Manufacturing Innovation for Smartphones

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Mobile phone manufacturers are now changing their main products from feature phones to smartphones. In addition, due to the stagnation of the global economy, the manufacturing industry in Japan is faced with six main issues: a strong yen, high corporation tax, a delay in trade liberalization, tight labor regulations, global warming, and a power shortage problem stemming from the accident at the nuclear power plant in Fukushima. While being exposed to cut-throat cost competition from overseas vendors, Fujitsu Mobile-phone Products Limited (FMPL), as a key factory of mobile phones, is not only providing even higher-quality products to customers but also working on production innovation so that FMPL can continue to manufacture in Japan. This paper presents the four pillars of our activities: smartphone test innovation, automation and robotization, strengthening of prototyping and evaluation, and standardization of manufacturing and repair.

1. Introduction

The Japanese manufacturing industry is in a very difficult business environment with what are now called the six difficulties (a strong yen, high corporation tax, tight labor regulations, a need to reduce greenhouse gas emissions, a delay in trade liberalization, and a power shortage problem). These difficulties have caused Japanese manufacturers to shift their manufacturing bases overseas at an increasing pace. Despite this situation, Fujitsu is committed to manufacturing in Japan and pursuing the Fujitsu Products Standard (FJPS). As a key factory of smartphones, Fujitsu Mobile-phone Products Limited (FMPL) not only offers higher-quality products to customers but also stakes its survival on activities for manufacturing innovation in competition with overseas electronics manufacturing service (EMS) vendors. This paper presents the current conditions of those activities and the achievements.

2. Environment surrounding mobile phone manufacturing

2.1 Market environment

The mobile phone market has rapidly been shifting from feature phones to smartphones since 2011.

Overseas vendors are taking the lead in the area of smartphones with Apple's iPhone and other products and their manufacturing bases are mostly large EMS vendors such as ones in China. Conventional feature phones in the Japanese market are mainly mobile phones with special features advanced to the degree of being called Galapagos mobile phones ("Galapagos" describes the phenomenon of a product or a society evolving in isolation from globalization; it refers to a similar phenomenon observed in the Galápagos Islands where plants and animals evolved in isolation from other locations). And, to ensure quality, the market is in a sense closed to overseas vendors, which generally manufacture products overseas. The multiple functions and complicated structures of feature phones have been dealt with by manufacturing in Japan. In comparison, smartphones have simple structures that basically consist of a touchscreen and a large display, and so special expertise is not required in their manufacture.

In this environment, together with the six issues mentioned earlier, Japanese mobile phone manufacturers are tending to make a major shift overseas. Fujitsu has also started overseas original design manufacturing (ODM) for some models. However, as the key factory of Fujitsu mobile phones, FMPL is working on creating additional values from manufacturing sites.

2.2 Differences between feature phones and smartphones

This subsection discusses the differences between feature phones and smartphones from the perspective of manufacturing.

1) OS/platform

The biggest difference is provided by the switch from dedicated platforms for mobile phones to global open platforms. For conventional feature phones, OSes especially for mobile phones (such as Symbian) were used to develop and apply dedicated platforms. For smartphones, general-purpose platforms (such as Qualcomm) are used in open environments such as iOS and Android. While it has been possible up to now to conduct tests by in-process or other testing using simple methods and dedicated tools, this change has made those existing assets useless and requires test methods to be fundamentally changed and new tools to be created. This poses a considerable burden in terms of development and has a substantial impact on Japanese manufacturers.

2) Structure

Most conventional feature phones have a double structure in which a display such as an LCD and keypad are connected with a hinge. Conversely, most smartphones have a slate-type structure where the keypad is eliminated and a touchscreen is adopted for the display unit. As an assembly structure, this is simpler than that of feature phones with their complicated hinge structure. Meanwhile, because a touchscreen, which was not standard, is now integrated as a standard device, there is a need to work on technologies such as that for pasting with a large high-definition display and ensure water-resistant performance, a characteristic of Fujitsu mobile phones, for the large screens of smartphones.

3. Approach to manufacturing innovation

To survive in domestic manufacturing and as a key factory of mobile phones, FMPL is taking a comprehensive approach to improving quality, cost and delivery (QCD) (**Figure 1**) as described below.

Specifically, there are four pillars (smartphone test innovation, automation and robotization, strengthening of prototyping and evaluation, and standardization of manufacturing and repair) that we use as the basis for manufacturing innovation. In addition, we are reconsidering the traditional manufacturing management system and attempting to synchronize manufacturing with the manufacturing management system. Our aim is to reduce the total lead time, decrease the amount of work in process and realize small-lot production so that we can achieve innovation in supply chain management (SCM) and be able to flexibly respond to changes in market demand.

3.1 Smartphone test innovation

In the shift to smartphones, test methods, above all, had the biggest impact on the manufacturing system. Testing during mass production is intended to verify assemblies at the time of manufacturing. For that reason, dedicated commands, or maker commands (MCs), which are different from end users' operating environments, are generally used for such testing.

