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# Progress of "Genba" Capability and IT/FA Platform: A Case of the Small and Medium Enterprise

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**Abstract**

This paper argues that progress of "genba (manufacturing-site) capability" utilizing Information Technology (IT) and Factory Automation (FA) in Small and Medium-Sized Enterprises (SMEs). It is the big problem how to keep and to evolve genba capability in Japanese industry. For upgrade genba capability, SMEs need to attempt continual "Kaizen" activities, but can't afford to do so from lack of production resource. Considering this problem, we take up case of company A that made attempt to IT and FA platform supporting to enhance genba capability. This paper has as its object to examine progress of genba capability in SMEs according to analyze company A's case.

Keywords: sites (genba), small and medium-sized enterprises, kaizen, information technology and factory automation platform, manufacturing (monozukuri)

## 1. Introduction

### 1.1 Purpose of this paper

The purpose of our paper is to examine progress of "genba capability" utilizing Information Technology (IT) and Factory Automation (FA) in Small and Medium-Sized Enterprises (SMEs). We take case of company A in illustration of this theme. Company A made attempt to IT and FA platform that supports building genba capability cooperating with vendors from 2010 to 2012.

Without a doubt, build genba capability is required in a lot of Japanese SMEs. "Genba" means the space and the group who operate an artifact in an environment, in order to produce an artifact with value (industrial goods and services). Genba afford and create employment to a large number of people. Particularly, in terms of the number of firms, the majority of genba are SMEs in Japan (For further details of number of small and medium business establishments, consult The Small and Medium Enterprise Agency 2012). They hold up many industries (automobile industry, for example). If SMEs can improve genba capability, this makes it contribute to enhance the level of Japanese manufacturing.

By the way, in general, how can manufacturer improve genba capability? When we say genba capability, it generally means manufacturing organizational capabilities (Fujimoto 2012). Manufacturing organizational capabilities is level of ability to do things on site (for example, continually high-productivity, short production lead time). If firms obtain great performance of QCT (Quality, Cost, Time: Lead Time) in genba, they need to improve these capabilities. On the basis of the design theory, which interpret manufacturing as "making design information into things", it is considered to create a good flow of design information (Fujimoto 2001, and 2004, Yoshimoto & Fujimoto 2010). According to the idea of design theory, Japanese blue-chip companies (for example, Toyota Motor) of manufacturing have the following characteristics: They create a smooth design information flow, making it to improve performance of QCT as a result. From their actions, genba assign high priority to solve the problem occurred in operation for aiming long-term rise of performance. In this way, for upgrade genba capability, it 's necessary to attempt continual "Kaizen" activities ("improvement" or "change for the better" in operation field). Moreover, from a historical fact of Japanese blue-chip firms, it is advisable that genba advance kaizen by worker's active effort. As pointed out by Imai 2010, essence of "KAIZEN" is philosophy that incremental improvement with involvement of workers.

However, the progress of genba capabilities is very difficult. This progress requires long time, change constitution of organizational culture, need to scientific approach for Kaizen. In point of fact, SMEs are prevented from building genba capability by particular

problem. They want to wrestle with Kaizen, but can't afford to do so from constraining factor. This constraint, as will be mentioned later, is caused by lack of production resource（resource used for production and development activities）.

Thus, if it is required for SMEs to build keep and to make a highly performance, progress of genba capability may be clearly described. We think IT/FA is a effective means of conquest of difficulties in SMEs. Actually, company A brought problem before SMEs under control by using IT/FA. This paper give a report of company A's achievements with "new fusion of a Monozukuri (Japanese basic concept of Open Manufacturing) concept and advanced technology (IT, FA)". So, Let's us next consider following subjects: what's the deep-rooted problem for Kaizen in SEMs? How does it can solve?

1.2 What's the deep-rooted problem for Kaizen in SEMs?

In many SMEs, there is an the two formidable difficulties : "trigger (chance)" and "persistence" for Kaizen.

