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Toyota Production System(TPS)×DX Machining Line Project

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For engine machining line operation, 70% of the time was spent on inspecting machined parts such as dimension inspections with gauges and measurement instruments and visual inspections. On the other hand, equipment control has grown sophisticated and the processing and operation speeds of equipment have become faster, and in addition, tools have greatly improved in terms of accuracy and lifespans. As a result, the rate of NG parts has been significantly reduced to one tenth of the rate 30 years ago.
Furthermore, 85% of the defects caused mainly by broken tools and machine problems were detected with the automatic stop function of equipment. If a defect is found in a sampling inspection, T/M will be busy with tracking the number of parts affected and investigating the cause. In the meantime, the remaining 30% of the engine machining line operation is low value-added work such as cleaning chips and replacing, supplying, and conveying chips, parts, tools, cutting fluid etc.

As summarized above, machining line operation is characterized by a dependance on T/M for old-fashioned inspections and low value-added work, and this is how the work has been conducted continuously for more than 30 years.

Therefore, in order to change how the work is conducted, we are taking on the challenge of realizing a modern-era JIDOKA (automation with human intelligence) line (hereinafter, refer to as “Woven Line”) where the Toyota Production System (TPS) and Digital Transformation (DX) are integrated. This is not promoting digitalization as an extension of current work. This forward-looking project, which evolves around TPS for producing quality products efficiently by complete elimination of Muri (over burden), Mura (unevenness), and Muda (waste), is based on the idea of easing the workload of T/M, and it aims to increase the added value of work and drastically change how the work is conducted with DX by using digital technology to realize visualization, data connection, and operation support, etc. The approach uses the following steps.

First of all, low value-added work such as replacement, supply, and conveyance were automated in order to ease the workload of T/M. The time and energy of T/M saved by this automation led to a shift to higher value-added work including more complicated work and Kaizen (improvement) for the prevention of defective parts, etc. This paper introduces three automation measures: development of a mobility control system for the automation of various conveyance work, automation of visual inspections by developing image processing technology, and automation of tool setting work (setting, tightening, measurement).

Next, this paper focuses on JIDOKA. JIDOKA is not simply replacing workers with machines but shifting how work is conducted to prevent defective parts by building quality into processes. We are testing various measures under the basic concepts of Woven Line which are completely changing the nature of work for the better, shifting to value-added work, easing the workload of T/M, and allowing T/M to work energetically. As an example, this paper introduces the forecasting of defects in advance by quality parts condition control.

Thirdly, in line management and operation, IoT is used to eliminate document entries and document searches, instantly connect various data, and create new value by utilizing the data.

The goal of Woven Line is changing work, management, and operations as illustrated in Figures 1 and 2 through these measures. This paper introduces each item.

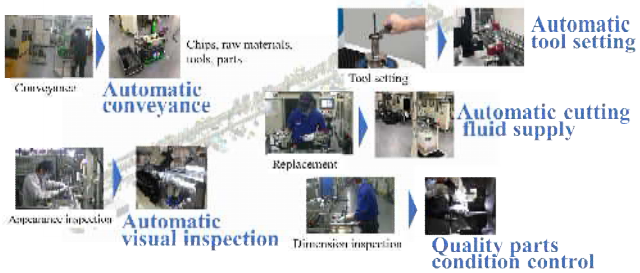

Fig.1 Goal (Work)

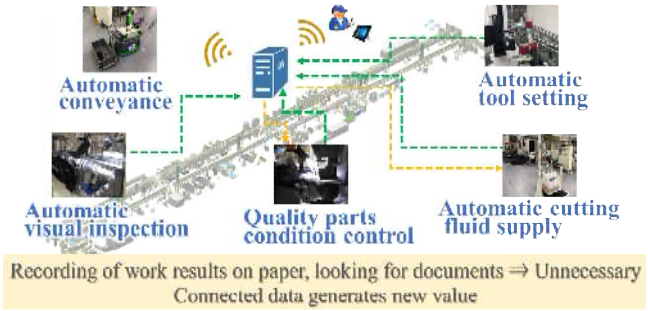

Fig.2 Goal (Management and Operation)