For the existing feature phones, based on OSes customized for mobile phones, MCs that run on dedicated platforms were used for testing. With smartphone OSes, global platforms built in an open environment are used and, as with the conventional handsets, MCs were run on those OSes for testing at

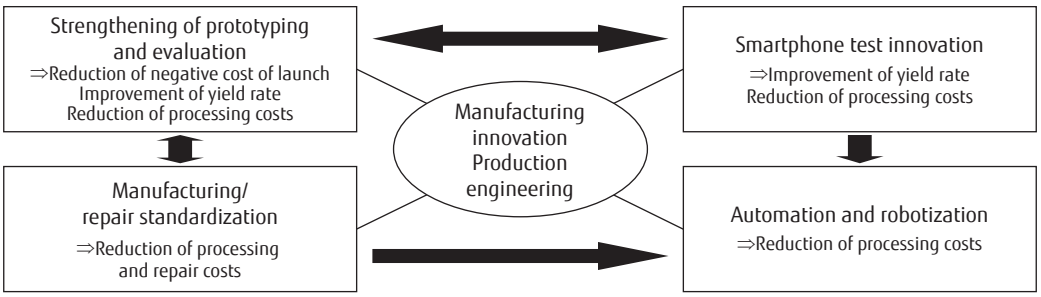

Figure 1
Policy of approach to improvement of QCD.

first. Fujitsu smartphones mainly adopt the Android OS and operations on Android were essentially used at first in the testing process at the time of manufacturing. This requires application operations not relevant to testing, and this sometimes caused problems such as unexpected test operations due to operation interference and excessive testing times. To solve these problems, we have changed the testing process so that the basic smartphone operations are run in the kernel layer, and the effect of the Android OS on manufacturing testing can be eliminated.

This has made it possible to reliably identify problems in operations, which is the aim of manufacturing testing, and optimized capital investment effects by reducing the testing time.

3.2 Automation and robotization

Obviously, the biggest difference between manufacturing in Japan and at overseas EMS vendors is labor cost. This directly increases the burden of manufacturing costs for Japanese manufacturers, and means they are accelerating their shift overseas. Fujitsu has made a point of manufacturing in Japan and is making efforts to reduce manufacturing costs. The principal measure taken is automation, but simple automation is achievable with facilities that can be adopted by overseas vendors, and so it is unable to make up for the difference in cost with overseas vendors.

FMPL combines industry engineering (IE) technology and IT, at which Fujitsu excels, to develop automation facilities capable of manufacturing with the optimum machine cycle time (MCT), and it has been applied to mass production. Its core technologies of the highest importance include one for quickly customizing general-purpose robots according to the short development periods of smartphones, and one that allows prompt changeovers when switching between models.

FMPL's smartphone manufacturing lines have many automated processes introduced into various assembly test processes in order to save labor. In the future, we plan to move ahead with significant automation of testing technologies together with the test innovation technology described in the previous subsection. We are developing technologies to save labor by about 40% as compared with the past. For example, in automation in the secondary assembly process of printed circuit boards (PCBs), handler robots have been used to save labor (**Figure 2**).