To begin with, there is no chance to study way of Kaizen in SMEs. Now, regarding difficulty of trigger, solution is beginning to be found out though. To cite a plain example, there is monozukuri instructors run by Yasu City and University of Tokyo. Monozukuri instructors are senior manufacturing people who have special training in offering manufacturing knowledge at school. They instruct SMEs in knowledge for a certain period. They come up with problem, teach the workers how to deal with the problem, and advance a variety of suggestion in workplace. Monozukuri instructor school made by University of Tokyo, and then affected Yasu City. Like this, Yasu City and University of Tokyo works to construct system that trigger is offered (For this system, see Yasuda 2005, Yoshimoto & Fujimoto 2010, and 2011). Furthermore, many SMEs face the difficulty of persistently carrying out kaizen. This constitutes a serious difficulty, and is more trouble than problem of trigger because of issues concerning consciousness among organization member. Hindrance to Kaizen is following two factors. Both factors are caused by lack of production resources in SMEs.

Firstly, IT/FA that supports kaizen is of the greatest usefulness, but is not difficult to introduce and use it in SMEs. Conventional IT/FA system is constructed on a massive scale, often require a huge budget. Under budget restrictions, genba in SMEs require IT/FA system that it can be installed and maintained at a low cost.

Secondly, Kaizen absorb some time of its own, and require additional burden on genba. For Kaizen, it is important to manage to find time that worker try various remedies and determine working environment. Therefore activity of Kaizen demand different time from what they daily work. However, part of this time contains workhour that does not

yield added value. Though precise measurement time of the working environment gives worker good grounding in Kaizen, it does not raise performance (Q, C, T). Consequently, measurement time is not necessary and sufficient condition to solve the problem in the workplace. If genba hire a staff for doing Kaizen, this problem will be solved. But such choice is an unrealistic notion at the thought that SMEs can't afford human resource. This way, genba in SMEs want to system that establishes continual Kaizen with minimal burden.

Consequently restrictions of production resources, such as lack of human resource and budget restrictions, are deeply rooted among SEMs. But, it will be hard for SMEs to enhance genba capability by continuous processes of kaizen if above system is not generally available to them. For example, there is a possibility that SMEs returns to the previous state after an instruction. Because SMEs are busy in their daily operation, it is difficult to pursue the problem and measure data of the production process. Accordingly creating system of persistence that maintains continuous Kaizen is necessary.

Against this background, vendors and we conducted the actual proving test for creating above system in company A from 2010 to 2012. Below, we focus particularly on persistence issue, explain company A's experience in the actual proving test, and then examine progress of genba capability.

## 2. Case of company A

### 2.1 Company A overview

Let us first look at capital, number of employees and product of Company A. Company A's capital is about 13 billion yen. Number of employees is approximately 1,800 persons (consolidated, Term ended March, 2012). Company A design, produce and sell high-density multilayer printed wiring boards (PWBs) and automated visual inspection for inspection process of PWBs. Company A sell product to variety field: Automobiles, Consumer electronics, Amusement equipment and so on. A's factories are located in Japan and China. Company A has five plants in Japan, are making the division of labor between these plants.

Company A has received the teaching of the monozukuri instructors. The instructor assisted the "genba a" of the five plants in Company A. PWBs are produced in two ways: The photographic method and the print method. Genba a make the resist and the pattern of PWBs by The photographic method. In the genba a, internal failures was affecting the cost competitiveness. Monozukuri instructors focused on the internal failures and worked on improving this problem.

