms in the upstream design stage of the manufacturing process and reforming the overall process — from sales activities through to product delivery to the customer — we selected manufacturing sites as the starting points and set the target of doubling their productivity levels within two years.

To achieve this target, we established the following three concepts as our innovative manufacturing themes.

1) Production line innovation

Introduction and development of TPS, development of reforms that return to the upstream stages

2) Supply chain innovation

Just-In-Time principle for the entire process from component procurement through to product shipment (observance of delivery date, compression of inventory)

3) Development innovation

Pursuit of the building-in of quality and ease of manufacturing and the reduction of costs and development period

The introduction of production line innovation has been promoted as the main concept. However, it goes without saying that implementing these innovation themes in the future is not just a case of solving each problem as it presents itself, but also requires knowing how to reform consciousness and behavioral patterns, how to reform business processes and formations, and how to promote human development.

3. Corporate activities and use of outside consultants

3.1 First plant to put TPS into practice

In May 2001, in advance of the company-wide introduction of TPS, we selected a company in the Fujitsu Group that needed to improve its management as a test case; this company was Fujitsu Component Limited. Outside TPS consultants were used, and in the short period of approximately 15 months we almost achieved our high goals of a three-fold increase in productivity, a 50% reduction in inventories, and a 50% reduction in space. We also improved the profit-and-loss performance.

The introduction of TPS in this plant was enabled by the sense of crisis felt by its employees and by their change in consciousness. In addition, this is a successful example of a plant that achieved results by introducing TPS, which is different in style to the improvement activities used by Fujitsu to date.

3.2 TPS and use of outside consultants

The TPS that was introduced and developed at Fujitsu Component Limited is the pull production system, which is designed for producing what is needed in only the required quantity when it is needed. This system creates a mechanism that eliminates product stagnation, repeats operations so they become actions that create a flow, and visualizes conditions (distinguishes between normal and abnormal conditions) so that the problem points can be actualized (**Figure 1**). Furthermore, the search for and solution to the root cause of a problem and the complete elimination of waste create a perpetual cycle. This system places an emphasis on doing things thoroughly, and we came to understand that a revolution in consciousness is the most important factor for its execution. However, when it came to putting TPS into practice, we lacked know-how about its true essence and the steps required for its implementation. We also needed to establish a route to company-wide innovation and required assistance with the implementation of TPS activities. We therefore asked outside consultants having a thorough knowledge of TPS to implement the activities.

With some of our plants, however, we shared the know-how that we obtained from introducing the outside consultants so we could start the introduction of TPS ourselves using a co-development model.

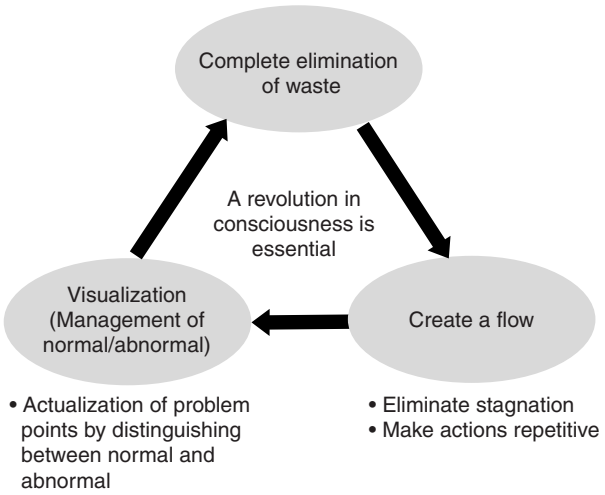

Figure 1
Toyota Production System.

4. First-stage activities

In this section, we introduce the activities at each plant from the start of production innovation up to September 2004, when the activities got off the ground after we received guidance from the outside consultants.

4.1 Implementation from base zero

These production innovation activities based on the introduction of TPS did not start simultaneously. Instead, some plants started reforms of their own, while other plants made the shift because of the activities of the Manufacturing Promotion Division, which was working on the premise that the company should proceed as a whole. By March 2004, however, first-stage activities had started throughout the entire company. At each plant, advance preparations such as employee consciousness-raising and education were made and the base-zero 2S principles of Sort and Straighten were introduced.

Building on this base, we used outside consultants in some of our plants from April 2004 and began the full-scale introduction of TPS.