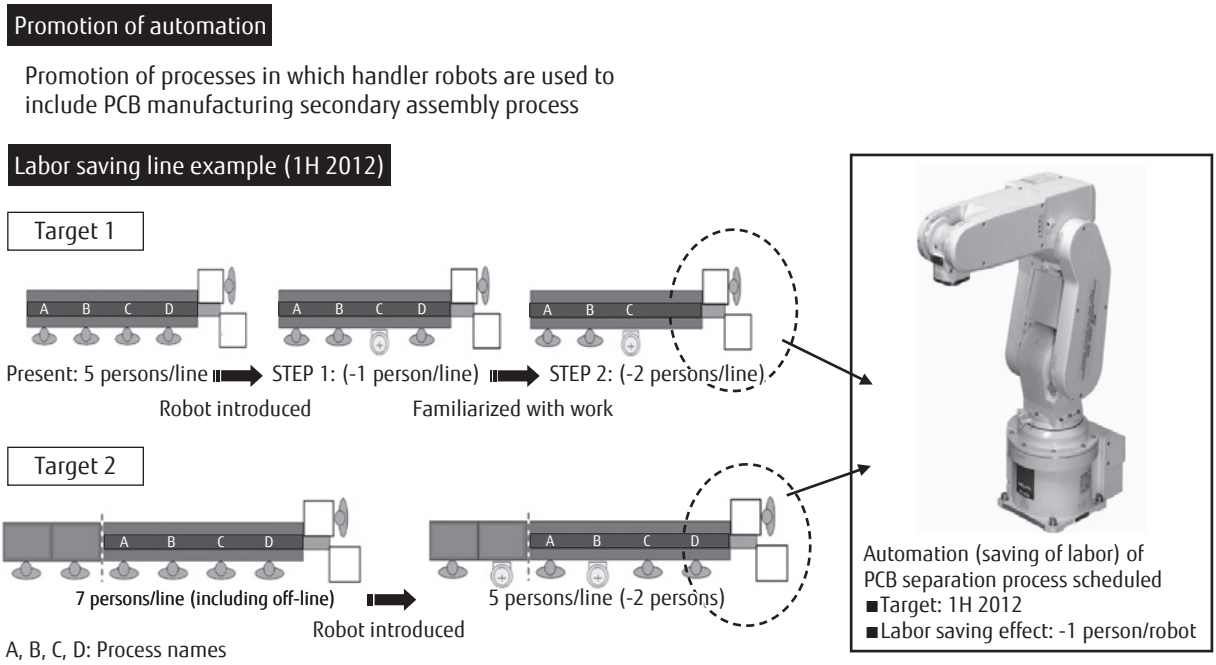

Figure 2
Example of promotion of automation.

3.3 Strengthening of prototyping and evaluation

FMPL owns a line dedicated to prototyping that allows an entire process from PCB assembly (using surface mount technology, or SMT) through device assembly to testing in-house. Unlike the mass production line personnel, the prototyping line personnel are a group of professionals who have been involved in manufacturing mobile phones for a long time. They make it significantly easier to manufacture mobile phones by working with the engineering department from the stage of initial development.

To study assembly technologies, the manufacturing technology and prototyping personnel use 3D digital mock-ups to review manufacturing issues and discuss jigs and tools together with the design department before building prototypes. Manufacturing reviews (MRs) that make use of failure mode and effect analysis (FMEA) are conducted in order to stabilize manufacturing quality at an early stage.

In addition, testing facilities are synchronized with product development to keep up with environmental changes, and this allows challenging new models to be developed and problems to be eliminated before the start of mass production.

In the future, FMPL intends to further enhance the cooperation with the development department based on this prototyping line, and thereby work on reducing development periods and costs. We are also working to build more effective production lines and moving ahead with automation by strengthening verification of mass productivity at the time of prototyping.

3.4 Standardization of manufacturing and repair

As described earlier, simple automation is achievable with facilities that, in a sense, can be adopted by overseas vendors and it is not a decisive factor in differentiating products from those of overseas vendors. So long as we are committed to manufacturing in Japan, the most effective way to add value is to improve production efficiency.

As a way to do this, Fujitsu is promoting innovation at production sites by introducing the Toyota Production System (TPS).[1)] At the same time, at FMPL, data on improvements to efficiency of mass production are fed back to the design section and the three activities described in the previous subsections (smartphone test innovation, automation and robotization, and strengthening of prototyping and evaluation) are carried out. In this way, we are promoting Design for X (or "DFX," where X stands for a variable such as manufacturing, testing, or reliability) as an approach to improving productivity in the design phase.

To standardize manufacturable and repairable designs, we intend to further strengthen the cooperation between design and manufacturing.

3.5 Restructuring activities for smartphone repair systems, space, and logistics (3-to-1 project)

The shift to smartphones has prompted us to innovate our repair system and reorganize our space and logistics while also innovating mass production. The number of units to repair is expected to increase along with the increase in the number of mass produced units, and this has made repair innovation an urgent issue. Accordingly, we have constructed an integrated repair factory while incorporating mass production know-how and promoted innovation that combines mass production and repair to deal with smartphone manufacturing.

At the repair factory, different floors are used for different carriers to realize stronger security.

To construct the integrated repair factory and improve efficiency in terms of shipping and logistics, warehouses, shipping yards and pre-manufacturing processes that were dispersed in various locations outside have been incorporated into the factory.

Smartphones do not have a folding structure and they do not require many pre-manufacturing processes. Therefore, we will proceed to incorporate more processes into the factory so that we can improve efficiency by making them in-line ones. By incorporating processes into the factory to reduce the amount of space needed, which included incorporating external warehouses and shipping yards, we have successfully made it possible to ship products to locations all over Japan from the Nasu Plant.

Concerning logistics, we have reduced transportation costs by reducing the number of external warehouses, and building and operating a circular transportation system.

4. Conclusion

This paper has presented the activities that FMPL is carrying out, while being faced with tough competition in smartphone manufacturing, so that it can continue to manufacture in Japan. While these activities are still underway, we intend to keep making attempts for change and innovation so that FMPL's approach will become the future standard of Fujitsu's manufacturing and form the basis of the Fujitsu Products Standard (FJPS).

One aim we have for Fujitsu mobile phones is to make them human-friendly with Human Centric Engine (HCE) at the core. In addition to continuing to manufacture in Japan, it is FMPL's wish to make use of Fujitsu's IT technology in the process of manufacturing to realize a human-friendly factory and find a common interest with local communities.

References

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