Improving the Productivity of Food Manufacturing through Information Technology

—Case Studies of Medium Sized Food Factories—

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Abstract: The tasks in factories consist of direct jobs and indirect jobs. Waste usually exists in the indirect jobs. The management of a factory focused on the differences between the production schedule suggested by our software and the actual schedule, and wasteful tasks were successfully cut by studying the causes of these differences and by responding to their causes. The supplied manpower was decreased by more than twenty percent in a food factory of high-mix low-volume production. The use of suitable information technology proved to be effective even in a low productivity manufacturing industry.

Key words: direct job, indirect job, scheduling software, scheduler, food–manufacture, productivity, level production, high-mix low-volume production, IT

1. Introduction

The productivity of food-manufacturing process is quite low, i.e., less than 60% of the mean productivity of all manufacturing process [1]. Food manufacturing involves highly productive equipment-intensive manufacturing processes such as those for oil, seasoning, milling, and sugar production, and labor-intensive processes with low productive such as those for baking & confectionery, traditional fish cakes, delicatessen products, and so on. Most employees of food-manufactures work in medium sized (employee numbers 50-199) factories. Increasing the productivity of low productivity process such as those mentioned above is important for improving the overall productivity of food-manufacturing processes [2] [3]. In this paper, the author studied the effect of introducing information technology (IT) into a medium sized bakery and a medium sized frozen dough factory (labor-intensive factories).

2. Requirement for productivity improvement

Productivity is calculated by dividing the amount of value-added by the amount of manpower used. Accordingly, either increasing the amount of value-added or decreasing the amount of manpower would increase productivity. In order to increase productivity, increasing the value-added by expanding the sales volume is one possible strategy. However it is difficult to expand sales volume of low productivity food manufactures in the Japanese domestic market as the population has started to shrink gradually. Increasing the value-added by developing new products is also important. Although we aspire to increase the value-added, practically, it may be difficult to do. Nevertheless, this matter will be discussed in future reports.

Meanwhile, there is an acceleration of automation involving the introduction of equipments to factories in order to improve productivity by decreasing the amount of manpower. The manufactures who have realized factory automation are involved in equipment intensive manufacturing process such as those used for oil, milling, and sugar production as described above. The majority of these are manufactures that make food-ingredients for processed-foods from plant materials in large-scale facilities. The problem with such facilities is their costs; not all companies can afford such expensive facilities.

Another is that manpower input needs to be used efficiently via good work-shift management. The author defines direct jobs as those used to make products directly and indirect jobs as those involved in preparation, idle time, waiting time, needless work, meetings, and cleaning that are indirectly involved in the making of products. Although cleaning is an essential job for a food factory, as workers are inclined to extend the time used for cleaning beyond that which is than necessary, we have classified cleaning as an indirect job. As the amount of manpower needs to be decreased to raise productivity, increasing the efficiency of direct jobs and decreasing the time used for unnecessary indirect jobs are important.

3. Increasing the Production Efficiency of Low

Productivity Manufacturing Process

The features of the food manufacturing processes such as those used for daily fresh foods are high-mix low-volume production, handmade-like products, large workload fluctuations that depend on the number and nature of the items being produced, and a short delivery lead time from order entry. In general, the people involved in these manufacturing processes tend to adhere to the delivery deadline rather than concentrate on the efficiency of production because the production process is so complicated, and the control and planning of production are pretty difficult. This is the reason why the productivity of the daily fresh food manufacturing process is lower than that of other manufacturing process.

As decreasing the amount of manpower is important for increasing productivity, an appropriate amount of manpower should be allocated on a minute by minute basis, and unnecessary jobs should be eliminated as much as possible. The conditions for efficient factory management are **A**: establishment of an efficient work method, **B**: recognition which jobs are necessary, **C**: rational scheduling of manpower that matches the natural variations in the job, **D**: making a work shift pattern for realizing **C** and **E**: an awareness of the necessity of improving productivity (The need for a low cost operation).