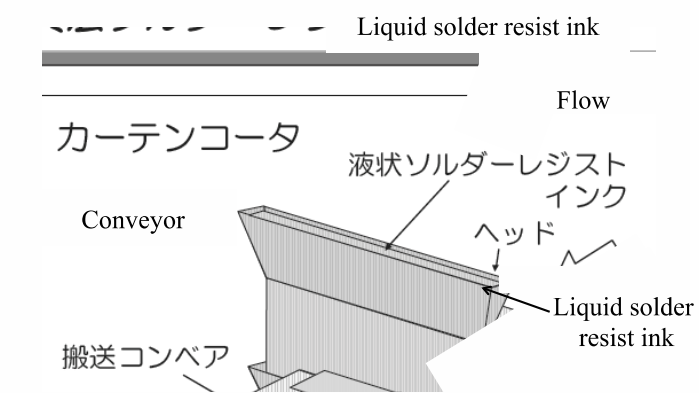
But genba a is the thinness of improving awareness in workplace. This was the genba a's biggest problem. Kaizen was the ad hoc and depended on skill of workers in genba a. In fact, Company A's manager said that many improvements were sense of workers, not scientific approach. Moreover characteristics of the failures that convert good product by rework had confusing the problem. Monozukuri instructor's aim was that genba a can actively improve flow. After an instruction, genba a became necessary to create a system that maintains continuous Kaizen. As a result, vendors and we work on actual proving test for creating this system in genba a. In this regard, we think that genba a is most appropriate case to consider problem of "persistence".

**2.2 Actual proving test in the Liquid Resist Process**

Figure 1 shows the production process that we are targeted at. This process is called "Liquid Resist". In genba a, liquid resist is the core of internal failures. We decide to target the liquid resist according to discussion by Company A and vendors. In liquid resist, they paint both faces of PWBs liquid solder resist ink. They use equipment called "Curtain Coater" for paint. Process flow of liquid resist is as follows: Paint, Preliminary drying, Exposure, Developing, Drying (see Fig. 2).

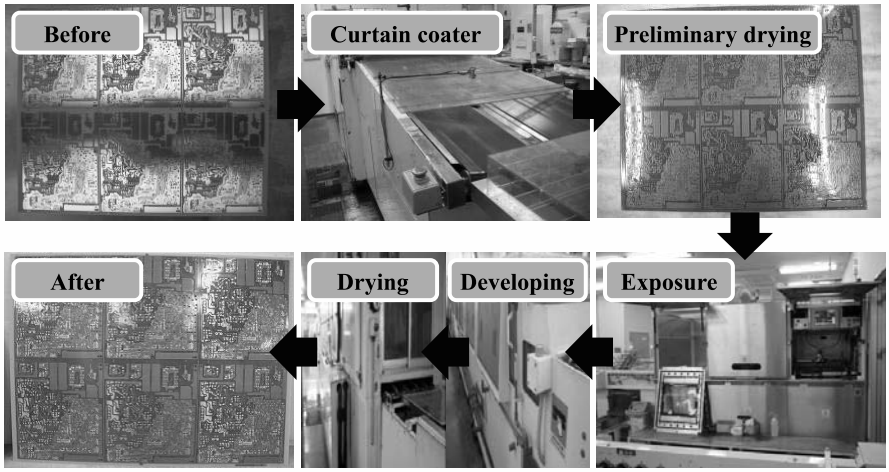
Internal failures were "unevenness of liquid solder resist ink". Occasionally, effect that not well painted with ink was caused in liquid resist. Genba a took two approaches to improve. They attacked task of measuring the changing working environment on the one hand, and analyzing defective product on the other.

Fig. 1. Liquid resist process




Source: Company A

Fig. 2. Flow of liquid resist process




Source: Company A

**2.2.1 Relationship between failures and working environment**

Genba a kept a daily record of working environment in written form. The worker recorded condition by hand, are called “Sagyou Nippou”. But anybody did not exploit these documents.

Liquid resist is station that produce intermediates of PWBs. Genba a can’t inspect this intermediates for failure because of product characteristic, and then install inspection machine in the backend of Liquid resist. Therefore, they took a long time to know the failure in genba a. After recognizing the failure, they investigate the Sagyou Nippou. However, since Sagyou Nippou is handwritten, this seeking task is troublesome. Moreover, they can’t bother about such complicated task at busy times of daily operation. Consequently, when working environment was turning nasty, worker adjusted a condition to standard for situation. Genba a could not grasp causation of unevenness, and explained the basis for their question: Why the working environment had changed, what did worker adjust, were failures directly caused by changing working environment?

