DEVELOPMENT OF LABOR STANDARDS FOR A PLASTIC BAGS MANUFACTURER

by

Mr. Ritthikorn Uaphadunglert

A Final Report of the Six-Credit Course
CE 6998 - CE 6999 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
in Computer and Engineering Management
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The Graduate School of Assumption University has approved this final report of the six-credit course, CE 6998 – CE 6999 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

This project investigates each production process in UTK Co., Ltd. which produces plastic bags. The operation problems occur from inadequate planning so the production department has more jobs interrupting the process. There are problems of raw material loss and late delivery.

This project applies job measurement to determine and estimate time required of each step in production process. Stopwatch time study technique is used to find the standard time of each job element. The plan starts with studying the process existing. Next, data collection and target improvement are done. Then, improvement plan is analyzed to increase work efficiency. The study of the project includes interviewing operators, observing the operation, measuring the time and analyzing improvement plan.

Before the improvement plan is implemented, the standard time has to be set in each operation element. The result of the research can be developed into a program. This program can calculate time consumption of each job. So the planning schedule can be set. This schedule will help the sales department to know the delivery date and help the production department to set production schedule.

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I am indebted to the following people and organizations. Without them, this project would not have been possible.

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I. INTRODUCTION

1.1 Overview

UTK Co., Ltd. is one of the leading companies in the plastic packaging industry in Thailand, which mainly produces Polypropylene, Linear Density of Polyethylene, High Density of Polyethylene; most of the materials are first grade of plastic materials. This company was established in1975, which is accounted for more than 26 years in this business.

Currently, the production capacity is 100 tons per month or approximately 1,200 tonnage per annum. Productions of plastic bag sizes are varied from 1 inch to 40 inches. Because this business acts as a supporting industry, products are mostly supplied to various industries such as hotels, garment industries, food industries, hospitals, department stores and retail companies. UTK supplies its products to both local market and overseas markets in Singapore and the U.S.A.

Company Profile

(1) Land area : 2,000 m^2

(2) Building area : 1,200 m^2

(3) Register capital : 2,000,000 baht.

(4) Number of employees : 30 persons

(5) Production capacity : 100 tons/ Month

(6) Production facilities :

(a) Extruding equipment

There are 12 machines of extruding machines. There are 3 machines imported from Japan, 7 machines imported from Taiwan and 2 machines are locally made.

(b) Printing equipment

There are 5 printing machines,3 printing machines imported from Japan and 2 machines imported from Taiwan.

(c) Cutting equipment

There are 10 cutting machines,5 cutting machines imported from Japan and 5 cutting machines imported from Taiwan.

The business has been growing very fast among high competitions. Many serious problems have occurred and caused labors (work/employees) to do more work. According to the study, it is found out that this company have not have appropriate planning so the problem of late delivery occurs. As a result, there are conflicts with customers and production department has more job interrupting the process. So the company suffers loss of raw materials such as plastic resin, printing ink and setup cost in the process.

This project will apply work measurement (stopwatch time study) to determine an estimated time required of each step in production process which will develop and improve the performance of production department and set it to be the standard of each job. So the company can estimate the delivery date and plan the production schedule. Moreover the data of job measurement can be the information of personnel department to set reward and punishment of each worker's performance.

The production of plastic bags comprises the process of extruding the plastic resin passing extruder cylinder. The molten polythene is extruded upwards from a circular die and expanded outwards by internal air pressure. The cooled film can then be reeled for subsequent processing, or fed directly to the printing machine or cutting machine if it does not need to be printed. To make the surface of the polythene film receptive to

printing inks, it is oxidized by an electric discharge method using electrodes positioned as near to the pinch rolls as possible.

The printing process which are widely use is gravure printing process and flexographic printing process. UTK company selects the gravure printing process to use in factory. The gravure printing process is most suitable for printing variety sizes and designs on polythene film and using metal cylinder rolling on the film. It is possible to use up to 6 colors in one pass. The printed tubular film is readily converted into sacks by a single weld across its width; this is usually combined with the cutting operation.

For cutting operation, UTK company uses the continuous band heat-sealers which are the most widely used closing machine. A tubular plastic film runs into the cutting line, grip the mouth of the sack to pass it first over a series of electrically heated blocks. Under the pressure exerted by the bands, the two inner surfaces of the film sack are fused into a homogeneous mass the width of the band. The steps of plastic production are shown in Figure 1.1.

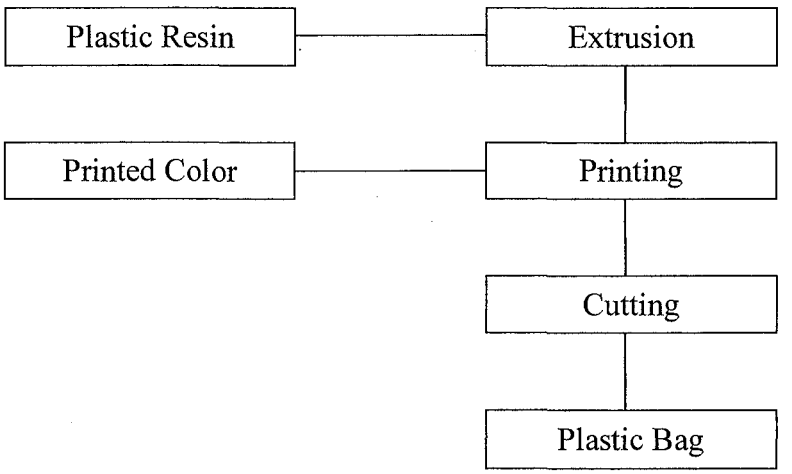

Figure 1.1. Plastic Production Flowchart.

1.2 Research Objectives

(1) To find the standard time of each process in production line.

UTK company wants to find out the standard time of each process in each department, so the company can determine an estimate of the time to do a job. The planner can plan the time requirement for each job and arrange each job to fit in the delivery date of customers. If some jobs cannot finish on time, the planner can solve the problem before the delivery date.

(2) To analyze the workload for each operator.

Workload of all operators should be analyzed. I can determine the percentage utilization of all operators and try to balance them. It is not appropriate if two operators are very different on percentage utilization. One operator may be very busy but another one may take more rest. This will create discontent among employees.

(3) To determine and prepare for manpower in case of future capacity expansion.

My production plan intends to increase in sales demand. Not only do I get the workload analysis but also can prepare this percentage utilization in the increasing demand for the future expansion.

(4) To increase the efficiency of work or decrease time waste.

After I get the standard time, I can make quality improvement of work, promote safety activities, or set environment concerning training. I will not do well if I do not know the standard time of each work. If any operators work very slowly, I can set some training programs can be arranged to improve the performance of the operators. So I can increase the jobs instead of increasing more operators.

(5) To reduce unnecessary operators.

The other benefit for the company is labor reduction because the company does not pay only salary for one operator but it includes welfare, training, expenses, etc. The cost of company will increase if I do not make a appropriate hiring operators. Saving cost from unnecessary operator reduction is preferable for any company, especially in the time of economic crisis.

II. LITERATURE REVIEW

Work measurement is determining how long it takes to do a job. Managing human resources requires a manager to know how much work operators can do during a specific period. Otherwise production schedules or output cannot be planned. Without a good idea of how long it takes to do a job, a company will not know if it can meet customer expectations for delivery or service time (Russell 1998).

Work measurement, known as time study, determines the amount of time required to perform a unit of work. It establishes the amount of time required by a qualified operators, using a standard method and working at a standard work pace, to perform a specified operation. When properly utilized, work measurement can increase overall efficiency, which can make possible higher wages for labor, lover prices for customers and higher profits for equity interests.

The traditional means for determining an estimate of the time to do a job has been the time study, in which a stopwatch is used to time the individual elements of a job. These elemental times are summed to get a time estimate for a job and then adjusted by a performance rating of the operators and an allowance factor for unavoidable delays, resulting in a standard time. The standard time is the time required by an average operators to perform a job once under normal circumstances and conditions (Russell 1998).

Work measurement techniques have developed into several distinct categories. The most common work measurement techniques are stopwatch time study, work sampling, elemental time files and predetermined time studies.

For work measurement technique, stopwatch time study technique of work measurement will be used to conduct this report.

Time study refers to a subset of work measurement procedures used where human endeavor is involved in the productive act and some procedure is used to adjust the human time to some concept of a standard level of endeavor (Barnes 1980).

Objectives

(1) To determine labor and equipment requirements.

Any managerial plan for the production of outputs must be tested for feasibility with respect to available resources. Feasibility is examined by converting a statement of the desired quantity of outputs to a statement of required resources and determining whether this amount of resources is within the allowable limitations. If the plan is not feasible, either the amount of the desired outputs must be altered or the factors affecting the need for resources must be altered (Kanawaty1992).

(2) To assist in developing effective methods.

(a) To determine the number of pieces of equipment a person may run.

Time values for human parts of the production cycle are important factors in setting up the job method for such work (Kanawaty 1992).

(b) To balance the work of crews, coordinate or in sequence.

Efficient crew work demands an even distribution of work among the members of the crew. It is the crew member with the longest job who determines the output of the crew. Office processing sequences, assembly lines, and most crew activities usually achieve higher production and lower cost than individuals doing complete operations (Kanawaty1992).

(c) To compare methods.

As can easily be seen, a standard of consistent difficulty is required to provide an unchanging yardstick for the comparison of two or more methods of performing the same work. In this case the relationship of the standard time to possible performance is immaterial (Kanawaty 1992).

(2) To constrain the use of operator resources.

(a) To set schedules.

Production schedules are a vital necessity for any organization. They are used to control the rate of using resources. They also serve as a basis for planning sales programs in profit-motivated organizations and for planning accomplishment programs for government or service organizations. Production schedules, if they are to be reliable guides, must be based on measures bearing a known relationship to the expected rate of output (วิจิตร 2542).

(b) To set labor standards.

This does not necessarily refer to wage incentives. Labor standards can be the levels of individual or group production deemed satisfactory and may be applied without financial incentives. The standard times used for this purpose should be readily attainable by the type of worker who is expected to be average for the job, to avoid either making substandard performance typical or creation a frustrated feeling on the part of the workers (วิจิตร 2542).

(c) To determine supervisory objectives.

A supervisor is supplied with a mix of staff, materials, space, machines, tools and methods. In the non-manufacturing environment, the names of the components of the mix may vary. Time standards for this use should indicate the rate at which the supervisor is expected to coordinate the facilities in order to meet schedules and produce outputs within the standard costs (Barnes 1980).

(d) To provide a basis for the setting of piece prices of incentive wages.

Incentive wages are a means of automatic financial supervision for both labor and management. They tend to reward the more productive workers in proportion to their output (วิจิตร 2542).

(4) To assist in comparing performance with plans with respect to workload and resource usage.

An organization, if profit motivated, usually prices its merchandise prior to manufacture. To do this it must predict how much labor or production-center time will be expanded on each phase of the work and must have a means of continuously comparing actual performance with predicted performance (Barnes 1980).

(5) For total productivity measurement.

In order to improve the productivity of an organization, first measure productivity must be measured so as to have a datum from which to measure the improvement. The productivity of any organization can be measured by comparing the ratio of the aggregated outputs to inputs, for some period, to the same ratio for a base year (Barns 1980).

Labor Standards and Work Measurement

Effective management of people requires knowledge of labor standards. Even though employees and unions may be opposed to jobs being observed and timed, labor standards are necessary to help a firm to determine as follows:

(1) Labor content of items produced (the labor cost) (Heizer 1996).

(2) Staffing needs of organizations (how many people it will take to make the required production) (Heizer 1996).

(3) Cost and time estimates prior to production (to assist in a variety of decisions from developing cost estimates for customers, to the make-or-buy decision) (Heizer 1996).

(4) Crew size and work balance (who does what on a group activity or assembly line) (Heizer 1996).

(5) Production expected (both manager and worker should know what constitutes a fair day's work) (Heizer 1996).

(6) Basis of wage-incentive plans (what provides a reasonable incentive) (Heizer 1996).

(7) Efficiency of employees and supervision (a standard is necessary against which to determine efficiency) (Heizer 1996).

Work Measurement and Time Study

The written standard practice is usually checked and updated, if in existence, or made as part of the time study procedure. In that an actual worker or group of workers is being studied, the first data recorded are:

(1) Name, number of workers being studied, and work location.

(2) Date and time when the study began.

The other records are descriptions of each operation. The type of terminology used in the description of the elements varies with the nature of the job. For heavy work involving moving from place to place, a description of the activities of the person as a whole is most suitable (Kanawaty 1992).

The preparation of the description of the manual details of the job may be done most easily in two steps:

(1) Using a scratch pad, list a rough description of the elements and check these against the previously given requirements for time study elements, adjusting the elements as necessary (Barnes 1980).

(2) Using the time study form, detail the descriptions of the elements, one by one (Kanawaty 1992).

Time values for a time study may be recorded with equipment in the following three ways:

(1) Stopwatch - the most common type is the decimal minute watch with the usual clipboard. Electronic timers with digital readouts are also available to replace the watch (วิจิตร 2524).

(2) Video tape recorder and tape analysis – until the introduction of available light photography and the subsequent use of the video tape recorder, the cost of using recording, by pictures, was too high (Barnes 1980).

(3) Time study machine – a small, portable solid-state memory device is available. The observations are keyed in and stored in computer language. These data can be transmitted by the device to a computer for all further processing (Barnes 1980).

Improvement Theme

The improvement themes use the concept of rethinking about valuable works. Valuable work is a useful operation, transforming raw material to product. On the other hand, invaluable work is useless operation such as transportation, storing, etc. Therefore, any process with less invaluable work must be improved. The company can get the benefit of productivity up for process step or operation step.

(1) Process Improvement Principle (Barnes 1980)

(a) Reduce number of steps.

(b) Arrange steps in best order.

(c) Make steps as economical as possible.

(d) Reduce handling.

(e) Combine steps if economical.

(f) Shorten moves.

(g) Provide most economical means for moving.

(h) Cut in-process inventory to workable minimum.

(i) Use minimum number of control points at most advantageous places.

If the analyst is familiar with the product and applies each of these themes with an open mind rather than trying to find why each suggestion can be rejected, the analyst will find, in most cases, a variety of suggestions for improvement.

One of rethinking improvement for the system, Just-in-time, represented by the acronym JIT, became popular with American manufacturers as part of the Toyota approach of reducing production costs by cutting inventory to the minimum consistent with smooth production.

The questions for rethinking can be shown as follows:

(a) Can any step be eliminated?

(1) As unnecessary (Ask: Why is it done?)

(2) By new equipment (Ask: Why is present equipment used?)

(3) By changing the place where it is done or kept (Ask: Why is it done there?)

(4) By changing the product design (Ask: Why is it made as it is?)

(5) By changing the specifications of the incoming supply (Ask: Why is it ordered in its present form or used at all?)

(b) Can any step be combined with another?

(1) By changing the specification of supplies or of any raw material

(2) By changing the design of the product, even if only the tolerances?

(3) By changing the order of the steps of production or doing inspection at any operational station so as to avoid an inventory of faulty products?

(4) By changing the equipment used (e.g., using a multifunction machine or creation of a multi-machine work cell served by a single person or by a robot)

(5) By redesigning one or more workplaces?

(c) Can the steps be rearranged so as to make them any shorter or easier?

(d) Can any step be made easier? (If this looks like a possibility, make further detailed analysis of this step)

(2) Operation Improvement Principle (Kanawaty 1992)

(a) Eliminate all unnecessary steps.

(b) Combine steps.

(c) Shortens steps.

(d) Place in best sequence.

(e) Make each step as economical as possible.

Analyst must consider working steps of operators, connection of several operations, and moving into several steps, apparently feeling that some of them might later be eliminated, combined, or rearranged.

The questions for rethinking can be shown as follows:

(a) Can any operation be eliminated, combined, shortened or make easier?

(1) As unnecessary?

(2) By new or different equipment?

(3) By changes in the layout; by grouping equipment better?

(4) By changing the form of the product sent out?

(5) By more knowledge on the part of the worker?

(b) Can movement be eliminated, combined, shortened or made easier?

(1) By leaving out operations?

(2) By changing the places where things are kept?

(3) By shifting some operators to another job into which they fit more conveniently?

(4) By changing equipment?

(5) By changing layout?

(6) By changing the order of work?

(7) By conveyors (make sure that they are economical)?

(c) Can delays be eliminated, combined or shortened?

(1) By changing the order of work?

(2) By changing the layout?

(3) By new or different equipment?

(d) Can counting or inspections be eliminated, combined, shortened or made easier?

(1) Are they really necessary? What happens after they are done and the information is obtained?

(2) Do they provide unnecessary duplication?

(3) Are they done at the best point in the sequence?

(4) Can sample inspection or statistical control be used?

(e) Can any step be made safer?

(1) By changing the order of work?

(2) By new or different equipment?

(3) By changing the layout?

III. RESEARCH METHODOLOGY

3.1 Process Existing Conditions

At first, understanding the process or the problem will help me know the conditions exactly. After that, I can suggest improvement and improve many others things. I can use many ways to grasp the conditions, including interviews with operators or managers, observation and etc.

(1) Determine the number of operators in each process

The number of operators in working pattern or shift arrangement vary with characteristics of process and company. For UTK company, I study three processes. There are four operators for the extruding department, three operators for the printing department and ten operators for the cutting department. In extruding department employees are working two shifts. The first shift is 8:00-20:00 and the second shift is 20:00-8:00. In cutting and printing departments, if there are a lot of work, operators will work overtime. Overtime hours are from 18:00 to 22:00.

(2) Determine the role of each department

Since each group has a different role to conduct the job, I must understand the role of each department clearly.

First, the extruding department will extrude the plastic to be plastic roll. Each plastic roll has approximate weight of 25-30 kg. This company has 12 extruding machines. Each machine will have unique capability. There are many types and many sizes of plastics. The capability of each extruding machine is described in Table 3.1.

Table 3.1. Capability of Each Extruding Machine.

Machine number	Type of plastic resin	Size range of extruding machine
1	HD-PE	30 inches - 36 inches
2	HD-PE	20 inches - 30 inches
3	HD-PE	4 inches - 20 inches
4	LD-PE	30 inches - 36 inches
5	LD-PE	20 inches - 30 inches
6	LD-PE	10 inches - 20 inches
7	LD-PE	4 inches - 10 inches
8	L-LDPE	10 inches - 20 inches
9	L-LDPE	5 inches - 10 inches
10	PP	15 inches - 30 inches
11	PP	5 inches - 15 inches
12	PP	1.5 inches - 5 inches

Remark: HD-PE = High Density of Polyethylene, LD-PE = Linear Density of Polyethylene, L-LDPE = Low Linear Density of Polyethylene, PP = Polypropylene.

Secondly, the printing department brings plastic rolls from the extruding department. The operator in the printing department brings the plastic roll to print in printing machine. There are five printing machines in this department and each machine has its own capability. The Maximum width of printing machine is 30 inches and minimum width is 1.5 inches. The capability of each printing machine is described in Table 3.2.

Table 3.2. Capability of Each Printing Machine.

Machine number	Minimum printing cylinder	Maximum printing color
1	12 inches	2 colors
2	12 inches	6 colors
3	15 inches	6 colors
4	20 inches	6 colors
5	30 inches	6 colors

Remarks: cylinder is made of iron and coated with brass. One cylinder can print only one color. Each operators will operate one machine.

Thirdly, when the plastic rolls have been printed already, the operators from the cutting department brings the plastic rolls to cut to be plastic bags. There are two types of cutting plastic bags. First is bottom seal plastic bags. The heat seal line will seal at the bottom of plastic bag. This kind of heat seal is the normal type of sealing. Second is side seal plastic bags. The sealing line will seal at the side of plastic bags. This kind of plastic bags are normally used in garment industry. There are ten cutting machines in this department and each machine has its own capability. The capability of each cutting machine is described in Table 3.3.

Table 3.3. Capability of Each Cutting Machine.

Machine number	Type of plastic resin	Bottom seal or side seal
1	PP	Bottom seal
2	PP	Bottom seal
3	PP	Bottom seal
4	HD-PE	Bottom seal
5	LD-PE	Bottom seal
6	L-LDPE	Bottom seal
7	LD-PE	Side seal
8	LD-PE	Side seal
9	PP	Side seal
10	PP	Side seal

Remark: HD-PE = High Density of Polyethylene, LD-PE = Linear Density of Polyethylene, L-LDPE = Low Linear Density of Polyethylene, PP = Polypropylene.

For the less width of plastic roll, the operator can insert more rows in the cutting machine. The number of row can be clarified as follows:

Table 3.4. The Number of Rows for Each Width of Plastic Roll.

Width of plastic roll	Number of cutting row
1.5-3 inches	5 rows
3.25-6 inches	3 rows
6.25-14 inches	2 rows
14 inches above	1 row

After the plastic rolls have already been cut into bags, the cutting department will pack the bags and prepare to ship them to the customers.

3.2 Monitoring and Analyzing Existing Operations.

The process is more studied by observing actual working or implementing any technique to find out the working concept of valuable works.

(1) Collect operation data of each operator (work measurement)

Work measurement by stopwatch is one method to deeply understand the processes. In this method, it is necessary to follow the operators doing their jobs, interview them for their operations, measure the time for each working element and note necessary data to analyze later.