4. Case Example of a Bakery

4.1 Actual manpower allocation

This case concerns a medium sized central bakery that supplies more than 100 baking goods for over 100 retail shops a day [4]. The bakery employs approx. 90 workers. Fig.1 which was made by the Ad-lib (Technova Co., Ltd.) production scheduling software, [5] shows manpower conditions in the bakery. The figure consists of an upper Gannt chart, which shows an employee's labor schedule (a: the medium light gray areas present duty hours and b: the light gray areas present breaks), and the bottom histogram shows the amount of manpower (c: gray and d: dark gray) that accumulated throughout the employee's duty hours and their workload at every minute, which was calculated using the production scheduler shown in the upper Gannt chart displayed in Fig.2. The abscissas axis shows the time from 5 o'clock pm to 3 o'clock am of the next day. The factory's work starts at 8 o'clock pm, and man-power is supplied from 7.30pm unill 5pm of the next day. As the direct jobs in every minute make up the minimum amount of manpower required, when the manpower amount is lower than minimum amount required, the production line operation will be stopped or delayed. On the other hand, when the manpower amount exceeds the amount required, waste such as vacant hands and hands waiting will occur.

The time required to complete the direct jobs (man-hours (m/h)) was 84 hours 26 minutes; and the manpower supplied was 139 hours 30 minutes. Although the difference between the manpower supplied and time required does not perfectly correspond to time wasted, a lot of manpower supplied might have been wasted.

4.2 Difference between man-power input and manpower required

The factory demonstrated two peaks in manpower required, one was from 4.30 am until 6 am, and the other was from 9.30 am until 1 pm. However, the peak of manpower supplied was from 8 am until 11 am as shown in Fig.1. The manpower supplied during this time was excessive and so was used inefficiently. Shortages of manpower were found at 4.30 am to 6 am and 11 am to 12 pm. Although the production department requested the labor department to recruit manpower for the early morning, the labor department could only supply manpower from eight or nine o'clock, which is the regular starting time in Japan, since recruiting manpower for the early morning is difficult. Another is that many temporally workers take lunch break at 11 am.

Although such a situation is evident on a scheduler's screen, the majority of managers in factories that do not have such software can not recognize the labor load variations that occur each minute, which seems to be caused by the differences between the requests of the producing department and the recruitment by the labor department.

4.3 Measuring time used for indirect jobs

The time required to complete the direct job was 84 hours 26 minutes; and the amount of labor supplied was 139 hours 30 minutes as described above. Changes in the time spent on indirect jobs spend on several conditions. If indirect jobs require 50 % of the time taken to complete the direct jobs, $84.43+84.43\times0.5=127$, the time required to complete

the job would become 127 man-hours. If the time required for such indirect jobs could be decreased to 30% of that required for direct jobs, the necessary labor volume would be 110 man-hours. The necessary labor amount would therefore be decreased by 12 man-hours and 30 man-hours respectively. Reducing the time taken by needless jobs is the key to improving the productivity of food factories.

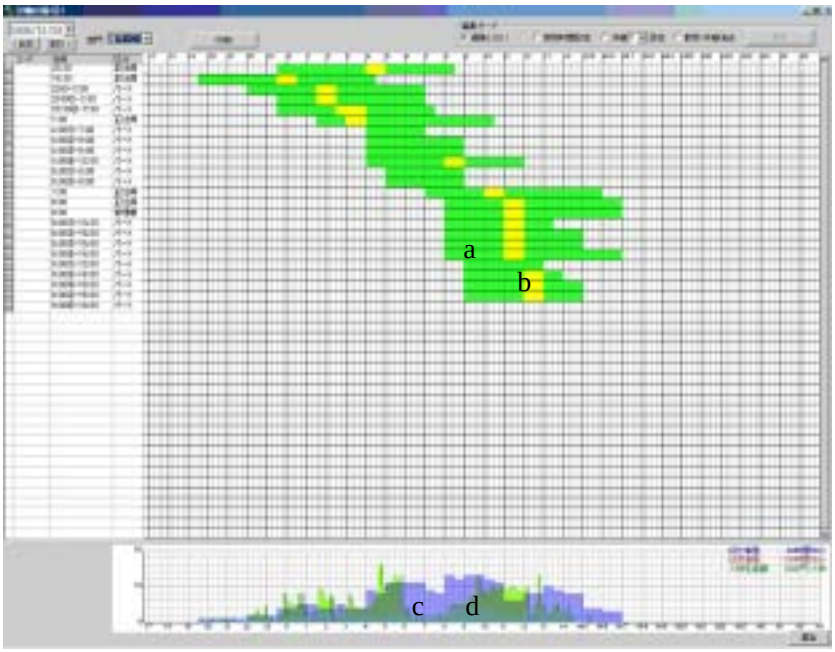

Fig.1: A labor shift Gannt chart by the Ad-lib software
a: duty hours
b: break
c: indirect job
d: direct job

* These figures show the original Japanese version. An English version is available on request.