To begin with, genba a tried to grasp relationship between failures and working environment. This task was carried the following steps. First, they converted daily document into database, and analyzed it. Vendor’s comment and Flow-Oriented Approach (FOA) suggestion helped the progress of the converting materially (For FOA, see Oku, Park & Abe 2010). FOA is view that IT system of user initiative need for SMEs. One of FOA's ideas is that worker know better than anyone else for causation of failures. Therefore, according to FOA view, workers analyze the causes of failure using cause and effect diagram in genba a. Then, they decided to convert the data in the two indices (temperature of ink and room temperature) on this analysis. They identified lot number of defective

product by inspection, and then checked variation of environment by database. Second, they attempted to gather date from liquid resist device automatically. Genba A introduced following two devices: The device for monitoring temperature of ink, and for measuring room temperature. These devices are generic and cheap. Vendor supplied genba a with knowledge and know-how about device.

These efforts enhance the prospect for Kaizen and brought about the three outcomes in Company A. Firstly; they know that failures were not directly caused by changing environment (temperature of ink and room temperature). However, fluctuation of working environment is not good. An increase in temperature of ink and room would affect their operation considerably. Therefore, they need to solve this fluctuation. Secondly, they get knowledge for which they can practical application in another production process and equipment. In other words, they became possible to deal scientifically with the matter that occurred in genba using data. Furthermore, We note the fact that they decided to introduce these automation device after careful consideration, did not put a higher priority on the introduce programs. Finally, it points out the importance, they are likely to afford time for Kaizen. We think that automatic gathering date produced a margin for improvement.

**2.2.2 Understanding the "core" about failures**

Next, genba a analyzed the causes of defective product rigorously under a electron microscope, and finally found out the "core" about failures. As a result of the element analysis, then they understood clearly what "core" is. "Core" is made from an ingredient α. In brief, this infusion brings about dispersion of outturn. They discovered an ingredient α under an electron microscope but not stereomicroscope. However, any material that use in the liquid resist did not include an ingredient α. Therefore, they arouse following questions: Why is an ingredient α mixed into surface of PWBs, Where an ingredient α is being introduced?

To solve these question, genba a began to explore front-end process, and airflow in process of liquid resist. Moreover, to comprehend airflow, they invest the device for measuring particle and are analyzing a problem. Of course, they adopted the same method with regard to temperature of ink and room temperature as with the device for measuring particle. In brief, this device was generic and cheap. As a result of this effort, they understood that contamination was due to dust resulting from degradation of heat insulating material in the pretreatment equipment. In addition to keep out the dust, they put heat-resistant tape over heat insulating material, and did maintenance on equipment.

As shown above, Kaizen, which started with the certain process, prompted an investigation of other process and equipment. They conducted these efforts from the

autumn of 2010 to the spring of 2011. Next, we will confirm their efforts in the springtime of 2012 from the summer of 2011.

2.2.3 Creation of the prototype of IT/FA platform

After introducing three devices (temperature of ink, room temperature and particle), genba a furthered Kaizen. They took following two approaches to problem solving.

First is detailed consideration of changing environment. Genba a brought in additional devices for measuring room humidity, and for monitoring viscosity of ink. Consequently, they became possible to understand the various aspects of the working environment. Moreover, they reviewed the way management of each instrument. An outstanding example of this effort is seen in monitoring temperature of ink.

As stated previously, in coating machine, they gave both faces of PWBs − solder side and component side − coat of liquid solder resist ink. Because of mechanical efficiency, it frequently happens that time to paint solder side and component side are different, instead of coating both side at the same time. The working environment varies, according to the time of day. Then, the following situation occurs: failures are found in solder side on the one hand, and on the other component side is not defective. But, genba a has managed to divide solder side and component side. Accordingly, they construct a system to automatically record them separately, and then are able to fully grasp working environment.