With the work measurement details, the following are noted.

(a) Starting Time & Ending Time

Each element of works must be measured by stopwatch to find the time taken by each job.

(b) Contents of Operations

* All operations of workers must be observed. For example, setup extruder head, setup cylinder for printing plastic roll, change the plastic roll after finishing printing plastic roll, etc. Additionally, I can ask the workers are asked what they are doing in that process.

(c) Operation Classification

Classification of works by operation is also necessary. Operators' jobs is classified for the kinds of operations to find out the pattern of work.

(d) Process Classification

The workers support three kinds of main processes those are extruding plastic roll, printing plastic roll and cutting plastic to be plastic bags. Raw data of work measurement are in Appendix A.

(2) Arrange the data (graph, table and chart)

After the details of the operation are collected, the necessary data are transferred to be required information. At this strategy, it is necessary to apply any technique such as operation time chart, analysis of the number of sampling and etc.

Strategy 1: Classification of Works

In this step, it is important to calculate and classify the major or the minor work for each person as the follows:

(a) Extruding Department

The extruding department is responsible for extruding plastic rolls according to the job order. When the operators receive job order, at first they will set up machine (warm up). The extruder head of each extruding machine must be warm up it. Then the operators will prepare the plastic resin and put into extruding machine. Next the operators will put cooling ring in the extruding machine. Each cooling ring will extrude only one size if the operators want to change size of plastic roll. They must change the cooling ring. Next they must set extruder head. Then they can extrude the plastic rolls. In the process of changing plastic roll, it will not take any time because the extruder head is extruded continuously so the process of changing plastic rolls will be ignored. After the operators finish extruding each job, they must change the cooling ring.

(b) Printing Department

The major works of printing department are to set printing cylinder, if the job order need 5 colors, 5 cylinders must be set. After the operators set the cylinder, they will set a doctor blade. The doctor blade is a thin steel sheet of about 3 inches width but the length depends on the cylinder. After the operators finish setting the doctor blade, the rubber cylinder will be set. The rubber cylinder is above the printing cylinder. The rubber cylinder will compress the plastic sheet with printing cylinder. Next, the operators will pour the color. The process of set cylinder, set doctor blade, set rubber cylinder and pour color will be done according to the number of colors to be printed. With 3 colors printed, the operator will do all these process three times. After the operators finish all previous process, they will set the plastic roll in the printing machine. Then the operators can print the plastic roll. Each roll will contain about 25 kilograms. When they finish printing one roll, they will change the plastic roll. They will repeat all these process until they finish printing. After printing, they must pour the color back, take off the printing cylinder, rubber cylinder and doctor blade.

(c) Cutting Department

For the cutting department, the major work is to set up cutting machine(warm up). Then operators must put the plastic roll in the cutting machine and prepare for cutting. Next, they will cut the plastic rolls. When they finish cutting each roll, they must change new rolls.

The entire production process is summarized in Figure 3.1:

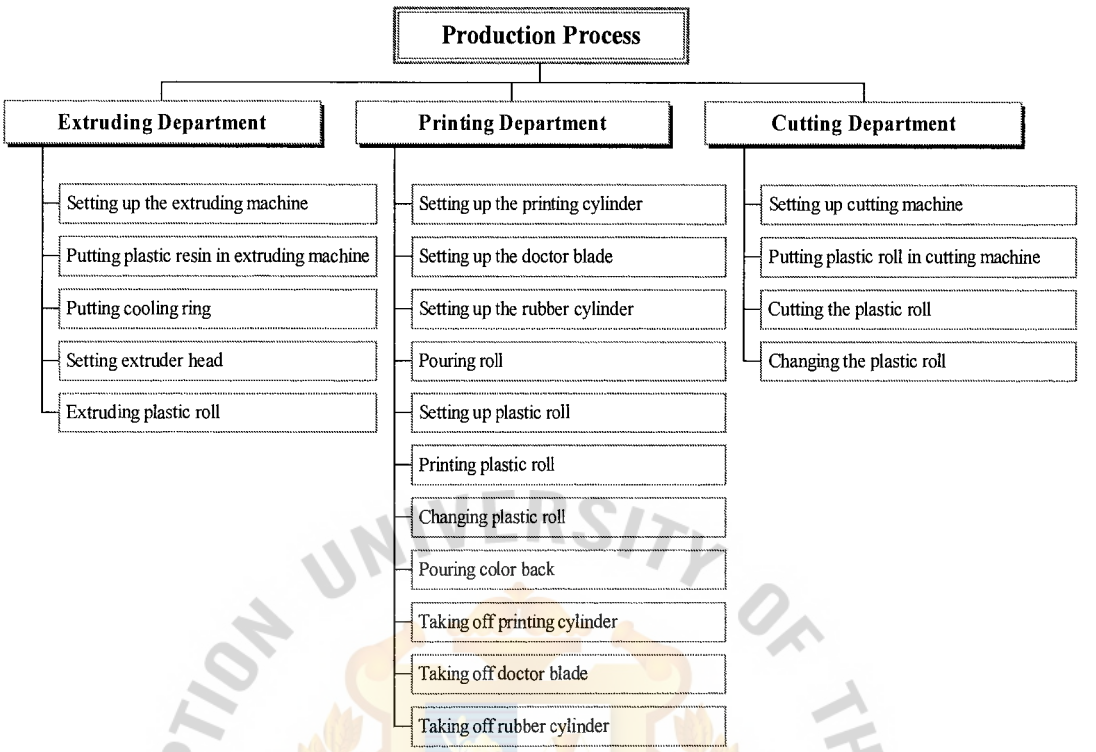

Figure 3.1. The Production Process Chart.

IV. CALCULATION OF LABOR STANDARD

The stopwatch method is used most often for setting time standards for a task. A job is divided into a series of smaller work elements representing the accepted work method for the job. Using a stopwatch, an analyst performs a pilot study by timing a trained worker performing the work elements for a number of work cycles, then calculates the average time for each element. Given the information from the pilot study, the analyst determines whether the sample size was adequate to provide the desired precision in the average time estimate. If not, additional observations must be made. Once the sample size is deemed sufficient, the analyst proceeds to develop a time standard for the task by using additional information such as judgment-based and performance ratings.

Step 1: Selecting work element

The first step in a stopwatch time study is to select the work elements. The work element can be clarified as follows:

(1) Extruding department.

(a) Setting up the extruding machine

(b) Putting plastic resin in extruding machine

(c) Putting cooling ring

(d) Setting extruder head

(e) Extruding plastic roll (main process)

(2) Printing department

(a) Setting up the printing cylinder

(b) Setting up the doctor blade

(c) Setting up the rubber cylinder

(d) Pouring color

(e) Setting up plastic roll

(f) Printing plastic roll (main process)

(g) Changing plastic roll

(h) Pouring color back

(i) Taking off printing cylinder

(j) Taking off doctor blade

(k) Taking off rubber cylinder

(3) Cutting department

(a) Setting up cutting machine

(b) Putting plastic roll in cutting machine

(c) Cutting the plastic roll (main process)

(d) Changing the plastic roll

Step 2: Timing the Elements.

After the work elements have been identified, the operator trained in the work method is selected for the study. For each department, two operators will be selected for the study. Using the continuous method of timing to record the observation time, it is necessary to enter the stopwatch reading for each work element on completion of each element . For example, the clock reads 0.49 minutes equals 29.4 seconds. (the numerals after the decimal refer to hundredths of a minute, not seconds)

An alternative timing technique, called the snap-back method, involves resetting the watch to zero after each work element has been completed.

Step 3: Determining Sample Size.

10 cycles of the operation of each operator are observed in each department. These 10 cycles will be used to determine the number of sample size "n". I will use 90%

level of confidence. The degree of error from the true mean of the distribution (e) is 8% or 0.08. 90% level of confidence and 8% of degree of error are noted down because the estimate job cycle time in producing plastic bags is not necessary to have quite accurate time. It can be flexible to set the production schedule. And the number of sample is appropriate to observe the operators. A formula, based on the normal distribution which can determine the sample size, n, required:

$$n = \left(\frac{zs}{e\overline{T}} \right)^2$$

where

n = required sample size

e = the degree of error from the true mean of the distribution

$\overline{T}$ = the average job cycle time

$s = \sqrt{\frac{\Sigma(t_i - \overline{t})^2}{n-1}}$ = sample standard deviation of representative observed times for a work element.

According to this formula, the number of samples requires for each work element of each department are noted. Refer to Appendix A at the Table A.1, Table A.3, Table A.6, Table A.8, Table A.12, Table A.14. Detail check sheet for the Result of Work Measurement. A stopwatch technique is used in each process in 10 samples. The time is recorded in second. Then the average time for each process is recorded. Next, the sample standard deviation is checked. At 90% level of confidence and 8% degree of error from the true mean of the distribution, the number of cycles or the sample size of the time study is noted down. Therefore, it is summarized that the number of cycles required of the time study are as follows:

In Extruding Department: Mr. Nai Thammasutorn (Table A.1)

(1) Setting up machine process requires 5 samples.

(2) Putting plastic resin process requires 18 samples.

(3) Put cooling ring process requires 5 samples.

(4) Set extruder head process requires 19 samples.

(5) Extruding process requires 32 samples (main process).

In Extruding Department: Mr. Sombat Chambang (Table A.3)

(1) Setting up machine process requires 4 samples.

(2) Putting plastic resin process requires 14 samples.

(3) Putting cooling ring process requires 12 samples.

(4) Setting extruder head process requires 13 samples.

(5) Extruding process requires 35 samples (main process).

In Printing Department: Mr. Precha Nampaisan (Table A.6)

(1) Setting cylinder requires 16 samples.

(2) Setting doctor blade requires 17 samples.

(3) Setting rubber cylinder requires 18 samples.

(4) Pouring color requires 22 samples.

(5) Setting plastic roll requires 24 samples.

(6) Printing requires 36 samples (main process).

(7) Changing plastic roll requires 24 samples.

(8) Taking off cylinder requires 23 samples.

(9) Taking off doctor blade requires 13 samples.

(10) Taking off rubber cylinder requires 22 samples.

(11) Pouring color back requires 20 samples.

In Printing Department: Mr. Sura Punpan (Table A.8)

(1) Setting cylinder requires 13 samples.

(2) Setting doctor blade requires 13 samples.

(3) Setting rubber cylinder requires 14 samples.

(4) Pouring color requires 14 samples.

(5) Setting plastic roll requires 15 samples.

(6) Printing requires 48 samples (main process).

(7) Changing plastic roll requires 20 samples.

(8) Taking off cylinder requires 23 samples.

(9) Taking off doctor blade requires 8 samples.

(10) Taking off rubber cylinder requires 22 samples.

(11) Pouring color back requires 7 samples.

For Cutting Department: Ms. Suda Thaitip (Table A.12)

(1) Set up machine requires 8 samples.

(2) Set plastic roll requires 22 samples.

(3) Cutting process requires 45 samples (main process).

(4) Change roll requires 8 samples.

For Cutting Department: Ms. Namtip Chitchop (Table A.14)

(1) Set up machine requires 6 samples.

(2) Set plastic roll requires 21 samples.

(3) Cutting process requires 37 samples (main process).

(4) Change roll requires 9 samples.

For each process in the first ten cycles, the process of extruding, printing and cutting are estimated in 100 Kg. because it is necessary to use the same quantity to measure the time of production. The average quantity which each department normally produces is 100 kg.

Step 4: Setting the Standard.

The normal time (NT) is determined for each work element by judging the pace of the operators. The operator's pace is assessed to see whether it is above or below average but also how much above or below average. The performance rating factor (RF) to the operator's performance is checked on each work element. For example the performance rating factor for the operator is 1.10. A performance rating factor greater than 1.0 means that in the subjective evaluation, the performance of the operator is faster pace than he or she would in normal conditions (that is, produced more output in a given amount of time). The rating factor is solely a judgment made by the factory manager, based on his experience.

For the performance rating factor of each department, it is not important to use the performance rating value in the main process of extruding plastic roll and cutting plastic roll. Because the process of extruding plastic roll depends on the machine and the speed depends on the size and thickness of plastic roll. If the plastic roll has high thickness, the speed of extruding plastic roll will be slower than the plastic roll that has low thickness. For the printing department, performance rating factor is applied because the capability of the operator can effect the speed of the printing process. For cutting process, the performance rating percentage is not necessary to calculate in this process because the cutting speed depends on the size and thickness of plastic roll.

Normal Time of Each Department

(a) For extrusion department, the work can be summarize as follows:

Table 4.1. Normal Time of Extrusion Department (Setup Process).

(Time Record in Minutes)

	Mr. Nai Thammasuntorn	Mr. Sombut Chambang	Total time of two operators	Normal time
Setting up machine	30.07383333	14.406	44.47983333	22.2399167
Putting plastic resin	4.199791667	1.859888889	6.059680556	3.02984028
Putting cooling ring	10.716125	3.836944444	14.55306944	7.27653472
Setting extruder head	4.2435	2.180444444	6.423944444	3.21197222

According to the Table A.2 and Table A.4, normal time of each operator is observed and then the average value of normal time is noted so the normal time of element is recorded in extrusion department.

For the part of extrusion plastic roll, the time to produce plastic roll will depend on the width of plastic roll. From Table A.5, it can be summarized that the time to extrude plastic must measure in kilograms per minute. Because the thickness does not affect the time to extrude plastic roll such as plastic roll of the same size but different thickness, the thicker one will extruding slower than the thinner one. At the same time

the output will be the same. Therefore, the normal time for extruding the plastic roll will be as follows:

Table 4.2. Normal Time of Extrusion Department (Extrusion Process).

Products: Plastic Bags	
Process: Extrusion	(Time Record in Minutes)
Width (inches)	Production time in1 Kg.
1.5-5.5 inches	5.679650111
6-13.5 inches	4.461544164
14-17.5 inches	2.445385763
18-36 inches	2.241958095

(b) Printing Department

Table 4.3. Normal Time of Printing Department (Setup Process).

(Time Record in Minutes)	Mr. Precha Nampaisan	Mr. Sura Punpan	Total working time of two operators	Normal time
Setting cylinder	5.116594203	4.083680556	9.200274759	4.6001373
Setting doctor blade	4.803369565	4.603541667	9.406911232	4.7034556
Setting rubber cylinder	1.896521739	3.535277778	5.431799517	2.7158997
Pouring color	1.528768116	3.494722222	5.023490338	2.5117451
Setting plastic roll	14.14775362	10.195	24.34275362	12.171376
Changing plastic roll	2.268514493	4.515347222	6.783861715	3.3919308

Table 4.3. Normal Time of Printing Department (Setup Process). (Continued)

(Time Record in Minutes)	Mr. Precha Nampaisan	Mr. Sura Punpan	Total working time of two operators	Normal time
Taking off cylinder	4.680869565	3.687847222	8.368716787	4.1843583
Taking off doctor blade	4.371521739	6.355555556	10.7270773	5.3635386
Taking off rubber cylinder	1.842862319	2.632291667	4.475153986	2.2375769
Pouring color back	2.466231884	4.449861111	6.916092995	3.4580465

According to the Table A.7 and Table A.9, normal time of each operator can be noted and then the average value of normal time is checked so the normal time of setting up parts can be recorded in the printing department.

For the part of printing plastic, the time to print plastic roll depends on the circumference of printing cylinder. If the printing cylinder has a larger circumference, the output of printed plastic will have more quantity than a cylinder with a small circumference. From Table A.10 and Table A.11, it is summarized that the time to print plastic must measure the output in inches per 1 kilogram per minute. The thickness of plastic film does not affect the speed of printing. The thickness affects the amount of inches per 1 kilogram. If the plastic roll has the same width but different thickness, the thicker one will have less amount of inches in 1 kilogram and the thinner will have more amount of inches in 1 kilogram. So the output will be measured by the speed of machine which measures in inches per minute in 1 kilogram. Therefore, the normal time for printing the plastic roll is described as follows:

Table 4.4. Normal Time of Printing Department (Printing Process).

Products: Plastic Bags Process: Printing	Circumference of printing cylinder	Number of circumferences per minute
(1)	12-14 inches	126
(2)	15-19 inches	113
(3)	20-24 inches	103
(4)	25-29 inches	91
(5)	30-34 inches	59
(6)	35 inches up	48

(c) Cutting Department

Table 4.5. Normal Time of Cutting Department (Setup Process).

(Time record in Minutes)	Ms. Suda Thaitap	Ms. Namtip Chitchop	Total working time of two operators	Normal time
Setup machine	26.12777778	25.75	51.87777778	25.938888
Set plastic roll	5.0275	3.717063492	8.744563492	4.3722817
Change roll	3.705	3.795833333	7.500833333	3.7504166

According to the Table A.13 and Table A.15, normal time of each operator is recorded and then the average value of normal time is noted so the normal time of element in cutting department can be calculated.

For the process of cutting plastic roll, the time to cutting plastic roll is divided according to the width of plastic roll. From Table A.16, it can be summarized that the time in cutting plastic must be measured in meter per 1 kilogram per minute per row.

Because the thickness does not affect the speed of cutting. The thickness affects the amount of meter per 1 kilogram. If the plastic roll of the same width but different thickness, the thicker one will have less number of meter in 1 kilogram and the thinner will have more number of meters in 1 kilogram. So the output is measured by the speed of machine which measures in meter per minute in 1 kilogram. Therefore, the normal time for cutting can be clarified as follows:

Table 4.6. Normal Time of Cutting Department (Cutting Process).

Products: Plastic Bags		(Time Record in Minute)
Process: Cutting	Width(inches)	Inches/Minute/Row/1Kg.
(1)	2.5-8 inches	1,482
(2)	9-14 inches	1,040
(3)	15-36 inches	940

Normal Cycle Time (NT)

For the normal cycle time is the summation of normal time. The normal cycle time will help the planner to set the schedule. For each job order, the planner must see the details of the job order such as size, thickness, color printed and the amount of order. Then the time for each job order can be calculated by finding out the following steps:

(1) Extrusion part:

For extrusion part, it starts from Table 4.1. The setup part takes about 36.20 minutes. The normal time of setup process is shown in Figure 3.1. Then I see at Table 4.2. The width of the plastic roll indicates the production time for example, 6 inches width takes 4.46 minutes to extrude 1kilogram of

plastic roll. So the number of kilogram is multiplied by 4.46 minutes so total extrusion time can be recorded. The normal time of extrusion process is shown in Figure 3.2.

(2) Printing part:

For printing part, it starts from Table 4.3. The setup part takes about 33.13 minutes. The setup takes about 33.13 minutes. The process of setup plastic roll will be done only one time and the process of changing the roll is controlled (3.39 minutes) by the number of kilograms in the job order (each roll will contain about 25 kilograms). If the job order indicates 3 colors print, every process is multiplied the number of colors except the process of changing the roll and setting the plastic roll to the machine. The process of changing the roll is controlled by the number of kilograms in the job order (each roll will contain about 25 kilograms). For example, the roll is changed 4 times for 100 kilograms of plastic roll. The normal time for setup process is shown in Figure 3.3. Next, Table 4.4 shows that the time to print plastic roll depends on the circumference of printing cylinder. If the printing cylinder has a larger circumference, the output of printed plastic will have more quantity than a cylinder with a small circumference. The output is measured by the circumference of cylinder. The net circumferences is the circumference of printing cylinder multiplies by the number of circumference per minute. The total inches of order find by (1850/(width * thickness * 39.5))* production order*39.5. Then the total inches is divided by the net circumferences, the output is the printing time in minutes. The performance rating is multiplied with the printing time, the output is the net printing time. The normal time of printing process is shown in Figure 3.4.

(3) Cutting part.

For cutting part, it starts from Table 4.5. The setup takes about 30.30 minutes. The process of setup plastic roll is done only one time and the process of change the roll is controlled (3.75 minutes) by the number of kilogram in the job order (each roll will contain about 25 kilograms). The normal time of setup part in cutting process is shown in Figure 3.5. Next, see Table 4.6. The width of plastic roll indicates the production time for example 6 inches width takes 1482 inches per 1 kilogram per minute to cutting the plastic roll. Then the total length in inches is calculated for the job. After the total length in inches are checked, the total length is divided by 1482 and the number of row then the number of kilograms is multiplied. So the total cutting time is recorded in minutes. The normal time in cutting process is shown in Figure 3.6.

The normal time for the cycle is not applicable, so it is not possible to use that time as a standard. It does not account for fatigue, rest periods, or unavoidable delays that occur during an average workday. Some allowance time is added to the normal time to adjust for these factors. According to the observations, it is found that the operators work 110 minutes out of 120 minutes. So 8.33% of the working time is noted as allowance time.

A standard time is the time spent by an average operator to complete a job under normal environment and conditions.