4.2 First-stage results of instruction activities and 2S/elimination of waste activities

As shown in **Figure 2**, the main activities that we implemented prior to the introduction of outside consultants were as follows:

1) Consciousness-raising and education of employees using videos and texts
2) Instruction using displays such as personal targets, posters, activities news, and action item charts
3) Awards for excellent small-group activities
4) Company-wide 2S activities: Sort and Straighten
5) Activities to minimize the surplus spaces between processes

Even with these types of activities, the review of the procedures used to date and the participation of all the employees led to impressive results from two plants as described below.

1) At plant A, after one year of activities there was a 50% increase in productivity per person, a 45% reduction in space as a result of reducing the use of external warehouses and so forth, and a 50% reduction in the manufacturing lead time.
2) At plant B, after six months there was a 60% increase in productivity per person and a 75% reduction in the manufacturing lead time on the model line.

5. Second-stage activities

The second stage started in October 2004, when we introduced full-scale TPS through the guidance of consultants. The second-stage activities are as follows.

5.1 Development steps

In the second stage, TPS was introduced full-scale through the guidance of consultants. When we implemented the second-stage activities, the following points were raised that were reflections on the first-stage activities:

1) Although we are still addressing the creation of a flow line, we are nevertheless addressing it somehow or other. With regards to the

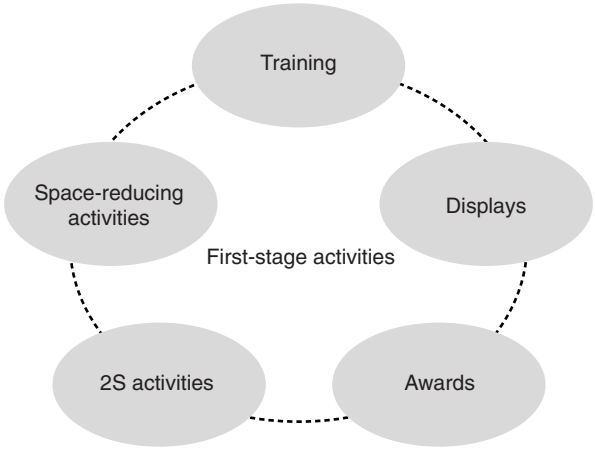

Figure 2
First-stage activities.

adjustment of personnel, we addressed the reduction of person-hours for each process and have obtained good results. However, our efforts in these issues were not sufficient from the standpoints of being particular about and doing things thoroughly.

2) Even with the Just-In-Time principle, we lacked the conviction to create a climate that allows thorough analyses and pursuit of issues such as manufacturing based on the Takt-time (cell production-rate) way of thinking; changing the focus from days to hours, from hours to minutes, and from minutes to seconds; and the adjustment of personnel due to multi-process handling.
3) The consultants pointed out that before introducing TPS, we needed to attempt a rectification of the process to see to what extent a flow line could be created.

As a result of these reflections, we implemented the second-stage activities in four steps (**Figure 3**) based on the following policies:

1) Adjust the flow pattern, reorganize the manufacturing process, review equipment constraints, remove flow route divergences and confluences, and simplify. In addition, connect processes and equipment and construct a line so that assembly units flow sequentially (single-piece flow). By doing this, construct a line in which there is no waste due to accumulated items between manufacturing processes and items set aside and in which problems can be identified.
2) To achieve the improvements described in 1), determine the standardization of operations, implement standardized operations, and further raise the level of visualization.
3) If the flow creation described in 1) and 2) can be achieved, use the ideology of the pull system, which is the essence of TPS, as the mechanism for construction.
4) Use the Takt-time concept to manufacture products. In other words, reduce the waste caused by manufacturing too much. Create a plant in which problems can be actualized and improvements can be made by controlling the amount of work in progress (raising the Just-In-Time level).

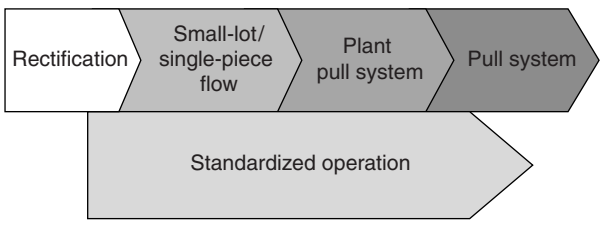

Figure 3
Implementation steps.

In the pull system, the required amount of products are manufactured and stored at the same location and then pulled at the required time.