Second is expansion in the range of activities for problem solving. Genba a create a prototype of the system that maintain and share collected data from each device. We call this system IT/FA platform. Let us consider effectiveness of IT/FA platform by confirming how they made this system in order of time.

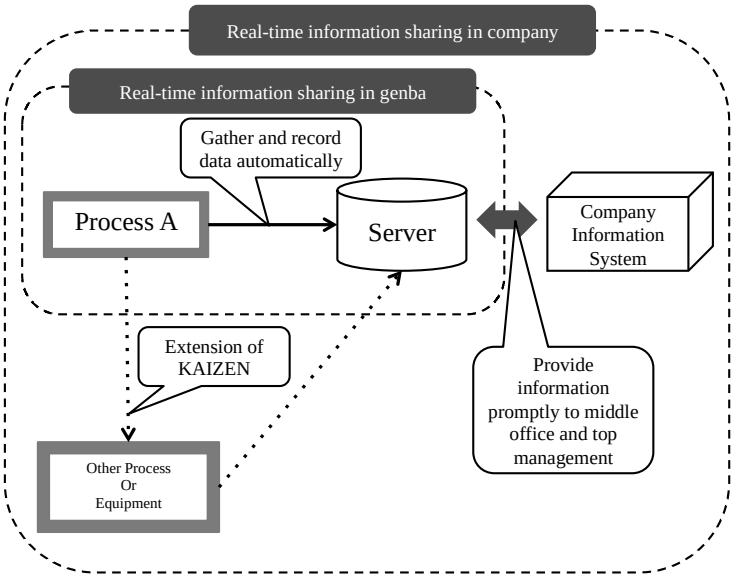
For a start they compiled the data gathering from five devices (temperature of ink, room temperature, particle, room humidity, and viscosity of ink) in a server computer on a batch-by-batch basis. On the other hand, similar to five devices, inspection results are sent to a server computer on a batch. Consequently, on server, they can know the working environments that produce lot including defective. Next, they shared these data (five devise and inspection results) with genba member and insider. IT/FA platform use generic software to link five devise to inspection results, which means that they take control of it autonomously. If they add additional facility as Kaizen advances, it is connected to the server computer whenever circumstances require (See figure 3 “Real-time information sharing in company”). In order to analyze and improve the problem, all members were able to take advantage of the date and advanced an opinion.

Finally, they linked server computer to the information system at headquarter (See

figure 3 “Real-time information sharing in genba”). As a result, they give out data promptly to middle office and top management, and involve these people in problem solving. Kaizen is company-wide subject as well as genba a’s subject in company A. Thus, actual proving test came to a close.

In this way, they tried everyone within the organization can see the internal data in company. During the development of IT/FA platform, the vendor’s knowledge gained form one’s own experience has greatly contributed. Genba a quickly build this IT/FA platform by the utilization of vendor’s practical knowledge.

Fig. 3. Accumulate and share internal data




Source: made company A’s and vender’s internal data

**3. Progress in genba capability**

Here, we examine the points for progress in genba capability in SMEs from the efforts of genba a. There are at least two following points: (1) IT/FA lighten load of additional work for Kaizen, (2) IT/FA platform unify intent among organization member. Below, We take these points in turn.

(1) IT/FA lighten load of additional work for Kaizen

Kaizen require worker to engage in additional task, such as the measurement and trial and error. Figure 4 shows relation among workhour and time as measured. First of all, let us describe span of problem solving as “Kaizen Lead Time” (For Kaizen Lead Time, see Yoshimoto & Fujimoto 2011). Kaizen lead time is composed of two factors. One of factor is measurement time of the working environment. Another is task as follows: Worker

consider a appropriate way to solve problem and a matter under consideration closely among everyone for workplace, Worker get a clue to improve process by trial and error etc. It might not improperly be called "Net Kaizen Hour". This net Kaizen hour is directly linked to rise in performance (Q, C, T). If Kaizen lead time is the same as ever, net Kaizen hour increase as more and more of measurement time is reduced (See figure 4 after 1). Moreover if Kaizen lead time can be shortened, then genba carry out various activity: They get down another matters for improvement and so on (See figure 4 after 2). That is to say, genba rise number of problem solving.