Standard time (ST) = (normal cycle time)(1+allownace factor)

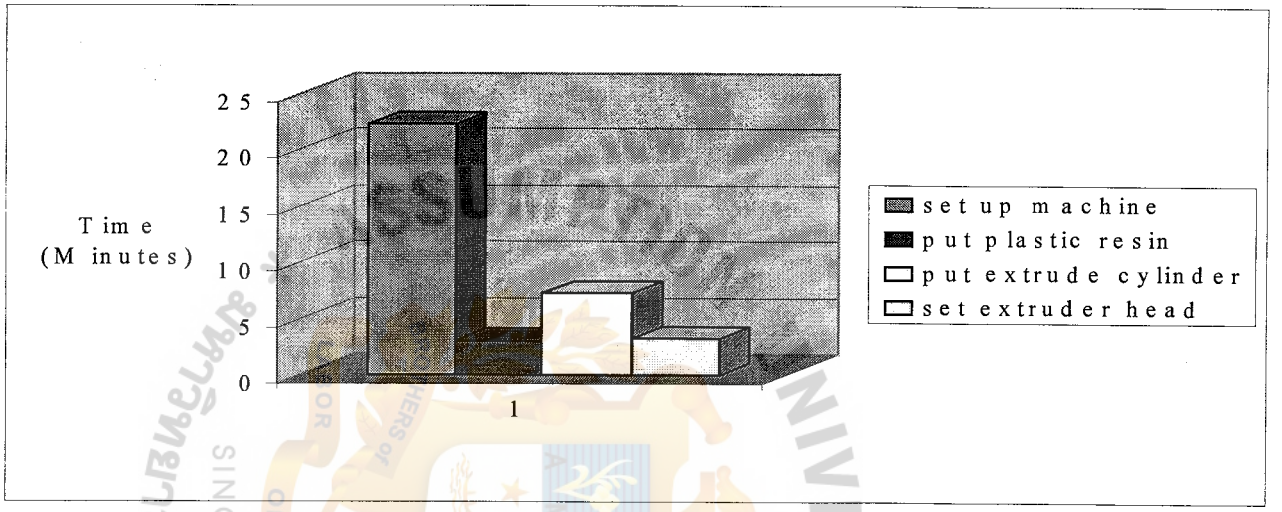

Figure 4.1. Normal Time of Setup Process in Extrusion Department.

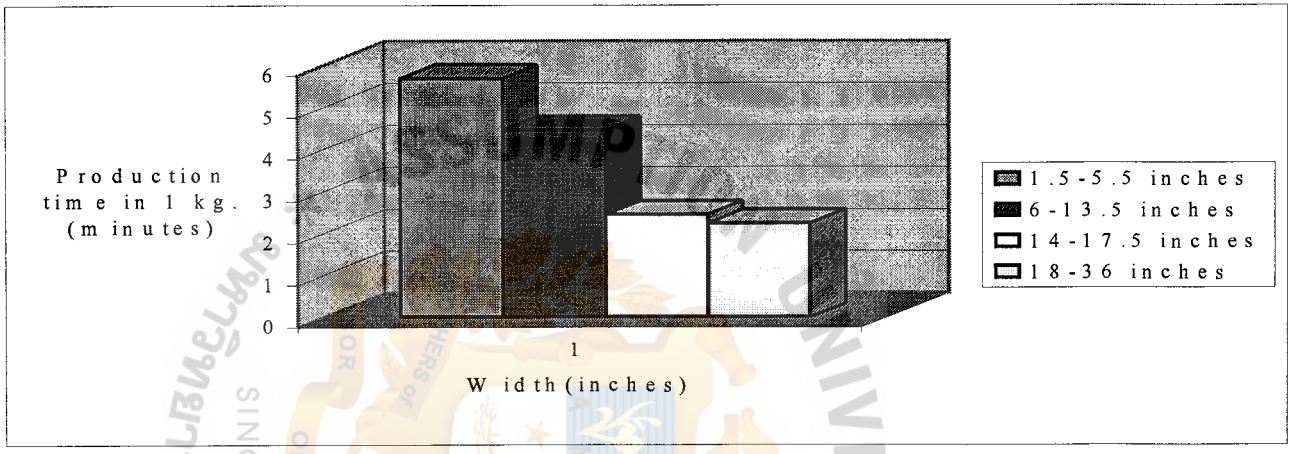

Figure 4.2. Normal Time of Extrude Plastic Roll in Extrusion Department.

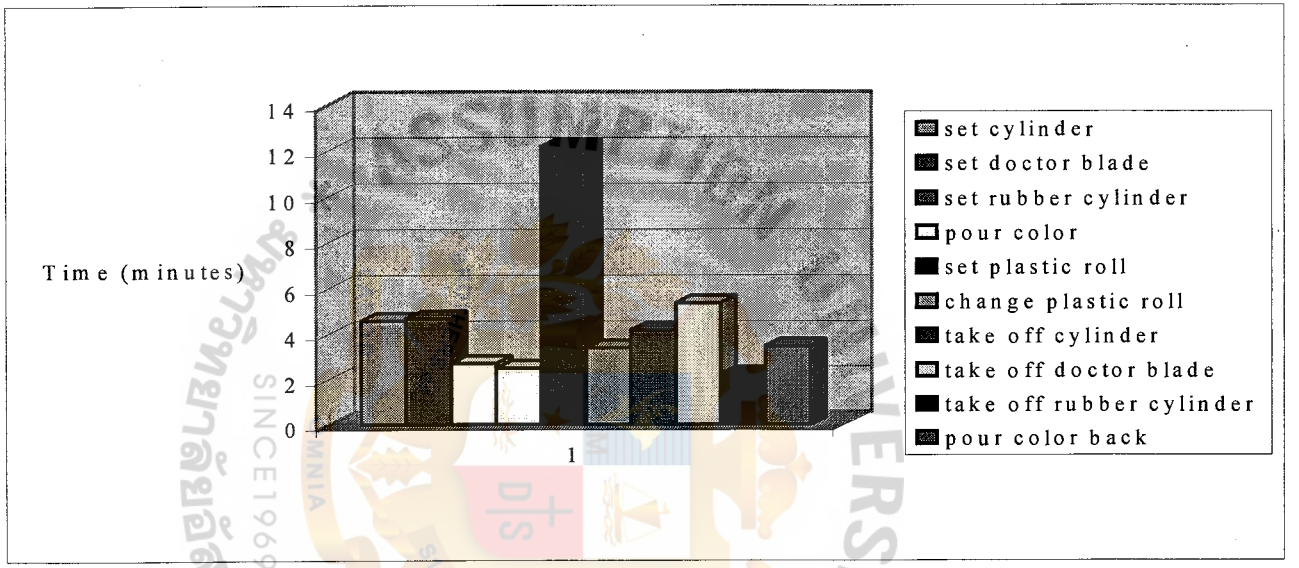

Figure 4.3. Normal Time of Setup Process in Printing Department.

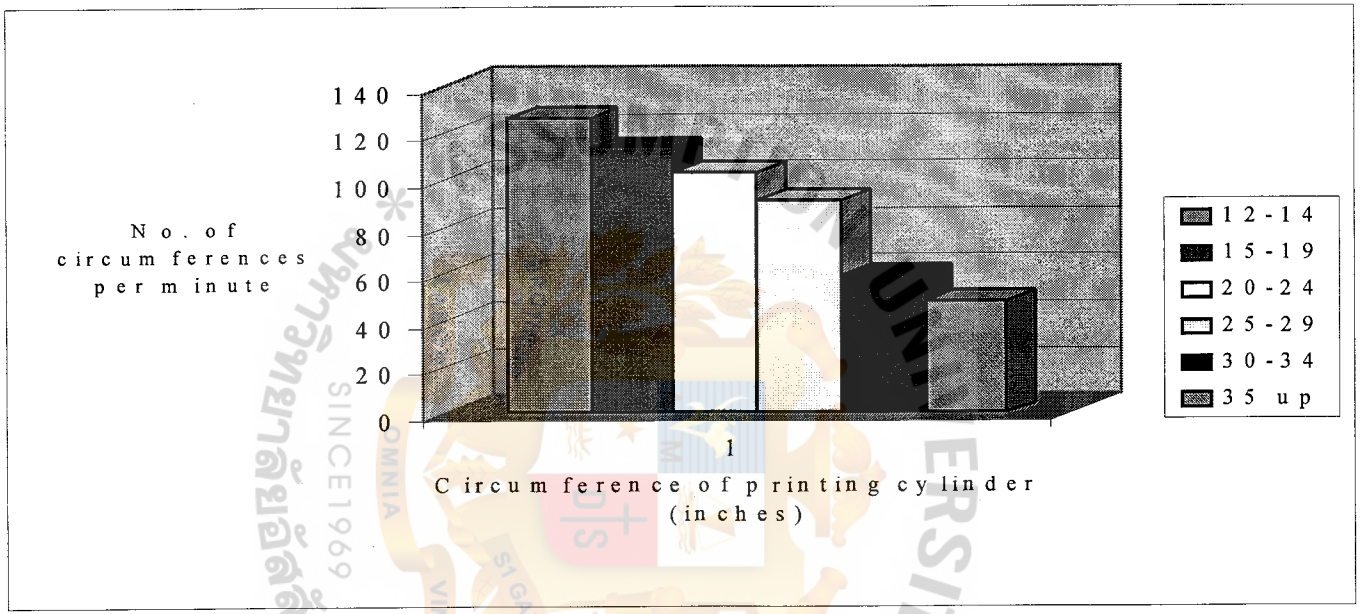

Figure 4.4. Normal Time of Printing Process in Printing Department.

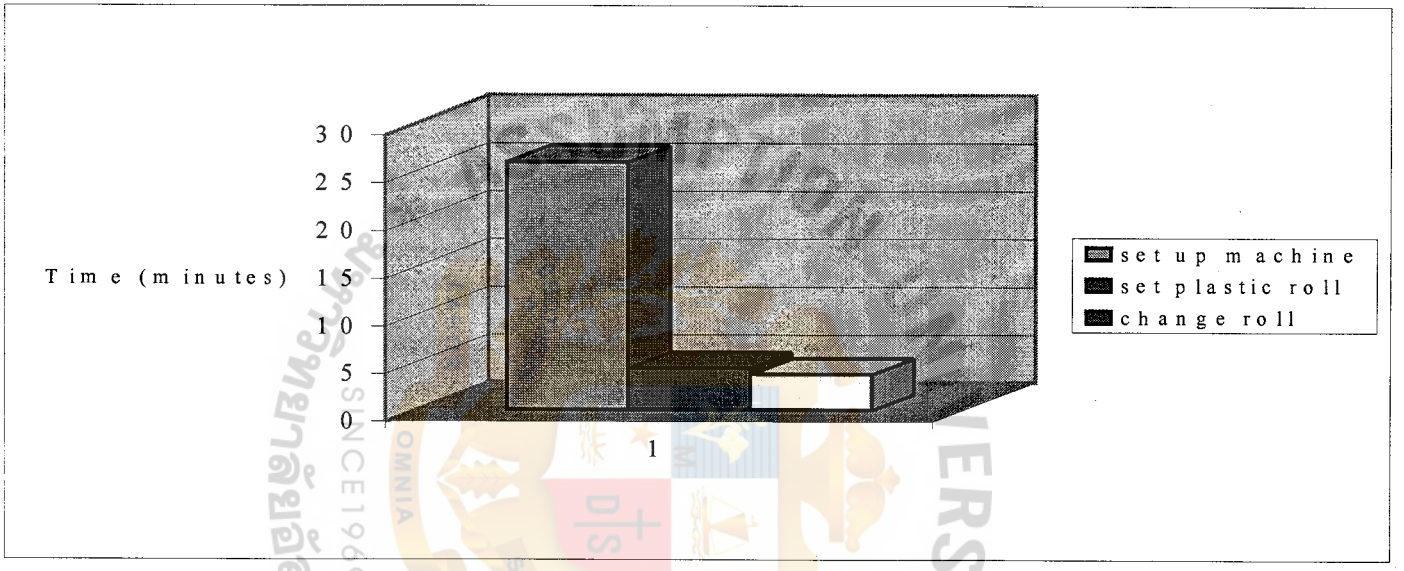

Figure 4.5. Normal Time of Setup Process in Cutting Department.

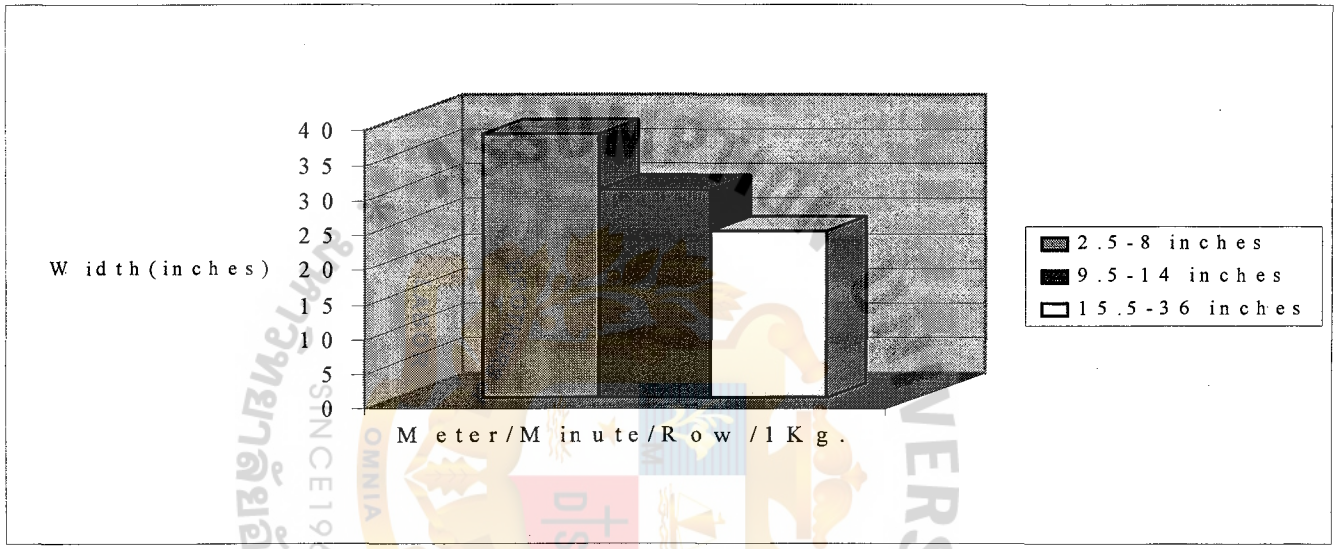

Figure 4.6. Normal Time of Cutting Process in Cutting Department.

V. SYSTEM DEVELOPMENT

The process of planning is involved in many other departments. In order to clarify the process of sales and planning picture, the data flow diagram can explain each element clearly. The data flow diagram explains the first step that sales person receives inquiries from customers. So the context and data flow diagram of planning are designed and sales system is also included. The planner will work between production and sales departments. The duty of the planner is to cooperate with sales persons and operators in the production line. The job order from sales person is used to calculate the production time.

In Figure 5.1 a context diagram explains the relationship among sales and planning systems and external entities. Figure 5.2 is the data flow diagram of sales and planning system.

Figure 5.3 is a data flow diagram of level 1 process 1. The first process verifies inquiry. The customer will contact sales person and the sales person will receive inquiry. The sales person will review whether the product type is available in the company, inquiry quantity is above minimum amount and printed details is not more than six colors. Then he will evaluate the inquiry whether to accept or reject it.

Figure 5.4 is a data flow diagram of level 1 process 2. The second process is the process to prepare quotation. First, the customer data and the accepted inquiries are brought to verify whether the customer is a new customer or not. If the customer is new then the customer data will be kept in the customer file. If the customer is an old customer, the inquiry will bring to calculate the unit price. Raw material price is brought from raw material file. The new customer data is checked to evaluate credit term. Then

the unit price and credit term will bring to generate quotation and then they are sent to customer.

Figure 5.5 is a data flow diagram of level 1 process 3. The third process verifies the purchase order. When a customer sends a purchase order to the company, the purchase order and customer details are considered to verify ordered item details. If the purchase order data is correct, the credit term will be checked.

Figure 5.6 is a data flow diagram level 1 process 4. The forth process records the order entry. When the purchase order is accepted, the sales person will record order item. The data will be kept in the order file and the purchase order file. The purchase order will be copied and send to accounting department. The purchase order details are looked into to check the raw material inventory. The sales person will check the inventory status from the inventory department. Then the sales person will inform the required inventory quantity to the inventory department to update the inventory status. After that the purchase order data is worked out to generate the job order. The job order details are checked to verify the job order details. If the job order details are complete, the job order is accepted. But if the job order details are not complete, the job order is rejected.

Figure 5.7 is a data flow diagram of level 1 process 8. The accepted job order is checked to calculate the production time in each department. The extrusion time, printing time and cutting time are considered to arrange the planning schedule. Then the planning schedule is printed out and sent to the production department and kept in the schedule file. The sales person will use the planning schedule to check the status of the production line. If the product is delayed from the delivery date, the sales person will inform the customer.

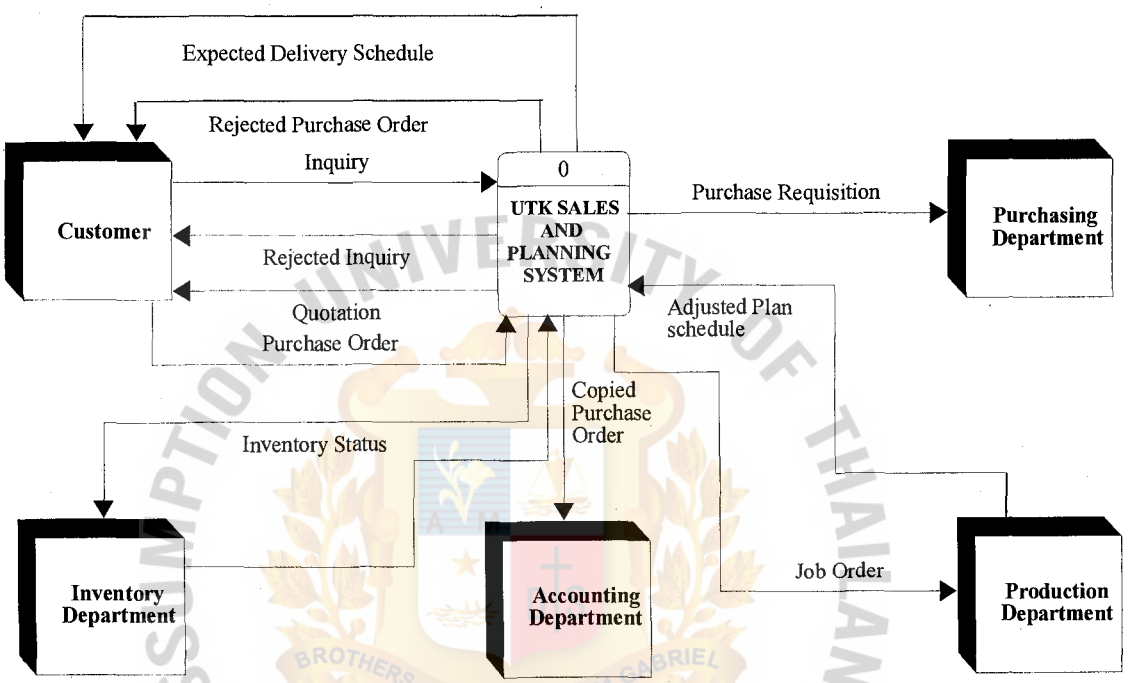

Figure 5.1. UTK Sales and Planning System - Context Diagram.

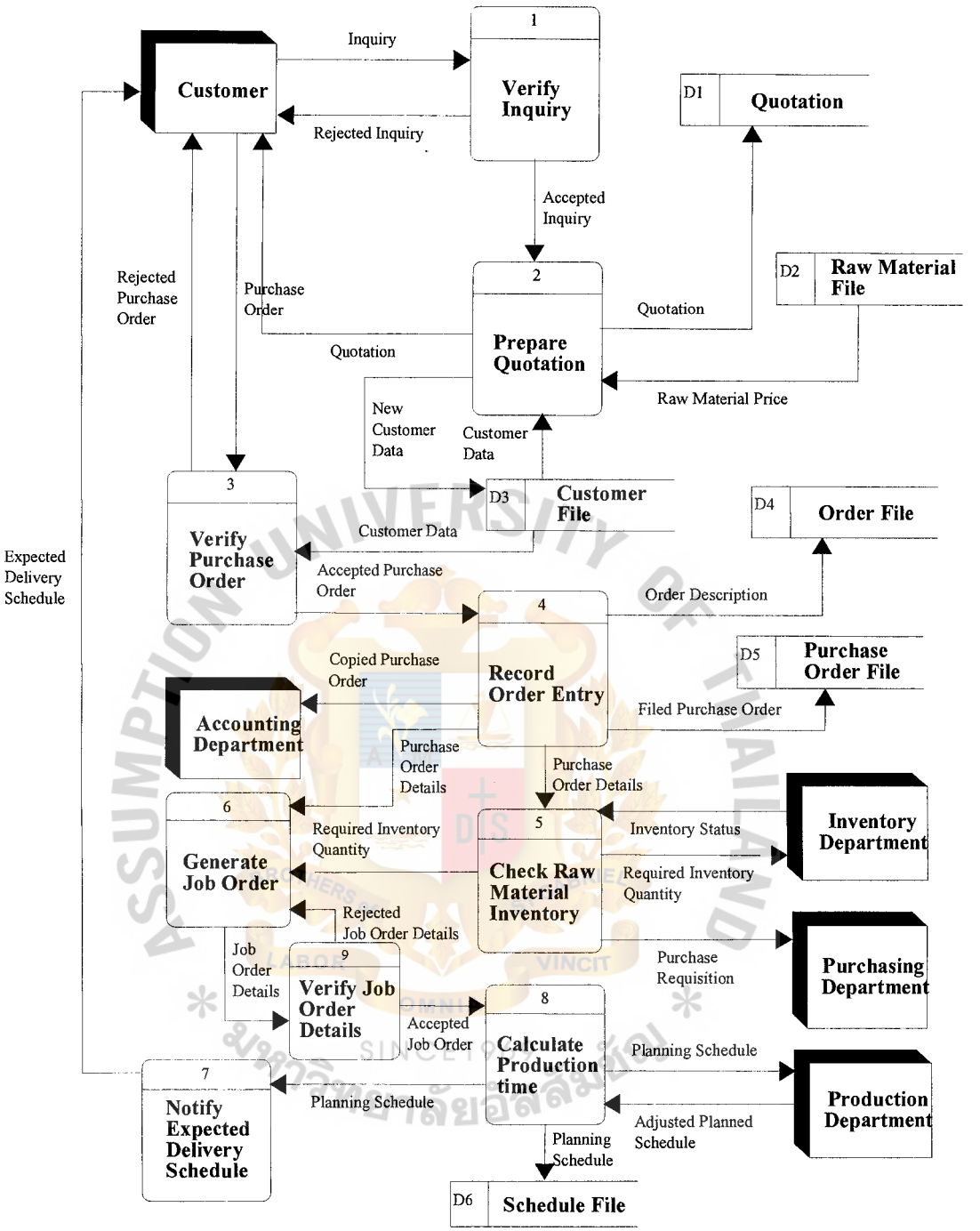

Figure 5.2. UTK Sales and Planning System-Data Flow Diagram Level 0.