Particularly, the second-stage activities at the plants that implemented TPS independently and did not receive guidance from the consultants include a review based on the four steps shown in Figure 3 while paying close attention to detail.

5.2 Implementation of PDCA and issues

In this section, we introduce the differences between the degree of activity implementation at each plant and manufacturing subsidiary. We also introduce the problems and issues that arose with the acceleration of activities.

In the initial phase of the second-stage activities, the activities of each plant followed the development steps. The implementation status of the grouped plants is shown in **Figure 4**:

1) In the Group A plants, some progress was made in consciousness-raising and individual improvement in the plants, but little progress was made in addressing the rectification issue.
2) In the Group B plants, powerful implementation of consciousness-raising activities from the top and the participation of all the employees resulted in considerable progress in individual improvement. However, there is still a long way to go regarding the address-

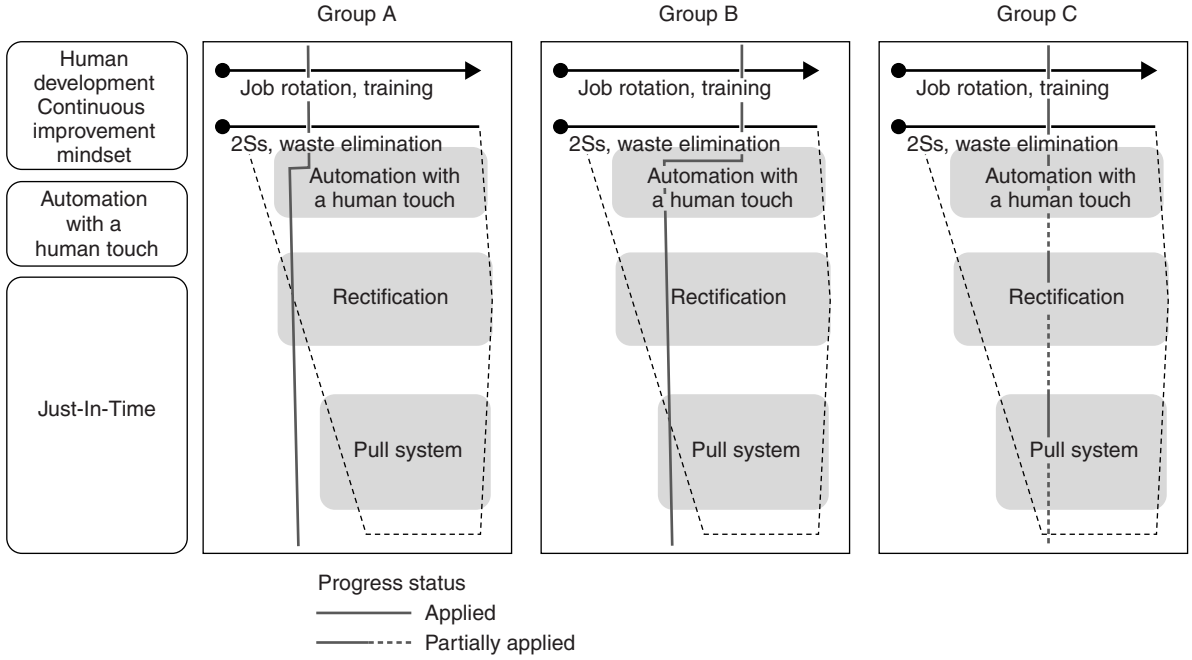

Figure 4
Progress status of each plant in initial phase of second-stage activities when compared with development steps.

ing of steps implemented prior to the pull system.

3) The Group C plants received guidance from the consultants, and development was done based on the implementation steps. Good results were obtained in the model lines.

When we look back to determine how to review the situation and accelerate these activities at the plants in Groups A and B, which did not receive guidance from consultants, it is obvious that powerful implementation from the top and unified management objectives (**Figure 5**) are indispensable. Moreover, in addition to these considerations, the following questions are also important:

1) How do we repeat the control cycle (PDCA) properly?
2) How well is the consultants' guidance understood, and how do we further develop it and transmit it to other areas?
3) To what extent are the plant personnel responsible for improvement using their intelligence to execute the policies?
4) To what extent do we need to foster such talented people?

With these issues as the base, we will reformulate development plans for each process and production line based on the implementation steps. This will allow us to properly expand the implementation from the plant units where the activities were performed to each process and production line. We will then review the developments and repeat the PDCA cycle for each unit. For the plants that are not receiving guidance from the consultants, we established a system in which the director responsible for manufacturing activities periodically and thoroughly reviews all activity confirmations .