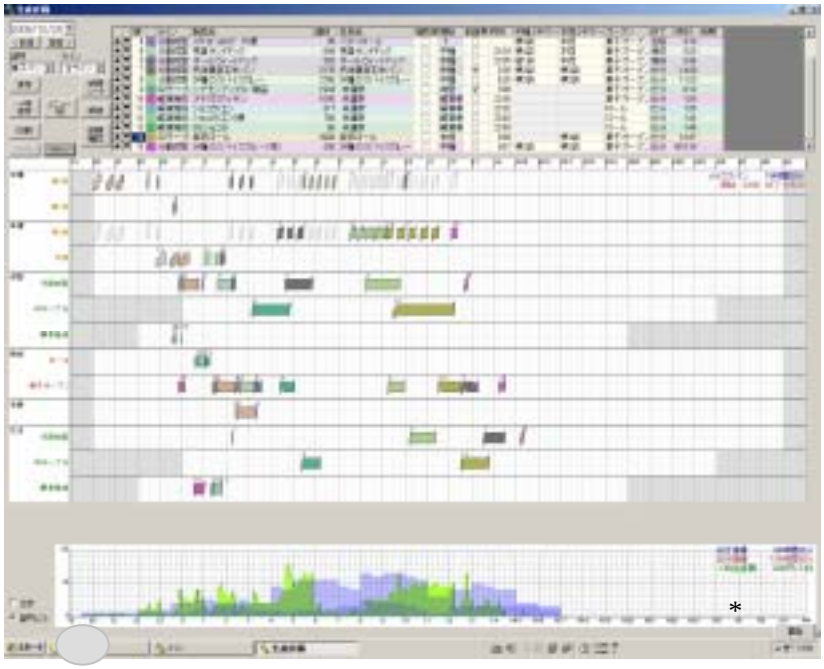

Fig.2: A screenshot of a production schedule Gannt chart by the Ad-lib software.
* same as above bottom

4.4 Lack of awareness of man-power inefficiency

Unfortunately factory managers often do not notice manpower inefficiency. The author thinks that this may be caused by Japanese nature and ethics. That you are not obligate to work if you have not been set a task is Western style thinking, however, Japanese employees think differently. When a Japanese employee has completed the task set for them, they look for another job or create a new task; for example, excessive cleaning, unnecessary arrangement of items, frequent, putting out of the trash, unnecessary preparation for future jobs, and so on. Therefore, the factory looks very

busy. “He moves well” is a compliment in Japan. “He produces good results” is not used usually. The majority of Japanese managers expect their workers to “move diligently”, and they do not recognize the difference between “move” and “work (make value)”. Japanese employees are therefore inclined to engage in pseudo-jobs to please their manager. Therefore, managers are not aware of the manpower inefficiency mentioned above.

Another cause of manpower inefficiency is the mismatch between the variation in labor load (manpower needed) during the production progress and the manpower supplied by the labor schedule. It is probable that more pseudo-jobs are carried out during such mismatched period.

The discrepancy between the peak of manpower requirement and the peak of manpower supplied breaks rule **C**: rational scheduling of manpower to match the natural variations of the job. However, the majority of food factories can not estimate the amount of manpower required for each period of time, because the production conditions of these factories is so complicated. In order to satisfy condition **B**, an accurate production schedule should be calculated based on the workload in each minute.

Another cause is that as many managers recognize that temporary workers are a cheap labor resource, they usually do not make a carefully planned work schedule for them.

5. Case Study of Frozen Dough Factory

5.1 Adoption of the software

This case involves the introduction of the Ad-lib software into a medium sized frozen dough division factory that employs around fifty workers [6]. The factory has 4 production lines and makes approx. 25 items a day among more than 200 products. The factory used to be open from 6 o’clock in the morning until midnight and sometimes would stay open into the next day in order to respond to complicated orders. During this period, the factory was operated based on experience and gut reaction. The factory management has been considering concurrently a reforming from an experience and gut reaction. Recently, the factory management has been considering using a more modern management method. The production plan of the factory was nominal and insufficient until the adoption of the Ad-lib software. In addition to using the software to make a better production plan, the management expects that it will help their young staff understand more about production efficiency. Although the company had been recording total labor time, ingredient loss, etc on a personal computer, they found it difficult to precisely plan the next day’s production. The management decided to adopt the software in February, performed a field test in September, and began using it operationally in November.