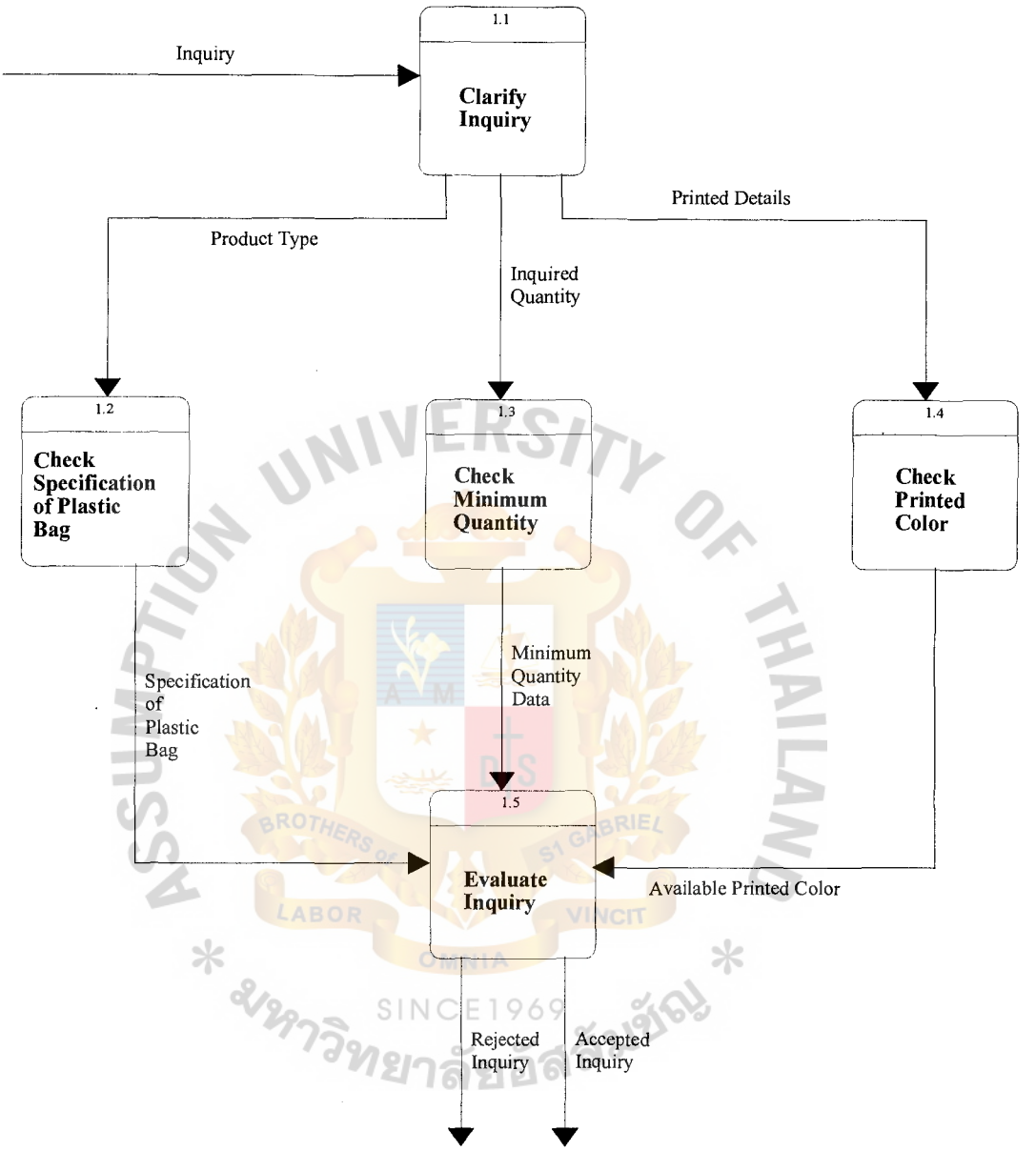

Figure 5.3. UTK Sales and Planning System – Data Flow Diagram Level 1 Process 1.

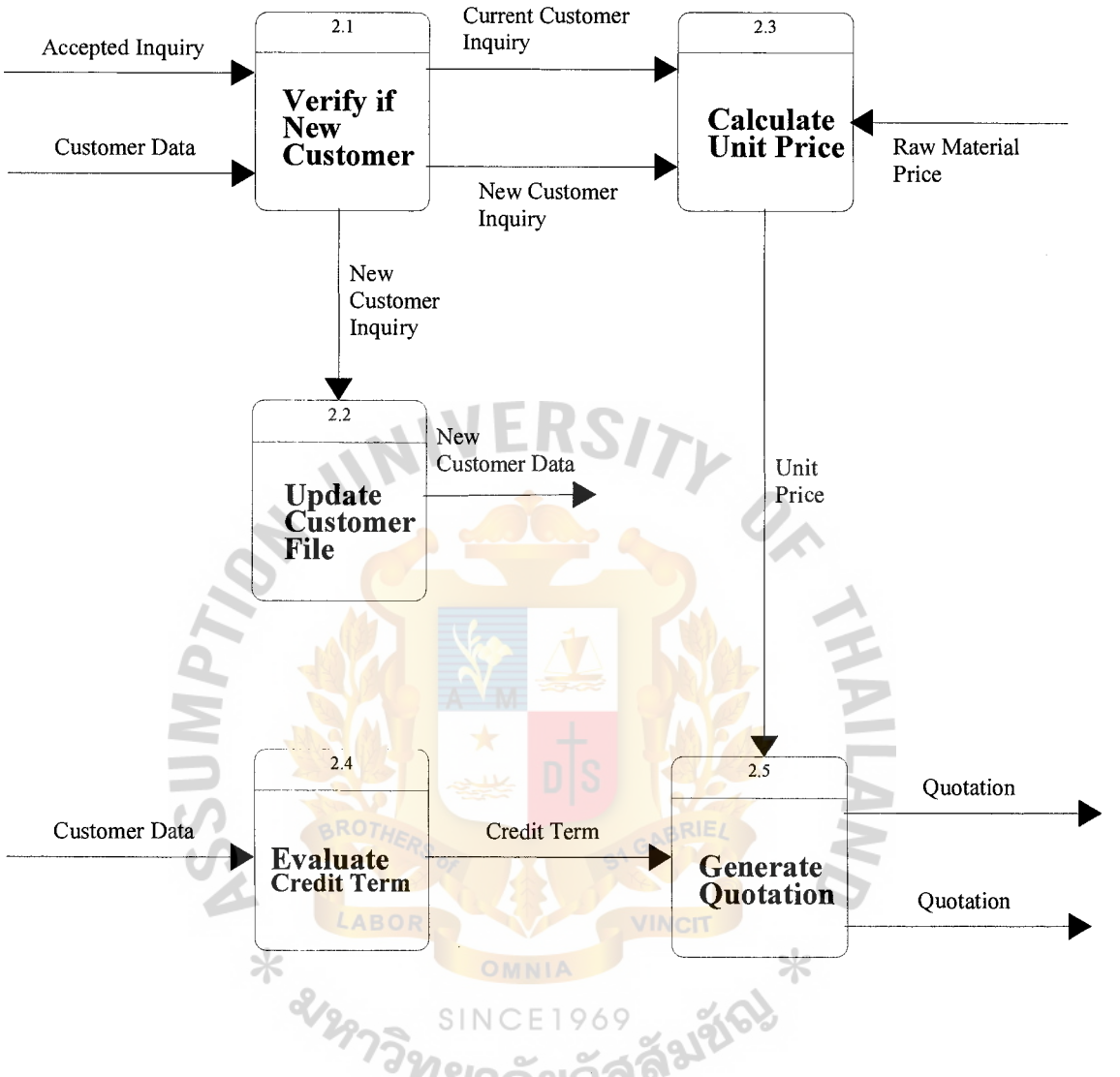

Figure 5.4. UTK Sales and Planning System – Data Flow Diagram Level 1 Process 2.

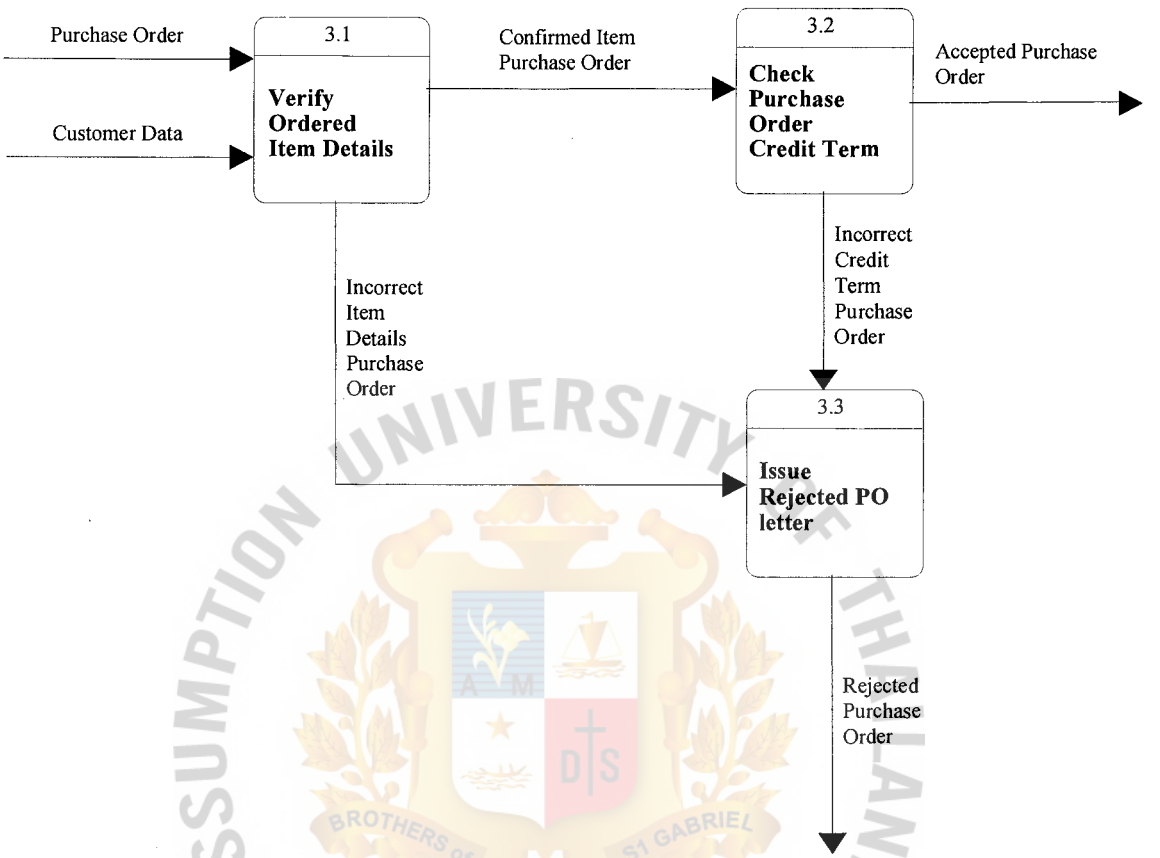

Figure 5.5. UTK Sales and Planning System – Data Flow Diagram Level 1 Process 3.

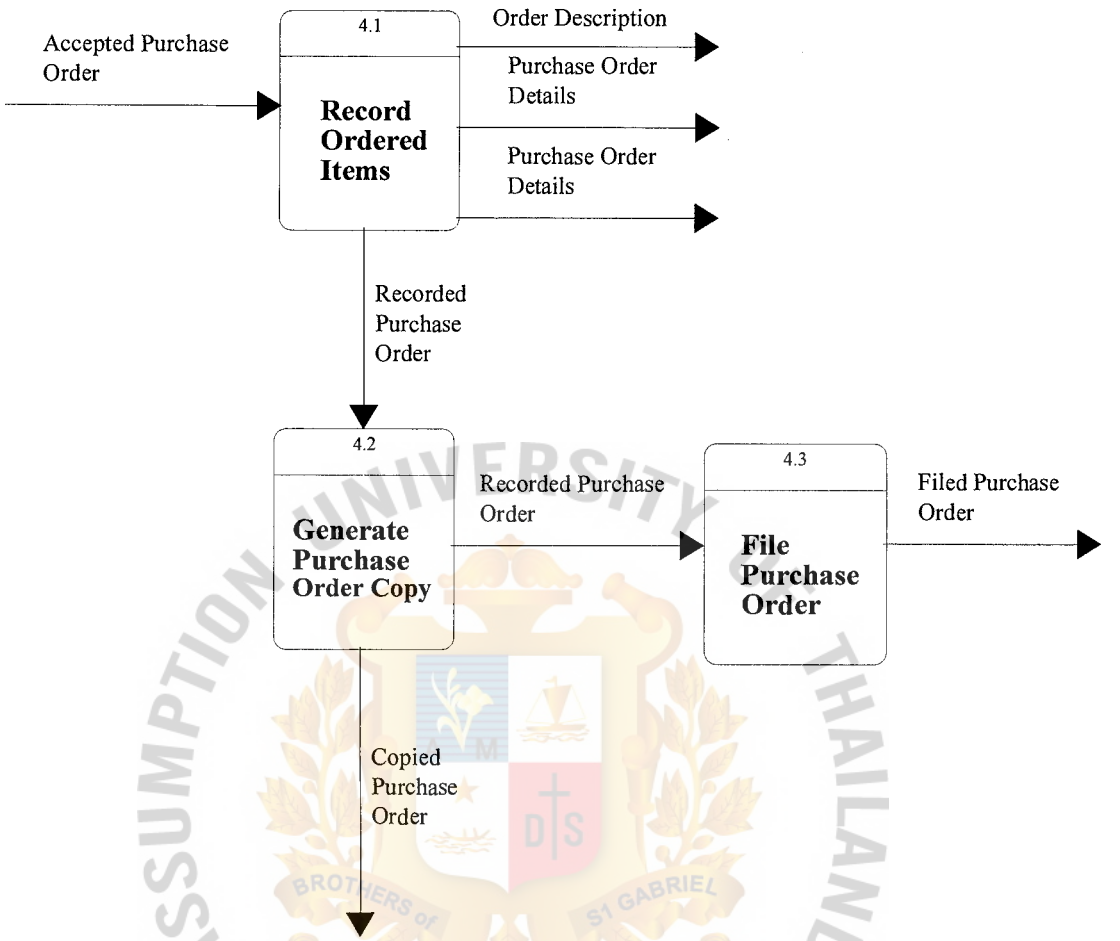

Figure 5.6. UTK Sales and Planning System – Data Flow Diagram Level 1 Process 4.

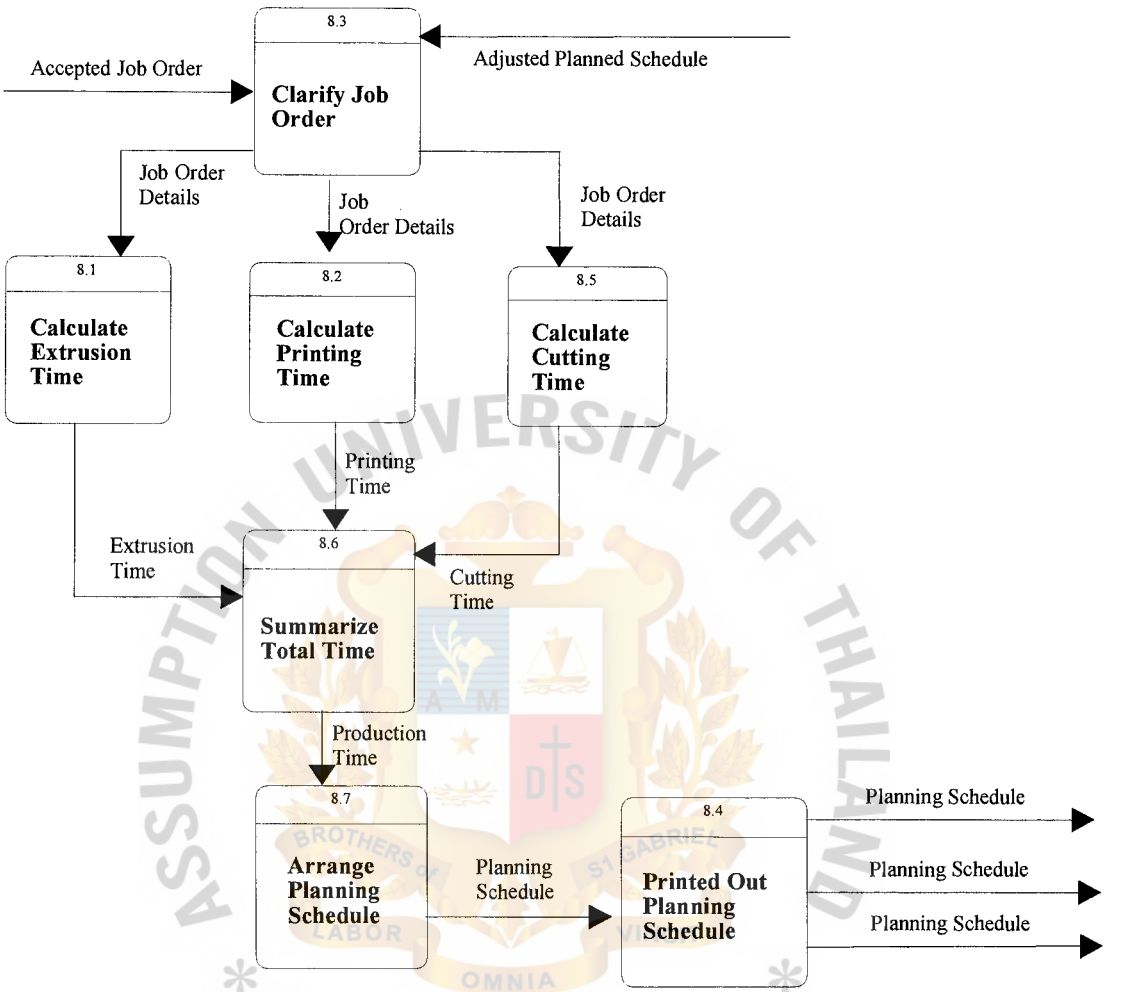

Figure 5.7. UTK Sales and Planning System – Data Flow Diagram Level 1 Process 8.