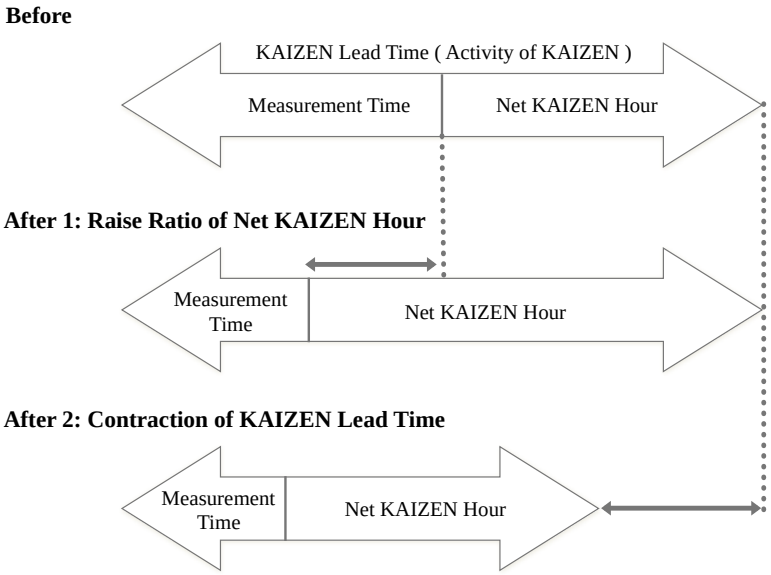
Thus, in any case, it is important to method for reduction of measurement time. Introducing automated measuring devise is one of the best ways of doing it. Because of this, worker can play active roles in Kaizen with minimal additional load. Again, in genba a case, they introduce automation device as needed at conference with vendor. For that reason, they could increase net Kaizen hour, or shorten Kaizen lead time. Then they make a start in the analysis of defective product, and improvement of front-end process and equipment. This genba a case suggest that IT/FA produce a margin to launch front-end process and equipment.

However, this is not to say that it is only necessary to introduce IT/FA in genba, and moreover that IT/FA bring about desirable effects such as reduction of Kaizen lead time immediately. Actually, regarding case of genba a, we think that effect on there's subsequent actions was the period between the start of actual proving test and the first time adoption of a devise. In this period, they went through the process of considerable trial and error cooperating with vendor. Accordingly, they get knowledge concerning scientific approach to Kaizen as explained above.

Figure 5 is total process of genba a's experience. This figure show the approximate amount of time required to each effort. We know that it takes long time to finish working on installation of first device, and takes only a short time to complete adoption of additional programs on the other hand. They verify a number of hypotheses and consequently acquire the skill of scientific method over a long time.