5.3 Results of implementing TPS principles

Next, we introduce examples of results from plants that have made progress in implementing the TPS principles.

Among the plants that received guidance

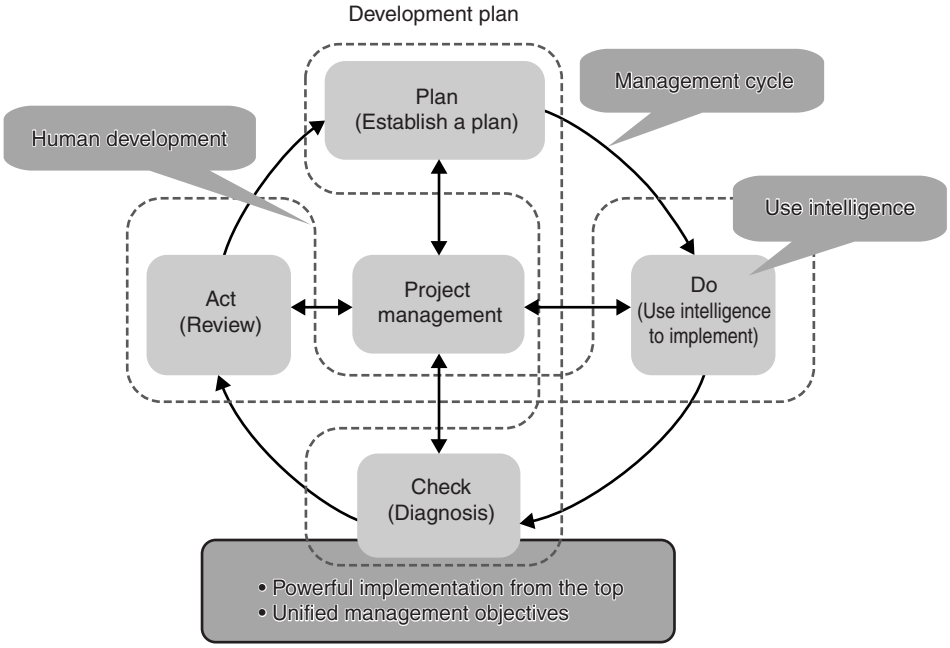

Figure 5
PDCA diagram of activities.

from consultants, the level of the system depended on the plant. The plant that realized the fastest reforms was the mobile systems products manufacturing plant, and the results that were achieved are as follows.

1) Productivity in 2005 on the TPS-developed model line compared to results for 2003
- 55% reduction in direct operations
- 48% reduction in manufacturing lead time
- 68% reduction in work-in-progress products within the line

2) Consciousness and behavioral patterns
- Reduction in excuses for "why I can't do that"
- Employees started to share goals and provide mutual encouragement
- Plants where line improvements were hands-on started to change daily

The system that enables problems in the plant to be identified is still at the level at which it was created. The pull system, which links the supplier to the customer and is the essence of TPS, will be addressed in the future. Currently, therefore, the results are limited to a reduction in lead time in the narrow range of the production plants. In the future, we must make changes so we can reduce the lead time company-wide and make our companies and plants more profitable.

6. Looking toward expansion to company-wide production innovation activities

Using the production line innovation activities described above as the starting point, and from the standpoints of the actual location and materials used there, direct interaction among the plants, manufacturing subsidiaries, sales divisions, and development divisions became even closer. In this environment, we began our full-scale development toward overall production innovation activities (**Figure 6**). The themes of this initiative are as follows.

1) Cooperation with SCM departments
- Introduce the TPS way of thinking from the manufacturing departments into the supplier (supply chain) and customer (demand chain) distribution fields.