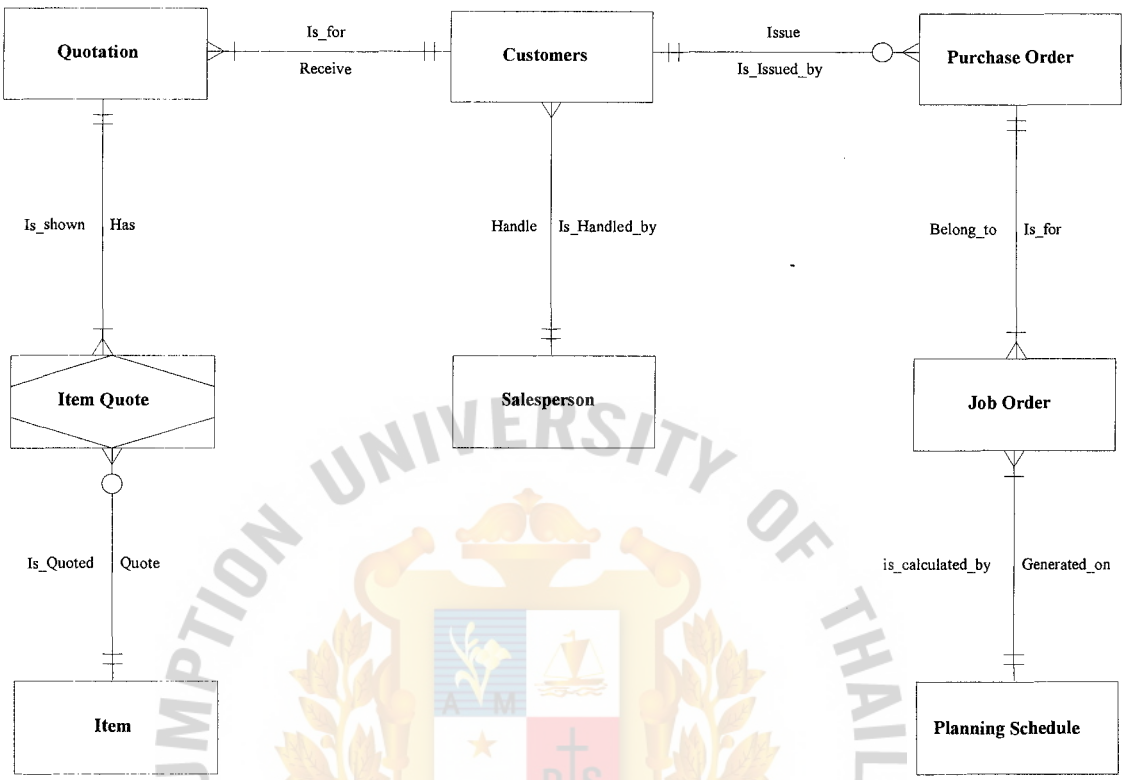

Figure 5.8. UTK Sales and Planning System – Entity Relationship Diagram.

VI. IMPLEMENTATION

Improving the labor standard is my main reason in doing this project. The standard time in production process can be used in many ways. First, the standard time can implement the planning schedule. For example, when a customer orders plastic bags, the planner will calculate the production time in each department. The daily production schedule will control the production department. The operators in each department know the schedule and what they are going to do next. So the operators can prepare the machine. For example in the printing department, if the operators knows the production schedule, they can prepare plastic roll, printing cylinder, rubber cylinder for printing process. So the operators will not have the problem of waiting for plastic roll or printing cylinder. The planner will plan the production program in the extrusion department corresponding to the printing department and the cutting department.

Increasing productivity of work is a benefit of arranging a planning schedule. To prepare for future expansion, operators must have some time allowance for more working load. The number of operators is assigned in each department according to the planning schedule.

Work reduction plan is made to improve each operation. Unimportant invaluable work in each operation process can be left out. Sometimes the operators must open and close the machine or it causes job interruption between processes because they do not have a proper plan. The operators can use the planning schedule to work continuously.

In case of marketing and sales department, the sales person will know the estimate delivery day in each job. If the job can not be finished on time, the planner will inform sales person so the sales person can negotiate with the customer. If the customer cannot

accept shipment delay, the planner can work out to increase the capacity by increasing operators or working time.

When the planner can control the job according to the production schedule, the shipping and accounting departments can plan to ship finished goods and collect bill in the same area. Most customers of UTK company live around Bangkok. If the proper shipping schedule is not available, the driver may drive around Bangkok to deliver the orders only to a few places.

The production cost is an essential data to calculate the fixed costs, variable costs and overhead expenses. When the planner can work on time to produce the plastic bags, the sales person can easily calculate the costs of production.

VII. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This project studies the process of producing plastic bags. I want to improve labor standard by setting the standard time in each process. My objectives are analyzing each production process and setting standard time for each job, solving the problem of late delivery and improving the productivity for the production department. My scope will focus on the production line of each department.

In the literature review, many objectives can be shown for the benefits of this project. Moreover, the project explains the techniques of work measurement, time studies, labor standard and etc. In addition, the question of improvement point are discussed, and implemented to set up the improvement plans.

This project explains stopwatch time study technique method to find out the standard time of each job element. The result can be concluded as follows:

(1) Process is the existing condition.

At first, understanding the process or the problem will help me know the conditions.

(a) Determining the number of operators in each process.

(b) Determining the role of each department.

(2) Monitoring and analyzing the existing operations.

The process is analysed thoroughly by observing actual working time and by implementing any technique to find out the working concept of valuable work.

(a) Collecting operation data of each operator (work measurement)

(b) Arranging the data (graph, table and chart)

(3) Calculating the number of sample size.

Using a stopwatch, an analyst performs a pilot study is performed by timing a trained worker performing the work elements for a number of work cycles, then calculates the average time for each element.

(a) Selecting work element.

(b) Timing the elements.

Using the continuous method of timing to record the observation time, the stopwatch reading is done for each work element on completion of each element.

(c) Determining Sample Size.

Only 10 cycles of the operation of each operator are observed in each department. These 10 cycles are used to determine the number of sample size "n". 90% level of confidence is considered. The degree of error from the true mean of the distribution (e) is 8% or 0.08. 90% level of confidence and 8% of degree of error are noted.

(d) Setting the Standard.

The normal time (NT) is determined for each work element by judging the pace of the operators. So the normal time is concluded as follows:

(1) Extrusion Department

(a) Setting up machine uses 22.23 minutes.

(b) Putting plastic resin uses 3.02 minutes.

(c) Putting cooling ring uses 7.27 minutes.

(d) Setting extruder head uses 3.21minutes.

(e) Extrusion time depends on the width of plastic roll as follows:

(1) The width 1.5-5.5 inches takes 5.67 minutes to produce 1 kilogram.

(2) The width 6-13.5 inches takes 4.46 minutes to produce 1 kilogram.

(3) The width 14-17.5 inches takes 2.44 minutes to produce 1 kilogram.

(4) The width 18-36 inches takes 2.24 minutes to produce 1 kilogram.

(2) Printing Department

(a) Setting cylinder uses 4.60 minutes.

(b) Setting doctor blade uses 4.70 minutes.

(c) Setting rubber cylinder uses 2.71 minutes.

(d) Pouring color uses 2.51 minutes.

(e) Setting plastic roll uses 12.17 minutes.

(f) Printing time depends on the circumference of printing cylinder.

(g) Changing plastic roll uses3.39 minutes.

(h) Taking off cylinder uses 4.18 minutes.

(i) Taking off doctor blade uses 5.36 minutes.

(j) Taking off rubber cylinder uses 2.23minutes.

(k) Pouring color back uses 3.45 minutes.

(3) Cutting Department

(a) Setting up machine uses 25.93 minutes.

(b) Setting plastic roll uses 4.37 minutes.

(c) Changing roll uses 3.75 minutes.

(d) Cutting time depends on the width of plastic roll as follows:

(1) The width 2.5-8 inches cut 1,482 inches per minute per row.

(2) The width 9-14 inches cut 1,040 inches per minute per row.

(3) The width 15-36 inches cut 940 inches per minute per row.

7.2 Recommendations

This project studies the production process of long-term working. It is beneficial to apply this scientific method to analyze and make reasonable improvement plans. However, the procedure of studying is also important. Like other improvement subjects, agreement from top management is necessary. Thus, permitting from the manager to support improvement theme is the key to success.

Operators should be explained about improvement activities. There are many reasons that can explain the necessity of improvement as follows:

(1) To balance the workload of operator.

(2) To prepare working condition supporting other activities.

(3) To support future demand in case of expansion.

(4) To reduce production costs of the company during the time of economic crisis.

(5) To improve the operators performance.

Knowing the operation is also necessary, it is important to understand the process and know the reason of working. Interview is one part of research. It is important to make clear of the operator's jobs.

In the analysis on improvement, I can initiate many improvements. However, discussing with process members is required to list the problems and take the corrective action.

7.3 Further Study

The concepts of work measurement and method study can be used to improve any processes, any jobs, or any organizations. With scientific thinking, it is necessary to find the reason, know the situation and analyze the problem. Many other techniques can be applied to study and to improve the operation or process as follows:

(1) Cost calculation chart

(2) Flow process chart

(3) Layout of working area

(4) Learning curve

(5) Gantt chart

Selecting any techniques depends on the characteristic of that process. However, all operations and processes can be improved because there are usually numerous ways to perform any task. It is always possible to find a better way to work for the betterment of a business.

APPENDIX A

DRAFT DATA OF WORK MEASUREMENT

Table A.1. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required).

Products : Plastic Bags Operator : Mr. Nai Thammasuntorn

Process : Extrusion Observer : Mr. Ritthikorn Uaphadunglert

Operation : P1 (Time Record in Seconds)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head	Extruding time in100Kgs.
1	1938	380	627	224	15000
2	1856	240	579	235	10800
3	1753	197	631	319	19304.34783
4	2160	257	720	280	14000
5	1980	280	610	326	19000
6	1731	330	592	268	15500
7	1766	219	637	298	11428.57143
8	2280	276	673	387	17302.32558
9	1719	259	534	218	8666.666667
10	1805	231	517	383	9559.322034
Total time in seconds	18988	2669	6120	2938	140561.2335
Average time in seconds	1898.8	266.9	612	293.8	14056.12335

Table A.1. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head	Extruding time in100Kgs.
	1536.64	12791.61	225	4872.04	890903.1235
	1831.84	723.61	1089	3457.44	10602339.29
	21257.64	4886.01	361	635.04	27543860.11
	68225.44	98.01	11664	190.44	3149.830826
	6593.44	171.61	4	1036.84	24441916.29
	28156.84	3981.61	400	665.64	2084779.77
	17635.84	2294.41	625	17.64	6904029.119
	145313.44	82.81	3721	8686.24	10537828.9
	32328.04	62.41	6084	5745.64	29046243.38
	8798.44	1288.81	9025	7956.64	20221222.11
	331677.6	26380.9	33198	33263.6	132276271.9
Sample standard deviation	191.9715257	54.14066042	60.73439443	60.79437108	3833.714067
Number of sample required	4.348135817	17.50402259	4.189425592	18.21424071	31.64435382

Table A.2. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process).

Products : Plastic Bags Operator : Mr. Nai Thammasuntorn

Process : Extrusion Observer : Mr. Ritthikorn Uaphadunglert

Operation : P1 (Time Record in Seconds)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head
11	1655	299	630	248
12	2013	317	579	320
13	1844	265	604	359
14	1776	204	628	217
15	1965	195	571	304
16	1632	270	490	269
17	1933	328	635	236
18	2279	232	688	209
19	2037	341	592	312
20	1866	185	710	246
Total time in seconds	19000	2636	6127	2720
Average time in seconds	1900	263.6	612.7	272
Average time in minutes	1899.4	265.25	612.35	282.9

Table A.2. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process). (Continued)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head
Performance rating	0.95	0.95	1.05	0.9
Normal time in minutes	30.07383333	4.199791667	10.716125	4.2435

Table A.3. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required).

Products : Plastic Bags Operator : Mr. Sombut Chambang

Process : Extrusion Observer : Mr. Ritthikorn Uaphadunglert

Operation : P1 (Time Record in Seconds)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head	Extruding time in 100Kgs.
1	1862	365	623	251	15254.23729
2	2199	253	509	283	20336.28319
3	2087	205	459	273	17347.15026
4	1947	214	534	312	30000
5	2165	312	687	375	24905.66038
6	1739	303	684	263	14921.73913
7	2297	334	519	239	17826.08696
8	1965	290	573	310	15319.14894
9	1846	256	421	354	15882.35294
10	2180	290	636	386	12813.55932
Total time in seconds	20287	2822	5645	3046	184606.2184
Average time in seconds	2028.7	282.2	564.5	304.6	18460.62184

Table A.3. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head	Extruding time in100Kgs.
	27788.89	6855.84	3422.25	2872.96	10280901.89
	29002.09	852.64	3080.25	466.56	3518105.486
	3398.89	5959.84	11130.25	998.56	1239818.961
	6674.89	4651.24	930.25	54.76	133157248.3
	18577.69	888.04	15006.25	4956.16	41538521.75
	83926.09	432.64	14280.25	1730.56	12523690.83
	71984.89	2683.24	2070.25	4303.36	402634.5179
	4057.69	60.84	72.25	29.16	9868852.003
	33379.29	686.44	20592.25	2440.36	6647470.513
	22891.69	60.84	5112.25	6625.96	31889315.08
	301682.1	23131.6	75696.5	24478.4	251066559.4
Sample standard deviation	183.0853171	50.69692079	91.70998976	52.15191485	5281.693324
Number of sample required	3.464649366	13.72894167	11.22776494	12.47006262	34.82103086

Table A.4. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process).

Products : Plastic Bags Operator : Mr. Sombut Chambang

Process : Extrusion Observer : Mr. Ritthikorn Uaphadunglert

Operation : P1 (Time Record in Seconds)

Observations	Set up machine	Put plastic resin	Put cooling ring	Set extruder head
11	1950	268	649	249
12	2070	231	570	217
13	2168	368	538	376
14	1867	304	642	259
15	2128	279	549	308
Total time in seconds	10183	1450	2948	1409
Average time in seconds	2036.6	290	589.6	281.8
Average time in minutes	823.2	117.4666667	242.3333333	118.9333333
Performance rating	1.05	0.95	0.95	1.1
Normal time (minutes)	14.406	1.859888889	3.836944444	2.180444444

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process).

Products : Plastic Bags

Operator : Mr. Nai Thammasuntorn, Mr. Sombut Chambang

Process : Extrusion

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P1

(Time Record in Minutes)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
1	2	16	110	620	563.6363636	5.636363636
2	4	20	64	390	609.375	6.09375
3	4.5	16	230	1180	513.0434783	5.130434783
4	5	12	57	340	596.4912281	5.964912281
5	5.5	8	15	95	633.3333333	6.333333333
6	5.5	15	116	610	525.862069	5.25862069
7	5.5	15	147	785	534.0136054	5.340136054
						39.75755078
						5.679650111
8	6	16	131	660	503.8167939	5.038167939
9	6.5	7	111	595	536.036036	5.36036036
10	6.5	6	232	1330	573.2758621	5.732758621

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process). (Continued)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
11	6.5	8	54	240	444.4444444	4.444444444
12	6.5	8	35	160	457.1428571	4.571428571
13	6.5	18	62	255	411.2903226	4.112903226
14	6.5	10	226	966	427.4336283	4.274336283
15	7	10	80	405	506.25	5.0625
16	7.5	16	101	496	491.0891089	4.910891089
17	7.5	16	205	854	416.5853659	4.165853659
18	7.5	16	210	871	414.7619048	4.147619048
19	7.5	16	113	529	468.1415929	4.681415929
20	8	10	70	305	435.7142857	4.357142857
21	8.5	10	172	655	380.8139535	3.808139535
22	10	12	217	1160	534.562212	5.34562212
23	10	12	62	333	537.0967742	5.370967742
24	10	12	64	370	578.125	5.78125
25	10	20	110	470	427.2727273	4.272727273
26	10.5	15	110	430	390.9090909	3.909090909

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process). (Continued)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
27	11	8	105	470	447.6190476	4.476190476
28	11	10	74	275	371.6216216	3.716216216
29	11	10	44	145	329.5454545	3.295454545
30	11.25	15	238	851	357.5630252	3.575630252
31	12	10	968	4992	515.7024793	5.157024793
32	12	12	106	445	419.8113208	4.198113208
33	12	14	54	240	444.4444444	4.444444444
34	12.5	15	181	840	464.0883978	4.640883978
35	12.5	8	106	435	410.3773585	4.103773585
36	13	8	114	540	473.6842105	4.736842105
37	13	8	423	1240	293.144208	2.93144208
38	13	8	106	415	391.509434	3.91509434
39	13.5	8	109	495	454.1284404	4.541284404
40	13.5	8	212	880	415.0943396	4.150943396
						147.2309574
						4.461544164

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process). (Continued)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
41	14	30	35	95	271.4285714	2.714285714
42	14	15	178	470	264.0449438	2.640449438
43	14	15	150	405	270	2.7
44	14	15	269	712	264.6840149	2.646840149
45	14	8	300	690	230	2.3
46	14	16	71	240	338.028169	3.38028169
47	14	16	80	240	300	3
48	14	15	115	255	221.7391304	2.217391304
49	14	8	334	747	223.6526946	2.236526946
50	14	8	90	230	255.5555556	2.555555556
51	14	20	102	360	352.9411765	3.529411765
52	14.5	8	403	954	236.7245658	2.367245658
53	15	8	330	840	254.5454545	2.545454545
54	15	10	118	250	211.8644068	2.118644068
55	15	10	64	165	257.8125	2.578125
56	15	10	129	270	209.3023256	2.093023256

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process). (Continued)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
57	15	10	121	280	231.4049587	2.314049587
58	15	8	271	630	232.4723247	2.324723247
59	15	8	115	240	208.6956522	2.086956522
60	15	8	115	230	200	2
61	15	10	138	280	202.8985507	2.028985507
62	16	8	245	615	251.0204082	2.510204082
63	16	8	287	690	240.4181185	2.404181185
64	16	10	279	810	290.3225806	2.903225806
65	16	10	90	250	277.7777778	2.777777778
66	16	8	289	630	217.9930796	2.179930796
67	16	8	241	534	221.5767635	2.215767635
68	16	10	986	2550	258.6206897	2.586206897
69	16.5	8	161	390	242.2360248	2.422360248
70	16.5	10	105	245	233.3333333	2.333333333
71	17	10	39	73	187.1794872	1.871794872
72	17	18	40	115	287.5	2.875

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process). (Continued)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
73	17	10	205	480	234.1463415	2.341463415
74	17	10	344	710	206.3953488	2.063953488
75	17	10	200	512	256	2.56
76	17	8	112	260	232.1428571	2.321428571
77	17.5	10	192	402	209.375	2.09375
78	17.5	10	417	870	208.6330935	2.086330935
						92.92465899
						2.445385763
79	18	8	308	450	146.1038961	1.461038961
80	18	10	123	244	198.3739837	1.983739837
81	18.5	10	38	75	197.3684211	1.973684211
82	18.5	10	36	65	180.5555556	1.805555556
83	18.5	10	111	220	198.1981982	1.981981982
84	19	15	190	435	228.9473684	2.289473684
85	20	8	190	430	226.3157895	2.263157895
86	20	8	90	195	216.6666667	2.166666667

Table A.5. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Extrusion Process). (Continued)

No.	Width (inches)	Thickness (mm)	Kgs.	Production time	Production in100 Kgs.	Production in1 Kg.
87	21	10	34	60	176.4705882	1.764705882
88	21	20	42	86	204.7619048	2.047619048
89	21	20	64	170	265.625	2.65625
90	21	9	372	775	208.3333333	2.083333333
91	22	12	120	312	260	2.6
92	23	7	181	465	256.9060773	2.569060773
93	24	12	141	400	283.6879433	2.836879433
94	25	12	138	390	282.6086957	2.826086957
95	25	7	114	285	250	2.5
96	26	8	210	510	242.8571429	2.428571429
97	27	8	295	630	213.559322	2.13559322
98	29	13	120	245	204.1666667	2.041666667
						44.41506553
						2.337635028

Table A.6. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required).

Products : Plastic Bags

Operator : Mr. Precha Nampaisan

Process : Printing

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P2

(Time Record in Seconds)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back	Printing time in 100Kgs.
1	273	259	145	80	632	184	280	276	158	105	5500
2	389	184	100	91	718	159	374	354	113	129	9523.809524
3	227	253	89	97	892	144	219	380	92	171	6792.45283
4	291	319	151	68	773	114	201	254	164	193	6716.41791
5	212	227	167	123	915	176	325	339	141	219	6554.621849
6	326	206	121	114	762	97	236	225	85	152	6666.666667
7	248	361	138	127	867	141	294	267	98	177	5000
8	234	275	131	146	802	178	237	335	127	201	6428.571429
9	301	246	97	116	707	196	321	262	133	137	4553.571429
10	265	270	115	92	696	104	188	291	106	167	11052.63158

Table A.6. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back	Printing time in 100Kgs.
Total time in seconds	2766	2600	1254	1054	7764	1493	2675	2983	1217	1651	68788.74322
Average time in seconds	276.6	260	125.4	105.4	776.4	149.3	267.5	298.3	121.7	165.1	6878.874322
	12.96	1	384.16	645.16	20851.36	1204.09	156.25	497.29	1317.69	3612.01	1901294.395
	12633.76	5776	645.16	207.36	3410.56	94.09	11342.25	3102.49	75.69	1303.21	6995682.224
	2460.16	49	1324.96	70.56	13363.36	28.09	2352.25	6674.89	882.09	34.81	7468.674177
	207.36	3481	655.36	1398.76	11.56	1246.09	4422.25	1962.49	1789.29	778.41	26392.08552
	4173.16	1089	1730.56	309.76	19209.96	712.89	3306.25	1656.49	372.49	2905.21	105139.6662
	2440.36	2916	19.36	73.96	207.36	2735.29	992.25	5372.89	1346.89	171.61	45032.08881

Table A.6. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back	Printing time in 100Kgs.
	817.96	10201	158.76	466.56	8208.36	68.89	702.25	979.69	561.69	141.61	3530168.716
	1814.76	225	31.36	1648.36	655.36	823.69	930.25	1346.89	28.09	1288.81	202772.6955
	595.36	196	806.56	112.36	4816.36	2180.89	2862.25	1317.69	127.69	789.61	5407033.544
	134.56	100	108.16	179.56	6464.16	2052.09	6320.25	53.29	246.49	3.61	17420249.64
	25290.4	24034	5864.4	5112.4	77198.4	11146.1	33386.5	22964.1	6748.1	11028.9	35641233.73
Sample standard deviation	53.00985233	51.67634318	25.52645686	23.83368298	92.6153335	35.19169725	60.90657691	50.51303462	27.38227326	35.00618993	1990.009317
Number of sample required	15.62416266	16.80446792	17.62681787	21.75148987	6.053166932	23.63462548	22.05305321	12.19799154	21.53504375	19.12420795	35.60109731

Table A.7. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process).