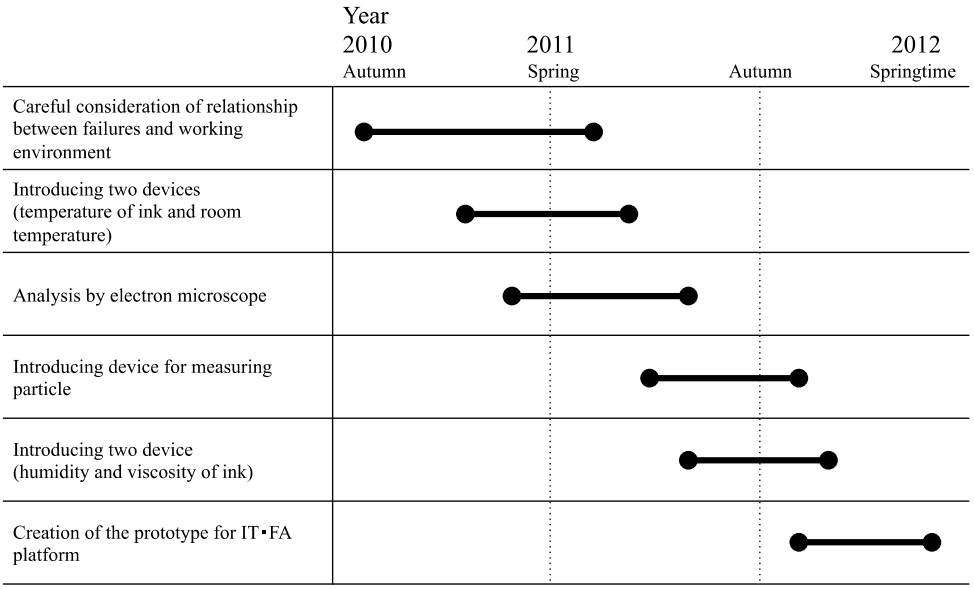
Furthermore, the cost of devise would change depending on trial and error in this term. If genba can narrow down the limits of their problems, they just purchase device of barebones function, and then hold down the costs of device. As just described, genba a's experience can clearly show importance of previous arrangement about introducing devise.

Fig. 4. The Concept of KAZIEN Lead Time




Source: made Yoshimoto & Fujimoto 2011

Fig. 5. Total process of actual proving test




Source: made company A's and vender's internal data

(2) IT/FA platform unify intent among organization member

Considering establishment of Kaizen, IT/FA is useful for creating workplace environment that allows organization member to participate in Kaizen activities. Many theoretical and demonstrative studies point out some features of Kaizen in Japanese firms

(Imai 1988, Nihonnouritukyokai 1978 etc.). Of course, improvement of operation based on industrial engineering is common activities in any other countries and regions firms, but characteristics of Japanese (called Kaizen), especially in the Japanese blue-chip companies (for example, Toyota Motor), are two; full participation by all the members, and bottom-up action (Fujimoto 2001). These companies have some tools to instill the conscious of KIZEN for the achievement of full participation. As an illustration of these remarks, we may take just-in-time system. In just-in-time system, inventory cutting of work-in-process expose many problems (loss of efficiency and dead time etc.), and as a result, Kaizen take root in organization through the solution of these problems. In the same way, IT/FA act as an engine in establishment of Kaizen.

Figure 6 shows development of Kaizen in case of genba a. From precedent, Kaizen that starts at the particular process affected another problem through reduction of measurement time (contraction of Kaizen Lead Time, or Increase in ratio of Net Kaizen Hour). This means that introducing IT/FA bring problems to light, and call on genba to analyze front-end process and equipment. At this time, knowledge and method obtained in (1) contributes greatly to the analysis of cause. Genba can apply the same basic approach to improve other problem. As the introduction progresses genba can verify a number of hypotheses by use of devises. Subsequently, integration of devises into server computer and into the information system at headquarters make organization member share internal data.