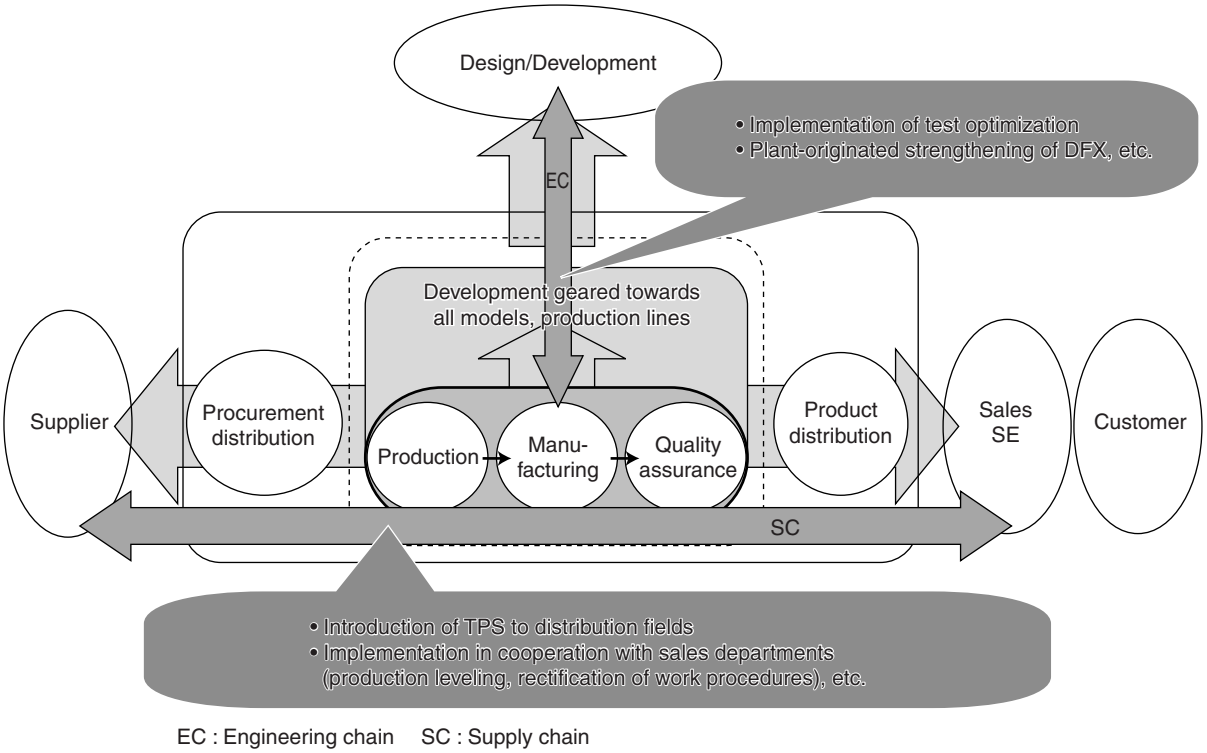

Figure 6
Development towards overall production innovation activities.

- Implement cooperation with the sales departments with a view toward 1) reducing the manufacturing department's product manufacturing lead time, 2) reducing the lead time of the information required to formulate a manufacturing plan at the plant that receives the order, and 3) production leveling.

2) Cooperation with development departments

- Carry out reforms that include quality assurance in the testing process, which accounts for a large share of the manufacturing lead time.
- With the plant as the starting point, strengthen Design For X (DFX) methodologies to improve the manufacturability and testability at the design stage.

In particular, when talking with the sales departments, we take an information processing system approach and tell them the distribution of the delivery dates of the main models and then focus on production leveling. To achieve production leveling, we have developed comprehensive point guides and a Web system for the standard delivery times, number of lot units, and order-locked period so the sales departments' employees can fully understand it. We are also developing tracking monitors and other tools so details of the progress made in the manufacturing process can be checked, and we plan to shortly proceed with full development.

7. Conclusion

In this paper, we described the TPS introduction policy we developed for our production innovation activities and looked at its implementation at some of our Information and Communication Technology product plants. We then described these activities and the results that were obtained. Finally, we described our plans for future development.

We are currently at the stage where production line innovations within the plants have gotten

off the ground and systems that enable problems to be identified are in place. In the next stage, we must expand the improvement activities and human development. Moreover, the shift toward expanding production line innovation from the plant level to overall production activities will soon be completed.

The principles we learned from the consultants provide a foundation for the introduction of TPS. Some examples of these principles are "grasp the problem at the actual location and materials used there;" "the objective is not to push forward with things that can be done, but to view those that cannot be done as a challenge;" "use the Five Why's for root-cause analysis;" "when you do not know what should be done, take the immediate action of doing something anyway and seeing what happens;" and "before you make improvements by the equipment, make improvements to the operations." If we remember these principles, the introduction of TPS leads to good results, and we can therefore implement TPS activities with conviction. In addition, in our plants, we will aim at human development and the creation of a suitable climate so that autonomous improvement activities can be continued in the Fujitsu style.

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