5.2 Improvement of Productivity

The mean manpower supplied is approximately 250 man-hours a day when the software was initially adopted. This included approx. 150 man-hours of direct jobs and approx. 100 man-hours of indirect jobs. The close of work was later than the end of manpower supply planed on September 2nd as shown in Fig.3. Overtime work exceeded 15 man-hours more than the manpower planed. Accordingly, the supplied manpower was 273 man-hours; direct job times accounted for 151.3 man-hours, and indirect job times accounted for 121 man-hours. The mean ratio of direct job time to total manpower supplied was approx 55% before the introduction of the software.

The management aimed to cut down on needless indirect jobs. They decided that the goal of the introduction of the software was to save 1.5 million yen each month. Indirect job time reduced from 120 man-hours at the onset to 60 man-hours in November. The saving of more than 50 man-hours was made by cutting the number of indirect job hours in half. This was achieved by adjusting the line balance, altering the production sequence, work scheduling, and so on. Assuming that the production cost was 1500 yen/m/h, the reduction labor was 50 man-hours /day, and the number of operating days per month was 25, the initial goal of 1.5 million yen was achieved because the reduction in the labor cost was 1500x50x25 1,875,000 yen. Thus, the ratio of direct job time to total working time increased from 55 to 75 percent. The ratio subsequently increased 85 percent.

5.3 Effect of introduction of the software and the change in the management’s behavior

Since the software has functions that help with inventory control, production planning, estimation of ingredient consumption, and so on in addition to production scheduling, it can model factory conditions

in future for instance to develop rational work-shifts that match the production schedule during the planning stage.

The finishing time of the factory became stable after the introduction of the software and was almost the same time week to week. Indirect job time per day was immediately decreased by around 10 man-hours after the introduction of the software. Assuming the production cost per man-hour (m/h) was 1500 yen, total production cost a day decreased by 15000 yen, equivalent to more than 4,500,000 yen per year, which was previously being thrown away unconsciously. The management did not notice the loss or accepted the inevitability of it due to experience and gut reaction. The modeling of factory conditions by the software made the management change their views. They noticed that they had not seen the factory scientifically until its introduction.