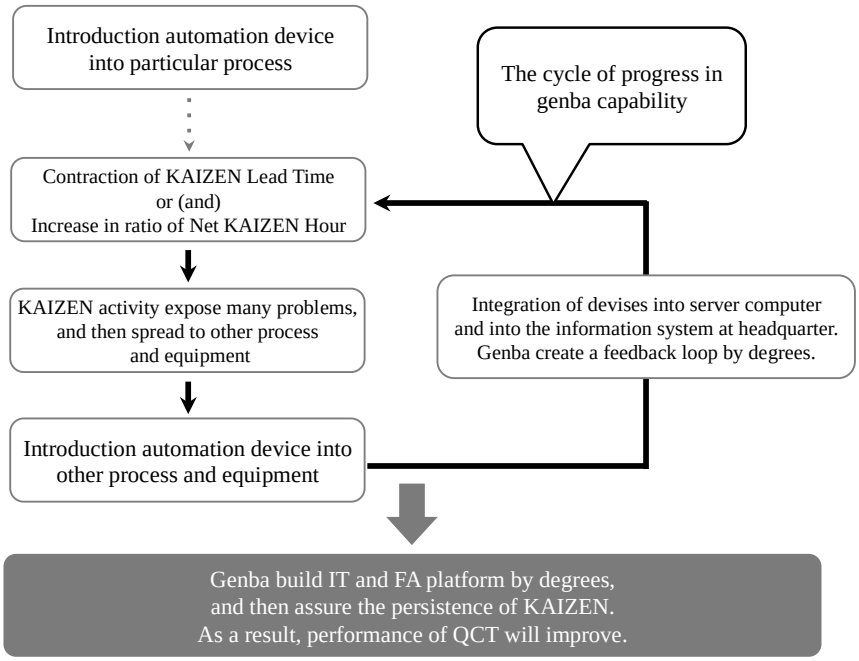
This integration exerts a favorable two influence upon genba. First is physical influence. By use of IT/FA, a cyclical of hypothesis and test can be converted into platform (hardware). With the expansion of Kaizen, platform builds up systematically on genba and offers more data to organization member. Therefore, everyone identify outcomes of Kaizen and daily status of production. This brings about a second effect. Second is mental impact. Everybody in genba and company can find small changes of daily work, such as relatively small rise in temperature of ink, as above platform. Hence, everyone can talk about this problem, and then create favorable atmosphere for everyone to come up with concrete actions to solve the problem. This platform forms a feedback loop between genba and headquarters, and therefore unify of intent among organization member. As a result, Kaizen will be impressed on the member's consciousness.

We tag above Kaizen process produced by application of IT/FA as “The cycle of progress in genba capability”. This cycle is the very essence of IT and FA platform of bottom-up type. If genba keep this cycle in successful operation, according to produce a little outcome, they can build platform by degrees. By continued repetition of practical use

and enlargement of platform, gradually intense consciousness of Kaizen can be developed among organization members. This cycle that physically and mentally affect genba exists as providing "persistence" of Kaizen. Ultimately, performance of QCT will improve.

As a matter of a fact, this cycle closely parallel Japanese blue-chip companies of manufacturing actions. As we pointed out earlier, they give preference to improving design information flow, instead of aiming to better short-term performance. By this means, it is the same essentials.

Fig. 6. The cycle of progress in genba capability




Source: made authors

**4.Conclusion**

This paper discussed issues in progress genba capability from the aspect of utilization of IT/FA. We regard actual proving test of genba as exemplification that solved problem under restrictions of production resources (lack of human resource and budget restrictions) in SMEs. The point of building genba capability is that genba run the cycle of progress in genba capability speedy. This cycle brings about an evolutionary change in Kaizen lead time or net Kaizen hour. As a result, workers more actively engage in Kaizen. IT and FA platform of bottom-up type is a most effective means of building this cycle.

By the way, from different viewpoint, this platform may seem like patchiness. Certainly genba a will enter into the period toward a complete unification of devises. But we think that function of this platform sufficient to gain foothold toward solving problem

with scientific approach for Kaizen. Therefore, this platform is an introductory model (entry model) for SMEs, which was suffering from lack of production resources. It is for this reason that we describe IT and FA platform in genba a as the prototype.

By discussing genba a, we can derive concept of building genba capability from their experience. However, case about this paper is a solitary instance. Hence we need to explore other cases, and enrich case study in order to illustrate a concept provided by this paper.

＊ This paper is grounded in Yokoi, Yoshimoto and Fujimoto 2011, and makes a drastic revision and correction. When we wrought above paper (Yokoi, Yoshimoto and Fujimoto 2011), genba a is not entering the termination phase of actual proving test and complete construction of prototype of the IT/FA platform. Similarly, in this sense, progress of genba capability was still in the intermediary stage of development. Therefore, We think that it is imperative to update a fact, and then reconsider the concept of genba capability after constructing this platform. To clear progress of genba capability, we wright this paper.

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