Products : Plastic Bags

Operator : Mr. Precha Nampaisan

Process : Printing

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P2

(Time Record in Seconds)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back
11	289	318	155	75	765	190	327	193	114	143
12	317	234	90	99	792	168	277	287	136	95
13	239	216	109	107	820	219	256	376	109	189
14	305	301	156	88	734	169	287	264	98	160
15	256	287	183	117	946	140	238	318	84	279
16	311	216	149	134	740	110	194	253	136	189
17	290	350	142	149	863	121	258	271	112	153
18	257	255	110	120	801	256	245	357	132	274
19	394	219	92	97	763	179	258	249	119	231
20	245	280	81	82	621	130	246	286	102	187
21	236	362	123	93	719	174	294	278	91	194

Table A.7. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process). (Continued)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back
22	270	319	136	125	684	156	295	246	128	133
23	244	356	128	142	737	178	302	342	99	126
Total time in seconds	3653	3713	1654	1428	9985	2190	3477	3720	1460	2353
Average time in seconds	281	285.6153846	127.2307692	109.8461538	768.0769231	168.4615385	267.4615385	286.1538462	112.3076923	181
Average time in minutes	279.0869565	274.4782609	126.4347826	107.9130435	771.6956522	160.1304348	267.4782609	291.4347826	116.3913043	174.0869565
Performance rating	1.1	1.05	0.9	0.85	1.1	0.85	1.05	0.9	0.95	0.85
Normal time (minutes)	5.116594203	4.803369565	1.896521739	1.528768116	14.14775362	2.268514493	4.680869565	4.371521739	1.842862319	2.466231884

Table A.8. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required).

Products : Plastic Bags

Operator : Mr. Sura Punpan

Process : Printing

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P2

(Time Record in Seconds)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back	Printing time in 100Kgs.
1	224	396	173	117	840	265	168	382	133	196	5520
2	191	298	191	136	602	179	192	338	147	287	3652.173913
3	298	205	119	175	445	186	138	275	110	227	7258.064516
4	205	261	153	163	499	190	184	409	97	243	5806.451613
5	261	280	194	125	725	289	278	426	136	226	7076.923077
6	287	266	186	205	687	277	188	374	184	269	6947.368421
7	324	327	204	198	531	153	210	321	107	197	6200
8	238	318	126	174	683	198	246	390	143	215	8307.692308
9	290	329	173	168	611	206	251	412	102	236	5454.545455
10	229	275	148	180	703	240	289	375	172	259	12315.78947

Table A.8. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back	Printing time in 100Kgs.
Total time in seconds	2547	2955	1667	1641	6326	2183	2144	3702	1331	2355	68539.00878
Average time in seconds	254.7	295.5	166.7	164.1	632.6	218.3	214.4	370.2	133.1	235.5	6853.900878
	942.49	10100.2	39.69	2218.41	43014.7	2180.89	2152.96	139.24	0.01	1560.25	1779291.551
	4057.69	6.25	590.49	789.61	936.36	1544.49	501.76	1036.84	193.21	2652.25	10251055.56
	1874.89	8190.25	2275.29	118.81	35193.7	1043.29	5836.96	9063.04	533.61	72.25	163348.2467
	2470.09	1190.25	187.69	1.21	17848.9	800.89	924.16	1505.44	1303.21	56.25	1097149.962
	39.69	240.25	745.29	1528.81	8537.76	4998.49	4044.96	3113.64	8.41	90.25	49738.90139
	1043.29	870.25	372.49	1672.81	2959.36	3445.69	696.96	14.44	2590.81	1122.25	8736.18168
	4802.49	992.25	1391.29	1149.21	10322.5	4264.09	19.36	2420.64	681.21	1482.25	427586.3577
	278.89	506.25	1656.49	98.01	2540.16	412.09	998.56	392.04	98.01	420.25	2113509.522
	1246.09	1122.25	39.69	15.21	466.56	151.29	1339.56	1747.24	967.21	0.25	1958195.6

Table A.8. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back	Printing time in 100Kgs.
	660.49	420.25	349.69	252.81	4956.16	470.89	5565.16	23.04	1513.21	552.25	29832227.04
	17416.1	23638.5	7648.1	7844.9	126776.	19312.1	22080.4	19455.6	7888.9	8008.5	47680838.91
Sample standard deviation	43.9900 2412	51.2493 9024	29.15113 872	29.5238 1336	118.685 579	46.322660 64	49.5315 8364	46.49444 411	29.60649 328	29.83007 431	2301.710449
Number of sample required	12.6893 222	12.7952 9636	13.00851 623	13.7694 2024	14.9735 7303	19.154350 72	22.7040 2099	6.709917 878	21.04775 331	6.825190 255	47.97485319

Table A.9. Detail Check Sheet for the Result of Work Measurement (Normal Time of Setup Process).

Products : Plastic Bags

Operator : Mr. Sura Punpan

Process : Printing

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P2

(Time Record in Seconds)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back
11	314	378	189	169	790	264	176	364	153	188
12	189	313	158	158	801	163	290	312	185	260
13	289	280	194	189	702	310	190	298	132	267
14	263	204	187	157	476	169	160	410	104	246
15	174	269	172	132	684	260	287	387	167	210
16	274	311	201	190	510	254	231	345	184	288
17	319	342	239	204	649	176	240	315	110	169
18	260	291	176	231	598	203	340	344	144	211
19	283	288	169	201	617	238	260	417	126	263
20	244	270	188	170	720	256	248	365	168	293
21	293	297	198	187	811	209	159	365	194	186

Table A.9. Detail Check Sheet for the Result of Work Measurement (Normal Time of Setup Process). (Continued)

Observation	Set cylinder	Set doctor blade	Set rubber cylinder	Pour color	Set plastic roll	Change plastic roll	Take off cylinder	Take off doctor blade	Take off rubber cylinder	Pour color back
22	193	246	243	200	798	325	214	238	138	205
Total time in seconds	3095	3489	2314	2188	8156	2827	2795	4160	1805	2786
Average time in seconds	257.9166667	290.75	192.8333333	182.3333333	679.66666 67	235.58333 33	232.91666 67	346.66666 67	150.41666 67	232.1666667
Performance rating	0.95	0.95	1.1	1.15	0.9	1.15	0.95	1.1	1.05	1.15
Normal time	4.083680556	4.603541667	3.535277778	3.494722222	10.195	4.5153472 22	3.6878472 22	6.3555555 56	2.6322916 67	4.449861111

Table A.10. Detail Check Sheet for the Result of Work Measurement (Normal Time of Setup Process).

Products : Plastic Bags

Operator : Mr. Precha Nampaisan

Process : Printing

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P2

(Time Record in Minutes)

Performance rating factor (RF) = 1.05

No.	Width	length	Thick-ness	Circum-ference	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
1	3.25	12	0.16	12	100	210	220.5	9006.815	355769.230	1613.465	134.4554916
2	2.75	6	0.08	12	30	150	157.5	6386.651	252272.727	1601.731	133.4776335
3	8	12	0.12	12	85	96	100.8	4146.888	163802.083	1625.020	135.418389
4	11.3	13	0.15	13	100	64	67.2	2775.433	109629.629	1631.393	125.4917922
5	11.3	13	0.15	13	110	90	94.5	3052.977	120592.592	1276.112	98.16246853
6	11.3	13	0.15	13	100	56	58.8	2775.433	109629.629	1864.449	143.419191
7	9.5	13	0.19	13	100	65	68.25	2594.761	102493.074	1501.730	115.5176949
8	9.5	14.5	0.19	14.5	60	30	31.5	1556.856	61495.8448	1952.249	134.6378651
											1020.580526
											127.5725657

Table A.10. Detail Check Sheet for the Result of Work Measurement (Normal Time of Setup Process). (Continued)

No.	Width	length	Thick-ness	Circum-ference	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
9	10	15	0.12	15	100	96	100.8	3902.953586	154166.6667	1529.431217	101.9620811
10	10	15	0.12	15	25	20	21	975.7383966	38541.66667	1835.31746	122.3544974
11	15	15	0.08	15	70	55	57.75	2732.067511	107916.6667	1868.686869	124.5791246
12	14	15	0.15	15	200	110	115.5	4460.518385	176190.4762	1525.458668	101.6972446
13	11	15	0.1	15	160	180	189	6812.428078	269090.9091	1423.761424	94.91742825
14	10	15	0.12	15	110	85	89.25	4293.248945	169583.3333	1900.093371	126.6728914
15	10	15	0.12	15	120	120	126	4683.544304	185000	1468.253968	97.88359788
16	11	15	0.1	15	110	145	152.25	4683.544304	185000	1215.106732	81.00711549
17	10	15	0.12	15	110	100	105	4293.248945	169583.3333	1615.079365	107.6719577
18	10	15	0.12	15	100	80	84	3902.953586	154166.6667	1835.31746	122.3544974
19	10	15	0.12	15	120	85	89.25	4683.544304	185000	2072.829132	138.1886088
20	10	15	0.12	15	110	90	94.5	4293.248945	169583.3333	1794.532628	119.6355085
21	14	15	0.08	15	110	89	93.45	4599.909584	181696.4286	1944.317053	129.6211368
22	10	15	0.12	15	60	55	57.75	2341.772152	92500	1601.731602	106.7821068
23	14	15	0.15	15	250	140	147	5575.647981	220238.0952	1498.218335	99.88122233
24	14	15	0.15	15	60	30	31.5	1338.155515	52857.14286	1678.004535	111.866969

Table A.10. Detail Check Sheet for the Result of Work Measurement (Normal Time of Setup Process). (Continued)

No.	Width	length	Thick-ness	Circum-ference	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
25	14	15	0.15	15	90	50	52.5	2007.233273	79285.71429	1510.204082	100.6802721
26	12.5	19	0.08	19	88	85	89.25	4121.518987	162800	1824.089636	96.00471768
											1983.760978
											110.2089432
27	13.5	10	0.08	20	31	25	26.25	1344.35068	53101.85185	2022.92769	101.1463845
28	6.5	10	0.03	20	27	105	110.25	6484.907498	256153.8462	2323.390895	116.1695447
29	10	15	0.08	20	60	55	57.75	3512.658228	138750	2402.597403	120.1298701
30	10	15	0.12	20	60	45	47.25	2341.772152	92500	1957.671958	97.88359788
31	15.5	12	0.1	24	200	70	73.5	6043.282973	238709.6774	3247.750713	135.3229464
											570.6523436
											114.1304687
32	23	26	0.15	26	250	70	73.5	3393.872684	134057.971	1823.917973	70.15069127
33	27	39	0.05	27	140	76	79.8	4857.008908	191851.8519	2404.158545	89.04290906
34	15	29	0.12	29	140	50	52.5	3642.756681	143888.8889	2740.740741	94.5083014

Table A.10. Detail Check Sheet for the Result of Work Measurement (Normal Time of Setup Process). (Continued)

No.	Width	length	Thick-ness	Circum-ference	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
35	18	29	0.12	29	230	70	73.5	4987.107361	196990.7407	2680.146133	92.41883216
											346.1207339
											86.53018347
36	20	31	0.05	31	100	90	94.5	4683.544304	185000	1957.671958	63.15070831
37	25	32	0.08	32	50	25	26.25	1170.886076	46250	1761.904762	55.05952381
38	17	32	0.08	32	80	65	68.25	2755.026061	108823.5294	1594.483947	49.82762336
39	28	33	0.1	33	120	35	36.75	2007.233273	79285.71429	2157.434402	65.37680007
											233.4146555
											58.35366389
40	25	38	0.12	38	80	25	26.25	1248.945148	49333.33333	1879.365079	49.45697577
41	29	40	0.12	40	120	43	45.15	1615.015277	63793.10345	1412.914805	35.32287013
42	30	40	0.15	40	250	65	68.25	2601.969058	102777.7778	1505.901506	37.64753765
43	30	40	0.1	40	150	40	42	2341.772152	92500	2202.380952	55.05952381
											177.4869074
											44.37172684

Table A.11. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Printing Process)

Products : Plastic Bags

Operator : Mr. Sura Punpan

Process : Printing

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P2

(Time Record in Minutes)

Performance rating factor (RF) = 0.95

No.	Width	length	Thick-ness	Circum-ferences	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
1	5		0.03	12	55	455	432.25	17172.99578	678333.3333	1490.842491	124.2368742
2	11		0.06	12	110	250	237.5	7805.907173	308333.3333	1233.333333	102.7777778
3	5		0.03	12	50	370	351.5	15611.81435	616666.6667	1666.666667	138.8888889
4	4.75		0.08	12	25	85	80.75	3081.279147	121710.5263	1431.888545	119.3240454
5	2.75		0.06	12	50	330	313.5	14192.5585	560606.0606	1698.806244	141.567187
6	2.75		0.06	12	30	200	190	8515.535098	336363.6364	1681.818182	140.1515152
7	6		0.16	12	230	310	294.5	11220.99156	443229.1667	1429.771505	119.1476254
8	12.5		0.1	12.5	50	55	52.25	1873.417722	74000	1345.454545	107.6363636
9	13		0.05	13	60	110	104.5	4323.271665	170769.2308	1552.447552	119.4190425
10	6.5		0.06	13	200	490	465.5	24018.17592	948717.9487	1936.159079	148.9353138
11	10.5		0.15	13	30	25	23.75	892.1036769	35238.09524	1409.52381	108.4249084

Table A.11. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Printing Process). (Continued)

No.	Width	length	Thick-ness	Circum-ferences	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
12	8.5		0.2	14	60	55	52.25	1653.015637	65294.11765	1187.165775	84.79755539
13	2		0.16	14	200	550	522.5	29272.1519	1156250	2102.272727	150.1623377
14	2.5		0.16	14	100	250	237.5	11708.86076	462500	1850	132.1428571
15	9.5		0.19	14.5	45	25	23.75	1167.642624	46121.88366	1844.875346	127.2327825
16	9.5		0.19	14.5	110	55	52.25	2854.237526	112742.3823	2049.861496	141.3697583
											2006.214833
											125.3884271
17	10		0.05	15	70	140	133	6556.962025	259000	1850	123.3333333
18	15		0.05	15	60	86	81.7	3746.835443	148000	1720.930233	114.7286822
19	15		0.28	15	180	50	47.5	2007.233273	79285.71429	1585.714286	105.7142857
20	15		0.1	15	100	65	61.75	3122.362869	123333.3333	1897.435897	126.4957265
21	16		0.12	16	70	30	28.5	1707.542194	67447.91667	2248.263889	140.5164931
22	13		0.05	16	55	105	99.75	3962.999026	156538.4615	1490.842491	93.17765568
23	16		0.1	16	50	45	42.75	1463.607595	57812.5	1284.722222	80.29513889
24	16		0.1	16	60	30	28.5	1756.329114	69375	2312.5	144.53125

Table A.11. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Printing Process). (Continued)

No.	Width	length	Thick-ness	Circum-ferences	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
25	16.5		0.1	16.5	160	95	90.25	4541.618719	179393.9394	1888.357257	114.4458944
26	17		0.1	17	250	120	114	6887.565153	272058.8235	2267.156863	133.3621684
27	17.5		0.1	17.5	400	190	180.5	10705.24412	422857.1429	2225.56391	127.1750806
28	18		0.08	18	70	35	33.25	2276.722925	89930.55556	2569.444444	142.7469136
29	14		0.05	18	75	85	80.75	5018.083183	198214.2857	2331.932773	129.5518207
30	22		0.15	18	120	45	42.75	1703.10702	67272.72727	1494.949495	83.05274972
31	18.5		0.05	18.5	90	90	85.5	4556.962025	180000	2000	108.1081081
32	18.5		0.1	18.5	100	55	52.25	2531.64557	100000	1818.181818	98.28009828
33	15		0.05	20	60	70	66.5	3746.835443	148000	2114.285714	105.7142857
34	10		0.15	20	350	220	209	10928.27004	431666.6667	1962.121212	98.10606061
35	4.75		0.08	20	10	20	19	1232.511659	48684.21053	2434.210526	121.7105263
36	24		0.13	20	120	45	42.75	1801.363194	71153.84615	1581.196581	79.05982906
37	24.5		0.1	20	380	110	104.5	7264.272798	286938.7755	2608.534323	130.4267161
38	16		0.08	20	90	40	38	3293.117089	130078.125	3251.953125	162.5976563
											2563.130473
											116.5059306

Table A.11. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Printing Process). (Continued)

No.	Width	length	Thick-ness	Circum-ferences	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
39	21.5	30	0.28	21.5	250	35	33.25	1944.993482	76827.24252	2195.064072	102.0960034
40	11		0.12	22	550	355	337.25	19514.76793	770833.3333	2171.361502	98.69825011
41	22		0.1	22	220	80	76	4683.544304	185000	2312.5	105.1136364
42	18		0.05	23	140	150	142.5	7285.513361	287777.7778	1918.518519	83.41384863
43	27		0.1	23	100	45	42.75	1734.646038	68518.51852	1522.633745	66.20146717
											455.5232056
											91.10464112
44	20		0.15	25	660	195	185.25	10303.79747	407000	2087.179487	83.48717949
45	3.5		0.16	29	350	450	427.5	29272.1519	1156250	2569.444444	88.60153257
46	3.5		0.16	29	80	90	85.5	6690.777577	264285.7143	2936.507937	101.2588944
47	3		0.16	29	90	110	104.5	8781.64557	346875	3153.409091	108.7382445
											382.0858509
											95.52146273
48	20		0.1	30	100	45	42.75	2341.772152	92500	2055.555556	68.51851852

Table A.11. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Printing Process). (Continued)

No.	Width	length	Thick-ness	Circum-ferences	Kgs.	Production time	Performance rating	Total meters	Total inches	Inches/ 1 minute	Circumferences/ 1 minute
49	23		0.12	32	50	20	19	848.468171	33514.49275	1675.724638	52.36639493
50	25		0.15	34	75	19	18.05	936.7088608	37000	1947.368421	57.2755418
											178.1604552
											59.38681841
51	23		0.1	35	120	50	47.5	2443.588332	96521.73913	1930.434783	55.1552795
52	29		0.13	36	120	28	26.6	1490.783333	58885.94164	2103.069344	58.4185929
53	26		0.12	38	150	45	42.75	2251.703992	88942.30769	1976.495726	52.01304543
54	30		0.1	40	120	38	36.1	1873.417722	74000	1947.368421	48.68421053
55	27		0.08	42	260	120	114	5637.599625	222685.1852	1855.709877	44.18356849
56	30		0.1	42	120	25	23.75	1561.181435	61666.66667	2466.666667	58.73015873
57	30		0.08	42	150	55	52.25	2744.264241	108398.4375	1970.880682	46.92573052
											364.1105861
											52.01579801

Table A.12. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required).

Products : Plastic Bags Operator : Ms. Suda Thaitap

Process : Cutting Observer : Mr. Ritthikorn Uaphadunglert

Operation : P3 (Time Record in Seconds)

Observation	Set up machine	Set plastic roll	Change roll	Cutting time in 100 Kgs.
1	1363	185	183	10500
2	1270	252	204	15166.66667
3	1586	342	196	6607.142857
4	1823	429	188	5657.142857
5	1407	309	210	14423.07692
6	1521	275	195	17000
7	1694	298	241	14500
8	1396	243	237	10263.15789
9	1776	271	251	14776.1194
10	1804	265	265	16654.20561
Total time in seconds	15640	2869	2170	125547.5122
Average time in seconds	1564	286.9	217	12554.75122
	40401	10383.61	1156	4222002.58

Table A.12. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observation	Set up machine	Set plastic roll	Change roll	Cutting time in 100 Kgs.
	86436	1218.01	169	6822102.296
	484	3036.01	441	35374045.25
	67081	20192.41	841	47577001.14
	24649	488.41	49	3490640.929
	1849	141.61	484	19760236.71
	16900	123.21	576	3783992.813
	28224	1927.21	400	5251399.973
	44944	252.81	1156	4934476.6
	57600	479.61	2304	16805526.27
	368568	38242.9	7576	148021424.6
Sample standard deviation	202.3660051	65.18597327	29.01340686	4055.468524
Number of sample required	7.121796068	21.96014111	7.604416637	44.38679238

Table A.13. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process).

Products : Plastic Bags

Operator : Ms. Suda Thaitap

Process : Cutting

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P3

(Time Record in Seconds)

Observation	Set up machine	Set plastic roll	Change roll
11	1289	195	176
12	1318	269	287
13	1429	398	287
14	1780	461	160
15	1578	330	298
16	1690	260	238
17	1762	297	298
18	1487	256	232
19	1771	253	238
20	1892	260	243
21	1285	185	287
Total time in seconds	17281	3164	2744
Average time in seconds	1571	287.6363636	249.4545455

Table A.13. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process). (Continued)

Observation	Set up machine	Set plastic roll	Change roll
Average time in minutes	1567.666667	287.2857143	234
Performance rating	1	1.05	0.95
Normal time	26.12777778	5.0275	3.705

Table A.14. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required).