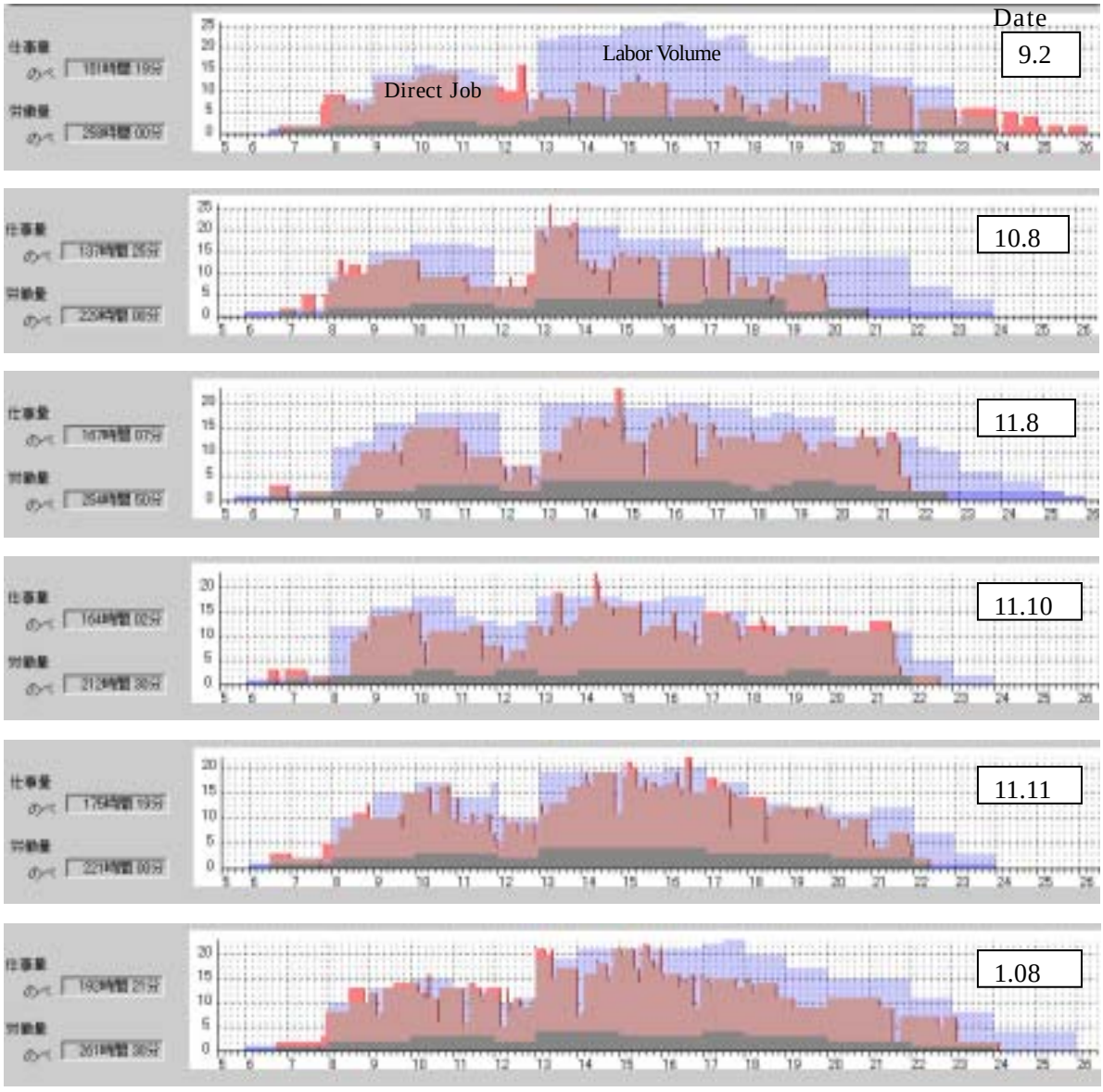

Fig.3: Decrease in manpower supplied and indirect job time

The minimum unit of production time in this factory used to be five minutes; however, as the software can plan minutely, it enabled the management to understand the value of each minute. The visualization of waste clearly changed their awareness and behavior. After they checked the results, they planed their next goals and carried them out every day. Although their goals became gradually more difficult, they successively created solutions to achieve these goals. For example, when the software highlighted a production bottleneck

due to an invisible disadvantage of machinery used; they improved productivity by solving the problem.

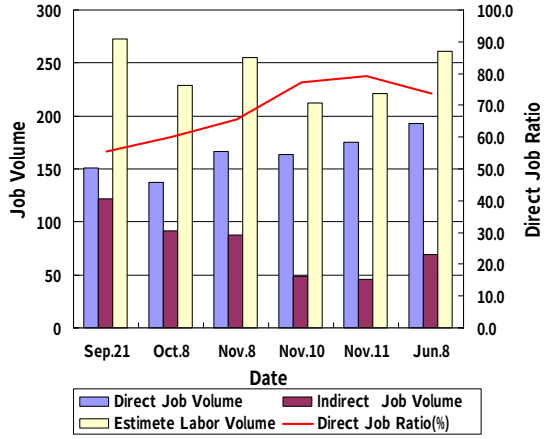

Fig.4: The increase in productivity in a frozen dough factory

Concluding remarks

The jobs in factories consist of direct jobs and indirect jobs; we noticed the indirect jobs include waste. The management in a factory we studied succeeded in cutting waste by half using the Ad-lib scheduling software. They focused on the differences between the rational production schedule suggested by the software and the situation on the factory floor. The success in cutting waste was achieved by constantly studying the causes of these differences and responding to them. Many kinds of previously invisible problems were exposed and solved by using the software. As the necessary of amount of manpower could be modeled for each minute by the software, the management was able to work out balance production better by changing the production sequence and adjusting work schedules. Consequently, the supplied manpower was decreased by more than 20 percent in a food factory involve high-mix low-volume production. Thus, it was confirmed that the suitable use of IT can deliver value companies even for low-productivity food -manufactures.

Note: Change “Estimate” to “Estimated” in Fig.4

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Biography

The author was born in Yamaguchi Pref. in 1950. He graduated from the master course of Kagoshima Univ. in 1976. Degrees: Master of Fisheries, Doctor of Agriculture (Kyusyu University), Memberships: Commissioner of Japanese Society for Cereal Scientists, Member of Japanese Society for Food Science and Technology, Japan Society for Production Management. Key papers “History of the First Breadmaker in a One-Cubic-Foot Bakery Plant”, *Cereal Food World*, American Association of Cereal Chemist (2000), “The Actual Circumstances of Food Industries in Japan” *Production Management*, the Japan Society for Production Management (2008). “Work toward Productivity Improvement serialized” Monthly Food Factory Manager, Japan Food Journal co., Ltd., Tokyo (2007-08)