Products : Plastic Bags

Operator : Ms. Namtip Chitchop

Process : Cutting

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P3

(Time Record in Seconds)

Observation	Set up machine	Set plastic roll	Change roll	Cutting time in 100 Kgs.
1	1423	173	194	11760
2	1302	192	242	15978.94737
3	1489	251	194	7083.333333
4	1732	245	179	6445.714286
5	1590	197	220	14160
6	1620	269	199	17800
7	1300	263	231	14500
8	1789	356	216	11938.77551
9	1691	240	256	14090.90909
10	1730	199	281	16455.44554
Total time in seconds	15666	2385	2212	130213.1251
Average time in seconds	1566.6	238.5	221.2	13021.31251
	20620.96	4290.25	739.84	1590909.256

Table A.14. Detail Check Sheet for the Result of Work Measurement (Find Number of Sample Required). (Continued)

Observation	Set up machine	Set plastic roll	Change roll	Cutting time in 100 Kgs.
	70013.16	2162.25	432.64	8747603.936
	6021.76	156.25	739.84	35259596.74
	27357.16	42.25	1780.84	43238492.05
	547.56	1722.25	1.44	1296609.192
	2851.56	930.25	492.84	22835854.1
	71075.56	600.25	96.04	2186516.683
	49461.76	13806.25	27.04	1171886.363
	15475.36	2.25	1211.04	1144036.839
	26699.56	1560.25	3576.04	11793269.68
	290124.4	25272.5	9097.6	129264774.8
Sample standard deviation	179.5439903	52.9910894	31.79377996	3789.82226
Number of sample required	5.587446991	20.99988147	8.788241803	36.03429874

Table A.15. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process).

Products : Plastic Bags

Operator : Ms. Namtip Chitchop

Process : Cutting

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P3

(Time Record in Seconds)

Observation	Set up machine	Set plastic roll	Change roll
11	1576	165	176
12	1450	183	276
13	1598	211	150
14	1690	238	139
15	1452	188	209
16	1218	276	218
17	1465	238	263
18	1789	339	231
19	1655	287	210
20	1590	234	265
21	1296	186	206
Total time in seconds	16779	2545	2343
Average time in seconds	1525.363636	231.3636364	213

Table A.15. Detail Check Sheet for the Result of Work Measurement (Find Normal Time of Setup Process). (Continued)

Observation	Set up machine	Set plastic roll	Change roll
Average time in minutes	1545	234.7619048	216.9047619
Performance rating	1	0.95	1.05
Normal time	25.75	3.717063492	3.795833333

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process).

Products : Plastic Bags

Operator : Ms. Suda Thaitap ,Ms. Namtip Chitchop

Process : Cutting

Observer : Mr. Ritthikorn Uaphadunglert

Operation : P3

(Time Record in Minutes)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
1	2.5	3.5	0.15	5	4933.333333	2220	45	20	44.44444444	0.444444444
2	2.5	3.5	0.15	5	4933.333333	1414.222222	86	60	69.76744186	0.697674419
3	2.5	3.5	0.15	5	4933.333333	1860.571429	66	35	53.03030303	0.53030303
4	2.5	3.5	0.15	5	4933.333333	920.8888889	28	30	107.1428571	1.071428571
5	2.75	6	0.06	5	11212.12121	1601.090909	35.7	50	140.0560224	1.400560224
6	2.75	6	0.06	5	11212.12121	1255.757576	42	75	178.5714286	1.785714286
7	2.75	6	0.06	5	11212.12121	1648.841355	50	68	136	1.36
8	3.25	10	0.18	3	3162.393162	1405.508072	200	150	75	0.75
9	6	12	0.15	3	2055.555556	1468.253968	75	35	46.66666667	0.466666667
10	6	12	0.15	3	2055.555556	1583.539095	104	45	43.26923077	0.432692308
11	6.5	16	0.06	3	4743.589744	2142.266336	210	155	73.80952381	0.738095238
12	6.5	16	0.06	3	4743.589744	1054.131054	30	45	150	1.5

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
13	7.25	13	0.15	2	1701.149425	1439.434129	110	65	59.09090909	0.590909091
14	7.5	20.5	0.15	2	1644.444444	1063.407407	97	75	77.31958763	0.773195876
15	8	12	0.1	2	2312.5	1445.3125	25	20	80	0.8
16	8	15	0.05	2	4625	1189.285714	54	105	194.4444444	1.944444444
						23712.51066				
						1482.031916				
17	9.5	13	0.19	2	1024.930748	1024.930748	40	20	50	0.5
18	9.5	13	0.19	2	1024.930748	986.4958449	77	40	51.94805195	0.519480519
19	9.5	14.5	0.19	2	1024.930748	761.377127	52	35	67.30769231	0.673076923
20	9.5	14.5	0.19	2	1024.930748	1171.349426	80	35	43.75	0.4375
21	9.5	13	0.1	2	1947.368421	1248.606811	109	85	77.98165138	0.779816514
22	10	15	0.12	2	1541.666667	946.0227273	135	110	81.48148148	0.814814815
23	10	15	0.12	2	1541.666667	1361.805556	26.5	15	56.60377358	0.566037736
24	10	15	0.12	2	1541.666667	1190.838675	120.5	78	64.73029046	0.647302905
25	10	20	0.08	2	2312.5	1127.34375	39	40	102.5641026	1.025641026
26	10	15	0.12	2	1541.666667	1027.777778	20	15	75	0.75

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
27	10	15	0.12	2	1541.666667	996.9444444	97	75	77.31958763	0.773195876
28	10	15	0.12	2	1541.666667	1156.25	52.5	35	66.66666667	0.666666667
29	10	14	0.2	2	925	1262.5	101	37	36.63366337	0.366336634
30	10	15	0.12	2	1541.666667	1125.416667	73	50	68.49315068	0.684931507
31	10	15	0.2	2	925	817.0833333	53	30	56.60377358	0.566037736
32	10	15	0.12	2	1541.666667	1027.777778	44	33	75	0.75
33	10	15	0.12	2	1541.666667	905.2810078	101	86	85.14851485	0.851485149
34	10	15	0.12	2	1541.666667	955.8333333	62	50	80.64516129	0.806451613
35	10	15	0.12	2	1541.666667	948.4601449	283	230	81.27208481	0.812720848
36	10	16	0.12	2	1541.666667	1171.666667	38	25	65.78947368	0.657894737
37	10.5	13	0.15	2	1174.603175	1138.645935	95	49	51.57894737	0.515789474
38	10.5	13	0.15	2	1174.603175	1174.603175	30	15	50	0.5
39	10.5	13	0.15	2	1174.603175	822.2222222	21	15	71.42857143	0.714285714
40	10.5	13	0.15	2	1174.603175	837.8835979	107	75	70.09345794	0.700934579
41	11	15	0.1	2	1681.818182	1167.379679	118	85	72.03389831	0.720338983
42	11	20	0.08	2	2102.272727	1001.082251	100	105	105	1.05

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
43	11	15	0.1	2	1681.818182	1051.136364	25	20	80	0.8
44	11	15	0.1	2	1681.818182	1177.272727	42	30	71.42857143	0.714285714
45	11.25	13	0.15	2	1096.296296	939.6825397	60	35	58.33333333	0.583333333
46	11.25	13	0.15	2	1096.296296	782.2530864	137	96	70.0729927	0.700729927
47	11.25	13	0.15	2	1096.296296	1027.777778	120	64	53.33333333	0.533333333
48	11.25	13	0.15	2	1096.296296	861.3756614	55	35	63.63636364	0.636363636
49	11.25	13	0.15	2	1096.296296	884.9620705	134	83	61.94029851	0.619402985
50	11.25	15	0.15	2	1096.296296	1025.820106	131	70	53.4351145	0.534351145
51	11.25	15	0.15	2	1096.296296	1049.64539	180	94	52.22222222	0.522222222
52	11.5	8.5	0.12	2	1340.57971	738.1673088	87	79	90.8045977	0.908045977
53	11.5	8.5	0.12	2	1340.57971	1117.149758	25	15	60	0.6
54	12	12	0.15	2	1027.777778	1068.888889	104	50	48.07692308	0.480769231
55	12	18	0.05	2	3083.333333	1101.190476	50	70	140	1.4
56	12	15	0.1	2	1541.666667	1065.151515	304	220	72.36842105	0.723684211
57	12	12	0.15	2	1027.777778	1180.041152	62	27	43.5483871	0.435483871
58	12	15	0.1	2	1541.666667	926.4823718	125	104	83.2	0.832

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
59	12	15	0.1	2	1541.666667	982.8125	255	200	78.43137255	0.784313725
60	13	15	0.05	2	2846.153846	1368.343195	125	130	104	1.04
61	13	15	0.08	2	1778.846154	889.4230769	104	104	100	1
62	14	15	0.15	2	880.952381	941.017316	235	110	46.80851064	0.468085106
63	14	15	0.15	2	880.952381	1376.488095	250	80	32	0.32
64	14	15	0.15	2	880.952381	916.1904762	52	25	48.07692308	0.480769231
65	14	15	0.15	2	880.952381	1004.285714	114	50	43.85964912	0.438596491
66	14	15	0.15	2	880.952381	1212.777778	123.9	45	36.31961259	0.363196126
67	14	15	0.15	2	880.952381	1184.391534	121	45	37.19008264	0.371900826
68	14	14	0.15	2	880.952381	922.0634921	31.4	15	47.77070064	0.477707006
69	14	15	0.15	2	880.952381	885.8465608	90.5	45	49.72375691	0.497237569
70	14	15	0.15	2	880.952381	947.0238095	301	140	46.51162791	0.465116279
71	14	15	0.15	2	880.952381	759.8214286	69	40	57.97101449	0.579710145
72	14	18	0.2	2	660.7142857	951.4285714	100.8	35	34.72222222	0.347222222
73	14	20	0.16	2	825.8928571	1393.694196	135	40	29.62962963	0.296296296
74	14	15	0.15	2	880.952381	1251.686508	341	120	35.19061584	0.351906158

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
						60339.87012				
						1040.342588				
75	15.5	27	0.1	1	1193.548387	864.2936596	105	145	138.0952381	1.380952381
76	16	42	0.1	1	1156.25	1010.197368	83	95	114.4578313	1.144578313
77	16	32	0.1	1	1156.25	937.3333333	304	375	123.3552632	1.233552632
78	16	42	0.1	1	1156.25	1995.719178	252	146	57.93650794	0.579365079
79	16	42	0.1	1	1156.25	1115.138889	434	450	103.6866359	1.036866359
80	16	30	0.09	1	1284.722222	884.80869	177	257	145.1977401	1.451977401
81	16	42	0.1	1	1156.25	994.7737069	249.5	290	116.2324649	1.162324649
82	16	32	0.1	1	1156.25	1091.007053	301	319	105.9800664	1.059800664
83	16	30	0.09	1	1284.722222	995.6597222	124	160	129.0322581	1.290322581
84	16	42	0.1	1	1156.25	1177.662037	275	270	98.18181818	0.981818182
85	16.5	30	0.1	1	1121.212121	1027.777778	220	240	109.0909091	1.090909091
86	17	20.5	0.15	1	725.4901961	1051.717331	216	149	68.98148148	0.689814815
87	17	18	0.1	1	1088.235294	999.197861	101	110	108.9108911	1.089108911
88	18	25	0.08	1	1284.722222	881.8587106	278	405	145.6834532	1.456834532

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
89	18	20	0.08	1	1284.722222	630.941358	221	450	203.6199095	2.036199095
90	18	28	0.1	1	1027.777778	814.3162393	103	130	126.2135922	1.262135922
91	18	18	0.05	1	2055.555556	676.344086	102	310	303.9215686	3.039215686
92	19	12	0.15	1	649.122807	861.5629984	146	110	75.34246575	0.753424658
93	20	39	0.1	1	925	1009.090909	60	55	91.66666667	0.916666667
94	20	39	0.1	1	925	1077.111111	262	225	85.8778626	0.858778626
95	20	30	0.1	1	925	873.6111111	102	108	105.8823529	1.058823529
96	22	19	0.12	1	700.7575758	918.2340648	190	145	76.31578947	0.763157895
97	24	35	0.16	1	481.7708333	827.5579637	213	124	58.21596244	0.582159624
98	24	35	0.06	1	1284.722222	982.1908602	474	620	130.8016878	1.308016878
99	24	21	0.12	1	642.3611111	1079.166667	42	25	59.52380952	0.595238095
100	26	60	0.1	1	711.5384615	798.1605351	258	230	89.14728682	0.891472868
101	26	30	0.1	1	711.5384615	1067.307692	315	210	66.66666667	0.666666667
102	27	36	0.05	1	1370.37037	783.0687831	200	350	175	1.75
103	27	36	0.05	1	1370.37037	884.1099164	100	155	155	1.55
104	30	40	0.1	1	616.6666667	1017.5	198	120	60.60606061	0.606060606

Table A.16. Detail Check Sheet for the Result of Work Measurement (Normal Time of Cutting Process). (Continued)

No.	Width (inches)	Length (inches)	Thickness (mm)	Row	Inches/1 Kg.	Inches/Minute/ Row/1Kg.	Kgs.	Production time	Production time in 100Kgs.	Production time in 1 Kg.
105	30	40	0.1	1	616.6666667	846.8888889	412	300	72.81553398	0.72815534
106	30	40	0.1	1	616.6666667	915.3645833	380	256	67.36842105	0.673684211
107	30	40	0.1	1	616.6666667	733.1481481	428	360	84.11214953	0.841121495
108	30	50	0.15	1	411.1111111	866.2698413	29.5	14	47.45762712	0.474576271
109	36	45	0.1	1	513.8888889	671.4814815	294	225	76.53061224	0.765306122
110	36	45	0.1	1	513.8888889	1115.56713	156.3	72	46.06525912	0.460652591
111	36	60	0.1	1	513.8888889	745.1388889	116	80	68.96551724	0.689655172
112	36	46.5	0.1	1	513.8888889	501.8446181	100	102.4	102.4	1.024
						35723.12319				
						940.0821893				

APPENDIX B

PROCESS SPECIFICATION

UTK SALES AND PLANNING SYSTEM Process

Process #: 0

Location:

Context Diagram (CONTEXT)

Input Flows:
Inquiry
Purchase Order
Adjusted Plan schedule

Output Flows:
Rejected Inquiry
Quotation
Rejected Purchase Order
Expected Delivery Schedule
Copied Purchase Order
Job Order
Purchase Requisition
Inventory Status

Date Last Altered: 6/6/2002 Date Created: 24/3/2001

Verify Inquiry Process

Process #: 1

Process Description:

```
DO
   READ  CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
         TYPE_OF_PLASTIC,PRINTED_DETAILS, AND
         AMOUNT_OF_ORDER
   BEGIN IF
      IF  TYPE_OF_PLASTIC IS NOT PREFER OR
          PRINTED_DETAILS HAS COLOUR GREATER THAN 6
          COLOURS OR
          AMOUNT_OF_ORDER IS LESS THAN 100 KILOGRAMS
      THEN  REJECTED INQUIRY
      ELSE  ACCEPTED INQUIRY
    END IF
  UNTIL  END-OF-FILE
```

Location:

Level-0 plan schedule (0)

Input Flows:
Inquiry

Output Flows:
Rejected Inquiry
Accepted Inquiry

Date Last Altered: 25/3/2001 Date Created: 24/3/2001

Clarify Inquiry Process
Process #: 1.1
Location:
Level 1-Verify Inquiry (1)
Input Flows:
Inquiry
Output Flows:
Product Type
Inquired Quantity
Printed Details
Date Last Altered: 14/6/2002 Date Created: 24/3/2001

Check Specification of Plastic Bag Process
Process #: 1.2
Location:
Level 1-Verify Inquiry (1)
Input Flows:
Product Type
Output Flows:
Specification of Plastic Bag
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Check Minimum Quantity Process
Process #: 1.3
Location:
Level 1-Verify Inquiry (1)
Input Flows:
Inquired Quantity
Output Flows:
Minimum Quantity Data
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Date: 28/6/2002 Project: UTK
Time: 10:02:53
Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Check Printed Color Process
Process #: 1.4
Location:
Level 1-Verify Inquiry (1)
Input Flows:
Printed Details
Output Flows:

Available Printed Color

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Evaluate Inquiry Process

Process #: 1.5

Location:

Level 1-Verify Inquiry (1)

Input Flows:

Minimum Quantity Data

Specification of Plastic Bag

Available Printed Color

Output Flows:

Accepted Inquiry

Rejected Inquiry

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Prepare Quotation Process

Process #: 2

Process Description:

```
DO
   READ  CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
         TYPE_OF_PLASTIC,PRINTED_DETAILS,SALESPESON_ID
         ,QUOTATION_ID AND AMOUNT_OF_ORDER
   IF  COMPARE CUST_NAME,CUST_ADD,CUST_TEL, AND
       CUST_FAX BETWEEN CURRENT CUSTOMER AND
       CUSTOMER FILE
   THEN  GENERATE QUOTATION
   ELSE  ADD NEW CUSTOMER TO CUSTOMER FILE
UNTIL  END-OF-FILE
```

Date: 28/6/2002 Project: UTK

Time: 10:02:53

Detailed Listing -- by Process Number

All Process Entries -- Data Flow Diagrams

Location:

Level-0 plan schedule (0)

Input Flows:

Accepted Inquiry

Raw Material Price

Customer Data

Output Flows:

Quotation

Quotation

New Customer Data

Date Last Altered: 12/6/2002 Date Created: 24/3/2001

Verify if New Customer Process

Process #: 2.1

Location:

Level 1-Prepare Quotation (2)
Input Flows:
Accepted Inquiry
Customer Data
Output Flows:
New Customer Inquiry
New Customer Inquiry
Current Customer Inquiry
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Update Customer File Process
Process #: 2.2
Location:
Level 1-Prepare Quotation (2)
Input Flows:
New Customer Inquiry
Output Flows:
New Customer Data
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Date: 28/6/2002 Project: UTK
Time: 10:02:53
Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Calculate Unit Price Process
Process #: 2.3
Location:
Level 1-Prepare Quotation (2)
Input Flows:
Raw Material Price
New Customer Inquiry
Current Customer Inquiry
Output Flows:
Unit Price
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Evaluate Credit Term Process
Process #: 2.4
Location:
Level 1-Prepare Quotation (2)
Input Flows:
Customer Data
Output Flows:
Credit Term
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Generate Quotation Process
Process #: 2.5

Location:
Level 1-Prepare Quotation (2)
Input Flows:
Credit Term
Unit Price
Output Flows:
Quotation
Quotation
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Date: 28/6/2002 Project: UTK
Time: 10:02:53
Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Verify Purchase Order Process
Process #: 3
Process Description:
DO
READ CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
TYPE_OF_PLASTIC,PRINTED_DETAILS,
AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,PO_NO,
AND DATE
IF
TYPE_OF_PLASTIC,PRINTED_DETAILS,THICKNESS_OF_PLASTIC,
AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,AND DATE
IS PREFER
THEN ACCEPTED QUOTATION
ELSE REJECTED QUOTATION
UNTIL END-OF-FILE
Location:
Level-0 plan schedule (0)
Input Flows:
Purchase Order
Customer Data
Output Flows:
Accepted Purchase Order
Rejected Purchase Order
Date Last Altered: 27/3/2001 Date Created: 24/3/2001

Verify Ordered Item Details Process
Process #: 3.1
Location:
Level 1-Verify Purchase Order (3)
Input Flows:
Purchase Order
Customer Data
Output Flows:
Confirmed Item Purchase Order

Date: 28/6/2002 Project: UTK
Time: 10:02:53

Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Check Purchase Order Credit Term Process
Process #: 3.2
Location:
Level 1-Verify Purchase Order (3)
Input Flows:
Confirmed Item Purchase Order
Output Flows:
Accepted Purchase Order
Incorrect Credit Term Purchase Order
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Issue Rejected PO letter Process
Process #: 3.3
Location:
Level 1-Verify Purchase Order (3)
Input Flows:
Incorrect Item Details Purchase Order
Incorrect Credit Term Purchase Order
Output Flows:
Rejected Purchase Order
Date Last Altered: 14/6/2002 Date Created: 24/3/2001

Record Order Entry Process
Process #: 4
Process Description:
DO
READ CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
TYPE_OF_PLASTIC,PRINTED_DETAILS,SALESPESON_ID
QUOTATION_ID,
AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,PO_NO,
AND DATE
ADD CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
TYPE_OF_PLASTIC,PRINTED_DETAILS,
AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,PO_NO,
AND DATE TO ORDER FILE
ADD CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
TYPE_OF_PLASTIC,PRINTED_DETAILS,
AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,PO_NO,
AND DATE TO PURCHASE ORDER FILE

SEND CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
TYPE_OF_PLASTIC,PRINTED_DETAILS,
AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,PO_NO,
AND DATE TO ACCOUNTING DEPARTMENT
UNTIL END-OF-FILE
Location:
Level-0 plan schedule (0)
Input Flows:
Accepted Purchase Order
Output Flows:
Copied Purchase Order
Order Description
Filed Purchase Order
Purchase Order Details
Purchase Order Details
Date Last Altered: 12/6/2002 Date Created: 24/3/2001

Record Ordered Items Process
Process #: 4.1
Location:
Level 1-Record Order Entry (4)
Input Flows:
Accepted Purchase Order
Output Flows:
Order Description
Purchase Order Details
Purchase Order Details
Recorded Purchase Order
Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Generate Purchase Order Copy Process
Process #: 4.2
Location:
Level 1-Record Order Entry (4)
Input Flows:
Recorded Purchase Order
Output Flows:
Copied Purchase Order
Recorded Purchase Order
Date: 28/6/2002 Project: UTK
Time: 10:02:53

Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

File Purchase Order Process

Process #: 4.3

Location:

Level 1-Record Order Entry (4)

Input Flows:

Recorded Purchase Order

Output Flows:

Filed Purchase Order

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Check Raw Material Inventory Process

Process #: 5

Process Description:

```
DO
   READ  CUST_NAME,CUST_ADD,CUST_TEL,CUST_FAX,
         TYPE_OF_PLASTIC,PRINTED_DETAILS,
         AMOUNT_OF_ORDER,CREDIT_TERM,PRICE,PO_NO,
         AND DATE
   EVALUATE  AMT_REQ_OF_PLASTIC_RASIN&COLOR
   IF  AMT_REQ_OF_PLASTIC_RASIN&COLOR_USED  IS LESS
     THAN  AMT_REQ_OF_PLASTIC_RASIN&COLOR_IN_STOCK
   THEN  DO NOTHING
   ELSE  GENERATE PURCHASE REQUISITION
UNTIL  END-OF-FILE
```

Location:

Level-0 plan schedule (0)

Input Flows:

Inventory Status

Purchase Order Details

Output Flows:

Purchase Requisition

Required Inventory Quantity

Required Inventory Quantity

Date Last Altered: 25/3/2001 Date Created: 24/3/2001

Date: 28/6/2002 Project: UTK

Time: 10:02:53

Detailed Listing -- by Process Number

All Process Entries -- Data Flow Diagrams

Get Required Material Inventory Status Process

Process #: 5.1

Location:

Level 1-Check Raw Material Inventory (5)

Input Flows:

Inventory Status

Purchase Order Details

Output Flows:
Purchase Order Details with Inventory Status

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Verify if Inventory Quantity Enough Process

Process #: 5.2

Location:

Level 1-Check Raw Material Inventory (5)

Input Flows:
Purchase Order Details with Inventory Status
Output Flows:
Required Inventory Quantity
Insufficient Inventory Quantity

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Generate Purchase Requisition Process

Process #: 5.3

Location:

Level 1-Check Raw Material Inventory (5)

Input Flows:
Insufficient Inventory Quantity
Output Flows:
Purchase Requisition

Date Last Altered: 24/3/2001 Date Created: 24/3/2001

Date: 28/6/2002 Project: UTK
Time: 10:02:53

Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Generate Job Order Process

Process #: 6

Process Description:

```
DO
    READ  CUST_NAME,PRODUCT_ID,
          SALESPESON_ID,PRODUCT_NAME,
          PRODUCT_CATEGORY,
          TYPE_OF_PLASTIC,PRINTED_DETAILS,
          AMOUNT_OF_ORDER,PRICE,PO_NO,JOB_NO,
          DATE, DELIVERY_DATE,SIZE_OF_PLASTIC, AND
          THICKNESS_OF_PLASTIC
    IF    PRODUCT_ID IS SAME AS PRODUCT OF
          INVENTORY_QUANTITY
    THEN  MINUS AMOUNT_OF_ORDER WITH
          INVERTORY_QUANTITY
    ELSE  READ PO_DETAILS
  UNTIL END-OF-FILE
```

Location:
Level-0 plan schedule (0)
Input Flows:
Purchase Order Details
Rejected Job Order Details
Required Inventory Quantity
Output Flows:
Planning Schedule
Date Last Altered: 13/6/2002 Date Created: 24/3/2001

Notify Expected Delivery Schedule Process
Process #: 7
Process Description:
DO
READ CUST_NAME,CUST_ID,PRODUCT_IDCUST_ADD
SALESPESON_ID, PRODUCT_NAME
PRODUCT_CATEGORY, TYPE_OF_PLASTIC,
PRINTED_DETAILS,SIZE_OF_PLASTIC,
THICKNESS_OF_PLASTIC,AMOUNT_OF_ORDER,
PO_NO,JOB_NO,DATE
DELIVERY_DATE,DATE_TO_FINISH,PRODUCT_STATUS
AND PRICE
IF DATE_TO_FINISH IS MORE THAN DELIVERY_DATE
THEN THE JOB IS DELAY
ELSE THE JOB IS ON TIME
Date: 28/6/2002 Project: UTK
Time: 10:02:53
Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

UNTIL END-OF-FILE
Location:
Level-0 plan schedule (0)
Input Flows:
Planning Schedule
Output Flows:
Expected Delivery Schedule
Date Last Altered: 13/6/2002 Date Created: 24/3/2001

Calculate Production time Process
Process #: 8
Process Description:
DO
READ CUST_NAME,CUST_ID,PRODUCT_ID,SALESPESON_ID,
PRODUCT_NAME,PRODUCT_CATEGORY,
TYPE_OF_PLASTIC,PRINTED_DETAILS,
SIZE_OF_PLASTIC, CIRCUMFERENCE,
THICKNESS_OF_PLASTIC
PO_NO,JOB_NO,DATE,DELIVERY_DATE AND

AMOUNT_OF_ORDER
CASE 1 READ TYPE_OF_PLASTIC, SIZE_OF_PLASTIC,
THICKNESS_OF_PLASTIC,AMOUNT_OF_ORDER
IF SIZE_OF_PLASTIC IS MORE THAN1.5 AND
LESS THAN 5.5
THEN PRODUCTION_TIME IS 5.67 MIN PER 1KG.
IF SIZE_OF_PLASTIC IS MORE THAN6 AND
LESS THAN OR EQUALTO 13.5
THEN PRODUCTION_TIME IS 4.46 MIN PER 1KG.
IF SIZE_OF_PLASTIC IS MORE THAN14 AND
LESS THAN OR EQUAL TO 17.5
THEN PRODUCTION_TIME IS 2.44 MIN PER 1KG.
IF SIZE_OF_PLASTIC IS MORE THAN18 AND
LESS THAN OR EQUAL TO 36
THEN PRODUCTION_TIME IS 5.67 MIN PER 1KG.
ELSE THE DATA IS IN CORRECT
BRING PRODUCTION_TIME PLUS 35.75 WILL EQUAL TO
TOTAL_EXTRUSION_TIME
CASE2 READ TYPE_OF_PLASTIC, SIZE_OF_PLASTIC,
THICKNESS_OF_PLASTIC,CIRCUMFERENCE,
AMOUNT_OF_ORDER AND
PRINTED_DETAILS
DO CALCULATE THE AMOUNT_OF_ORDER DIVIDE
BY25 EQUAL TO TIMES OF CHANGING ROLL
MULTIPLY
BY 3.39 EQUAL TO
TOTAL_TIME_OF_CHANGING_ROLL

DO CALCULATE 18500 DIVIDE BY SIZE_OF_PLASTIC
MULTIPLY BY THICKNESS_OF_PLASTIC
MULTIPLY BY 39.5 EQUAL TO TOTOL_INCHES
IF CIRCUMFERENCE LESS THAN TO 15
AND MORE THAN OR EQUAL TO 12
THEN CIRCUMFERENCE MULTIPLY BY 126.48
IF CIRCUMFERENCE LESS THAN 20
AND MORE THAN OR EQUAL TO 15
THEN CIRCUMFERENCE MULTIPLY BY 113.35
IF CIRCUMFERENCE LESS THAN 24
AND MORE THAN OR EQUAL TO 20
THEN CIRCUMFERENCE MULTIPLY BY 102.61
IF CIRCUMFERENCE LESS THAN 29
AND MORE THAN OR EQUAL TO 25
THEN CIRCUMFERENCE MULTIPLY BY 91.05
IF CIRCUMFERENCE LESS THAN30
AND MORE THAN OR EQUAL TO 30

```
                THEN  CIRCUMFERENCE MULTIPLY BY 58.87
                   IF  CIRCUMFERENCE IS MORE THAN 35
                THEN  CIRCUMFERENCE MULTIPLY BY 48.19
                      THE OUTPUT IS INCH_PER_MINUTE
                ELSE   THE INPUT IS WRONG
              DO  CALCULATE TOTAL_INCHES DIVIDE BY
                  INCHES_PER_MINUTE
                  OUTPUT IS PRINTING_TIME_PER_KG
                  BRING AMOUT_OF_ORDER MULTIPLY BY
                  PRINTING_TIME_PER KG IS PRINTING_TIME
               DO  PRINTING_TIME PLUS
                  TOTAL_TIME_OF_CHANGING_ROLL PLUS
                  41.94 EZUAL TO TOTAL_PRINTING_TIME
         CASE 3  DO
                  READ TYPE_OF_PLASTIC, SIZE_OF_PLASTIC,
                       THICKNESS_OF_PLASTIC,AMOUNT_OF_ORDER
                    DO CALCULATE THE AMOUNT_OF_ORDER DIVIDE
                       BY25  EQUAL TO
                       TIMES OF CHANGING ROLL MULTIPLY
                       BY 3.75 EQUAL TO
                       TOTAL_TIME_OF_CHANGING_ROLL
                    DO CALCULATE 18500 DIVIDE BY SIZE_OF_PLASTIC
                       MULTIPLY BY THICKNESS_OF_PLASTIC
                       EQUAL TO TOTAL_METERS_PER_KG
                       MULTIPLY BY AMOUNT_OF_ORDER
                       EQUAL TO TOTAL_METERS
                    IF  SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO
                       2.5 AND LESS THAN 8.5
                  THEN TOTAL_METERS DIVIDE BY 38.01
                       IF SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO
                       8.5 AND LESS THAN 14
                  THEN TOTAL_METERS DIVIDE BY  30.09
                       IF SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO
                       15 AND LESS THAN 36
                  THEN TOTAL_METERS DIVIDE BY 24.11
                       THE OUTPUT IS METER_PER_MINUTE_PER_KG
                    IF  SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO
```



```
                       1.5 AND LESS THAN OR EQUAL TO 3
                  THEN ROW IS 5
                    IF   SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO
                       3.25 AND LESS THAN OR EQUAL TO 6
                  THEN ROW IS 3
                    IF   SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO
                       6.25 AND LESS THAN OR EQUAL TO 14
                  THEN ROW IS 2
```

IF SIZE_OF_PLASTIC IS MORE THAN OR EQUAL TO 14
THEN ROW IS 1
OUTPUT IS ROW
BRING METER_PER_MINUTE_PER_KG MULTIPLY BY ROW PLUS TOTAL_TIME_OF_CHANGING_ROLL PLUS 30.31
OUTPUT IS TOTAL_CUTTING_TIME
UNTIL-END-OF-FILE

Location:
Level-0 plan schedule (0)
Input Flows:
Adjusted Planned Schedule
Accepted Job Order
Output Flows:
Planning Schedule
Planning Schedule
Planning Schedule
Date Last Altered: 17/6/2002 Date Created: 6/6/2002

Calculate Extrusion Time Process
Process #: 8.1
Location:
Calculate Production Schedule (8)
Input Flows:
Planning Schedule
Output Flows:
Extrusion Time
Date Last Altered: 10/6/2002 Date Created: 10/6/2002

Date: 28/6/2002 Project: UTK
Time: 10:02:53
Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Calculate Printing Time Process
Process #: 8.2
Location:
Calculate Production Schedule (8)
Input Flows:
Planning Schedule
Output Flows:
Printing Time
Date Last Altered: 10/6/2002 Date Created: 10/6/2002

Clarify Job Order Process
Process #: 8.3

Location:
Calculate Production Schedule (8)
Input Flows:
Adjusted Planned Schedule
Accepted Job Order
Output Flows:
Planning Schedule
Planning Schedule
Planning Schedule
Date Last Altered: 14/6/2002 Date Created: 10/6/2002

Printed Out Planning Schedule Process
Process #: 8.4
Location:
Calculate Production Schedule (8)
Input Flows:
Planning Schedule
Output Flows:
Planning Schedule
Planning Schedule
Planning Schedule
Date Last Altered: 10/6/2002 Date Created: 10/6/2002

Date: 28/6/2002 Project: UTK
Time: 10:02:53
Detailed Listing -- by Process Number
All Process Entries -- Data Flow Diagrams

Calculate Cutting Time Process
Process #: 8.5
Location:
Calculate Production Schedule (8)
Input Flows:
Planning Schedule
Output Flows:
Cutting Time
Date Last Altered: 10/6/2002 Date Created: 10/6/2002

Summarize Total Time Process
Process #: 8.6
Location:
Calculate Production Schedule (8)
Input Flows:
Extrusion Time
Printing Time
Cutting Time
Output Flows:
Production Time
Date Last Altered: 10/6/2002 Date Created: 10/6/2002

Arrange Planned Schedule Process

Process #: 8.7

Location:

Calculate Production Schedule (8)

Input Flows:

Production Time

Output Flows:

Planning Schedule

Date Last Altered: 10/6/2002 Date Created: 10/6/2002

Date: 28/6/2002 Project: UTK

Time: 10:02:53

Detailed Listing -- by Process Number

All Process Entries -- Data Flow Diagrams

Verify Job Order Details Process

Process #: 9

Process Description:

```
DO
    READ CUST_NAME,CUST_ID,PRODUCT_ID,
         SALESPESON_ID,CUST_ADD,PRODUCT_NAME,
         PRODUCT_CATEGORY,TYPE_OF_PLASTIC,
         PRINTED_DETAILS,SIZE_OF_PLASTIC,
         THICKNESS_OF_PLASTIC,AMOUNT_OF_ORDER,PRICE,
         PO_NO,JOB_NO,DATE,DELIVERY_DATE AND PACKING
    IF JOB_ORDER_DETAILS IS NOT CORRESPOND WITH
      PO_DETAILS
    THEN REJECTED JOB_ORDER
    ELSE ACCEPTED JOB_ORDER
UNTIL END-OF-FILE
```

Location:

Level-0 plan schedule (0)

Input Flows:

Planning Schedule

Output Flows:

Accepted Job Order

Rejected Job Order Details

Date Last Altered: 13/6/2002 Date Created: 10/6/2002

APPENDIX C

DATA DICTIONARY

ACCEPT_INQUIRY_INFOR	Data Element
Accepted Inquiry	Data Flow
Accepted Job Order	Data Flow
Accepted Purchase Order	Data Flow
Accounting Department	External Entity
Adjusted Plan schedule	Data Flow
Adjusted Planned Schedule	Data Flow
AMOUNT_OF_ORDER	Data Element
AMOUNT_OF_ORDER_AFFORDABLE	Data Element
AMOUNT_OF_PRODUCE	Data Element
AMOUNT_OF_RM_LEFT_IN_INV	Data Element
AMT_LEF_OF_PLASTIC_RASIN&COLOR	Data Element
AMT_LEFT_OF_PLASTIC_RASIN&COLOR	Data Element
AMT_OF_RM_LEFT_IN_INV	Data Element
AMT_REQ_OF_PLASTIC_RASIN&COLOR	Data Element
Arrange Planned Schedule	Process
Available Printed Color	Data Flow
Belong_to	Relationship
Calculate Cutting Time	Process
Calculate Extrusion Time	Process
Calculate Printing Time	Process
Calculate Production time	Process
Calculate Unit Price	Process
Check Minimum Quantity	Process
Check Printed Color	Process
Check Purchase Order Credit Term	Process
Check Raw Material Inventory	Process

Date: 28/6/2002 *Project:* UTK
Time: 10:59:42
Summary Listing -- Alphabetically
All Entries -- Whole Repository

Check Specification of Plastic Bag	Process
Clarify Inquiry	Process
Clarify Job Order	Process
Confirmed Item	Data Flow
Confirmed Item Purchase Order	Data Flow

Copied Purchase Order	Data Flow
Credit Term	Data Flow
CREDIT_TERM	Data Element
Current Customer Inquiry	Data Flow
CUST_ADD	Data Element
CUST_E-MAIL	Data Element
CUST_FAX	Data Element
CUST_ID	Data Element
CUST_NAME	Data Element
CUST_TEL	Data Element
Customer	External Entity
Customer Data	Data Flow
Customer File	Data Store
Customers	Entity
Cutting Time	Data Flow
CUTTING_TIME	Data Element
DATE	Data Element
DATE_TO_DELIVERY	Data Element
DATE_TO_FINISH	Data Element
DELIVERY_DATE	Data Element
ERROR_DETAILS	Data Element
Evaluate Credit Term	Process

Date: 28/6/2002 *Project:* UTK
Time: 10:59:42
Summary Listing -- Alphabetically
All Entries -- Whole Repository

Evaluate Inquiry	Process
Expected Delivery Schedule	Data Flow
Extrusion Time	Data Flow
EXTRUSION_TIME	Data Element
File Purchase Order	Process
Filed Purchase Order	Data Flow
Generate Job Order	Process
Generate Purchase Order Copy	Process
Generate Purchase Requisition	Process
Generate Quotation	Process
Generated_on	Relationship
Get Required Material Inventory Status	Process
Handle	Relationship
Has	Relationship
Incorrect Credit Term Purchase Order	Data Flow
Incorrect Item Details Purchase Order	Data Flow
INCORRECT_DETAIL_INFOR	Data Element
Inquired Quantity	Data Flow

Inquiry	Data Flow
Insufficient Inventory Quantity	Data Flow
Inventory Department	External Entity
Inventory Status	Data Flow
is_calculated_by	Relationship
Is_for	Relationship
Is_for	Relationship
Is_Handled_by	Relationship
Is_Issued_by	Relationship

Date: 28/6/2002 *Project:* UTK
Time: 10:59:42
Summary Listing -- Alphabetically
All Entries -- Whole Repository

Is_Quoted	Relationship
Is_shown	Relationship
Issue	Relationship
Issue Rejected PO letter	Process
Item	Entity
Item Quote	Associative Entity
Job Order	Data Flow
Job Order	Entity
Job Order Details	Data Flow
JOB_NO	Data Element
Minimum Quantity Data	Data Flow
MINIMUM_ORDER	Data Element
New Customer Data	Data Flow
New Customer Inquiry	Data Flow
Notify Expected Delivery Schedule	Process
Order Description	Data Flow
Order File	Data Store
PACKING	Data Element
Planned Schedule	Data Flow
Planning Schedule	Data Flow
Planning Schedule	Entity
PO_NO	Data Element
PR_NO	Data Element
Prepare Quotation	Process
PRICE	Data Element
PRICE_OF_RM	Data Element
Printed Details	Data Flow

Date: 28/6/2002 *Project:* UTK
Time: 10:59:42
Summary Listing -- Alphabetically
All Entries -- Whole Repository

Printed Out Planning Schedule	Process
PRINTED_AVAILABLE	Data Element

PRINTED_DETAILS	Data Element
Printing Time	Data Flow
PRINTING_TIME	Data Element
Product Type	Data Flow
PRODUCT_CATEGORY	Data Element
PRODUCT_ID	Data Element
PRODUCT_NAME	Data Element
PRODUCT_STATUS	Data Element
Production Department	External Entity
Production Time	Data Flow
PRODUCTION_DETAILS	Data Element
Purchase Order	Data Flow
Purchase Order	Entity
Purchase Order Details	Data Flow
Purchase Order Details with Inventory Status	Data Flow
Purchase Order File	Data Store
Purchase Order_1	Data Flow
Purchase Requisition	Data Flow
Purchasing Department	External Entity
Quotation	Data Store
Quotation	Data Flow
Quotation	Entity
Quote	Relationship
Raw Material File	Data Store
Raw Material Price	Data Flow

Date: 28/6/2002 *Project:* UTK *Time:* 10:59:42

Summary Listing -- Alphabetically

All Entries -- Whole Repository

Receive	Relationship
Record Order Entry	Process
Record Ordered Items	Process
Recorded Purchase Order	Data Flow
REJECT_INQUIRY_INFOR	Data Element
Rejected Inquiry	Data Flow
Rejected Job Order	Data Flow
Rejected Job Order Details	Data Flow
Rejected Purchase Order	Data Flow
REJECTED_PO_INFOR	Data Element
Required Inventory Quantity	Data Flow
Salesperson	Entity
SALESPESON_ID	Data Element
Schedule File	Data Store
SIZE_OF_PLASTIC	Data Element
Specification of Plastic Bag	Data Flow

Summarize Total Time	Process
THICKNESS_OF_PLASTIC	Data Element
TYPE_OF_PLASTIC	Data Element
TYPE_OF_PLASTIC_AVAILABLE	Data Element
Unit Price	Data Flow
Update Customer File	Process
UTK SALES AND PLANNING SYSTEM	Process
Verify if Inventory Quantity Enough	Process
Verify if New Customer	Process
Verify Inquiry	Process
Verify Job Order Details	Process

Date: 28/6/2002 *Project:* UTK
Time: 10:59:42
Summary Listing -- Alphabetically
All Entries -- Whole Repository

Verify Ordered Item Details	Process
Verify Purchase Order	Process
WRONG_CREDIT_TERM_INFOR	Data Element

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