CHAPTER 3

CURRENT MODEL OF THE MAKE-OR-BUY DECISION

The purpose of this chapter is to analyse the current process of a Make-or-Buy decision in relation to the acquisition of new moulds, which are required for the company's manufacturing line. This chapter is comprised of five sections. First of all, we shall begin with a description of the current model used for the Make-or-Buy decision. Secondly, the process of in-house production shall be presented for a better understanding of the different stages involved. Subsequently, we shall discuss the current capabilities of the mould department. Furthermore, the implementation of the current methodology will be illustrated by describing the details of a project to construct a mould for making the plastic lids of ice cream cones. Finally, we shall analyze various problems that are encountered in the application of the present decision model.

3.1 Current process

As the mould department has no standard model of its make-or-buy decision on mould fabrication, the model is created from the department manager, who is responsible for all projects under the mould department. In the current process, the experiences of the manager of the mould department would strongly influence his decision to proceed with fabrication or to outsource the new mould.

The current process is comprised of five stages, namely, (1) requisition for a new mould, (2) mould design, (3) estimation of production cost and time, (4) comparison of production cost and time with suppliers and (5) reach a make-or-buy decision for in-house production or outsourcing. The various steps leading to a make-or-buy decision according to this model are illustrated in Figure 3.1 below.

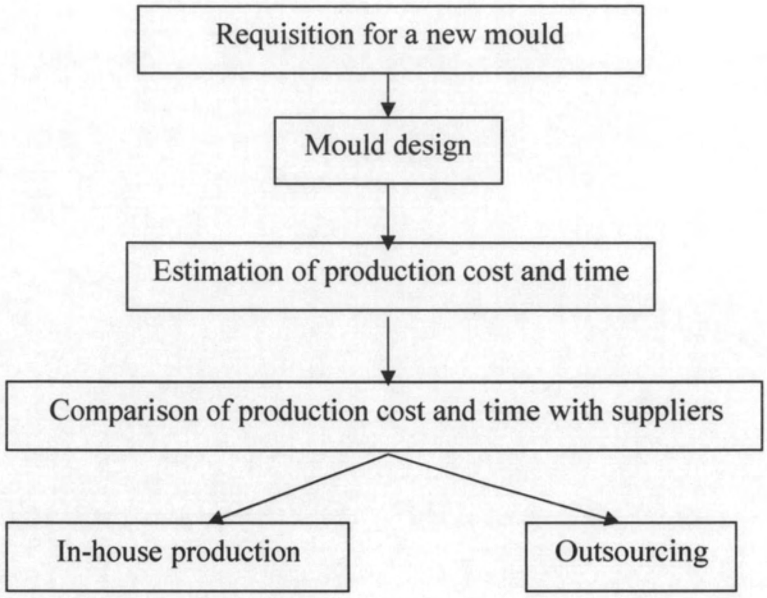

Figure 3.1: The current process for a make-or-buy decision

3.1.1 Requisition for a new mould

The request for a mould to manufacture a new product has been sent from the sales department to the mould department. Information on the product along with a sample (if available), specification of the type of plastic required, and relevant product drawings or sketches are relayed to the manager of the mould department.

3.1.2 Mould design

Since the manager of the mould department has been performing this function for over 20 years, he has extensive experience in the processes of mould fabrication. When the mould department receives a request for the construction of a new mould, the manager would design the mould roughly by himself.

3.1.3 Estimation of production cost and time

Production cost and time are estimated by the department manager. In general, the approximation of lead time and cost are dependent on the complexity of a new mould, and the numbers are compared with data from previous projects.

3.1.4 Comparison of production cost and time with suppliers

The production cost and time are compared with figures from subcontractors' quotations. In the comparison of production cost and time, there are basic criteria for each project that must be evaluated, which are listed in order of priority as follows:

a) Lead time of a project
b) Opportunity cost
c) Production cost

Here, the lead time of a project has been set as the first priority in order to be able to deliver a product by the due date and maintain customer's satisfaction, when the company decides on whether to construct a mould in-house or outsource it to subcontractors.

3.1.5 Outsourcing

Occasionally, the company has to outsource the fabrication of a mould to a subcontractor, because its mould department is unable to construct a new piece in a short period of time. At present, the company outsources its moulds primarily to four subcontractors in Thailand.

3.2 Process of in-house production

In order to construct a mould in-house, there are six stages to follow, namely, (1) ordering raw materials and components, (2) facing steel plates, (3) machining the mould base, (4) machining the mould shoe, (5) machining insert studs for cores / cavities and (6) final assembly. The various steps of this process are illustrated in Figure 3.2 below. As shown in the flow diagram, the process may be divided into two fabrication lines, which comprise a production line for steel plates and one for steel rods.

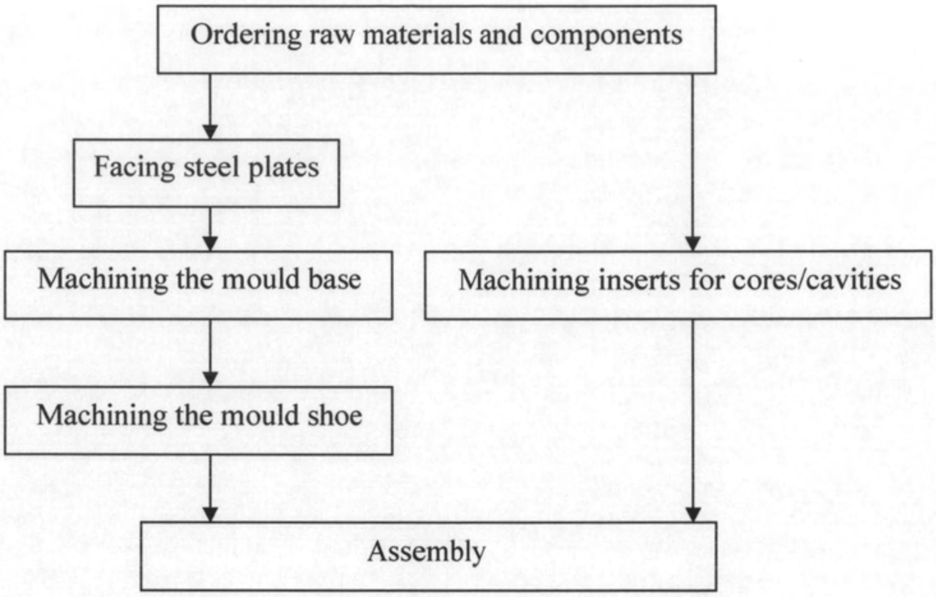

Figure 3.2: The process of in-house production of moulds

3.2.1 Order raw materials

Steel plates, steel rods, and components are ordered for use in constructing a new mould. They are cut a little longer than required. If the project starts with using plain steel plate, it is cheaper than starting from a steel plate that has been faced. Facing is the process of producing a flat or smooth surface for steel plates. A faced work piece may be called a finishing plate.

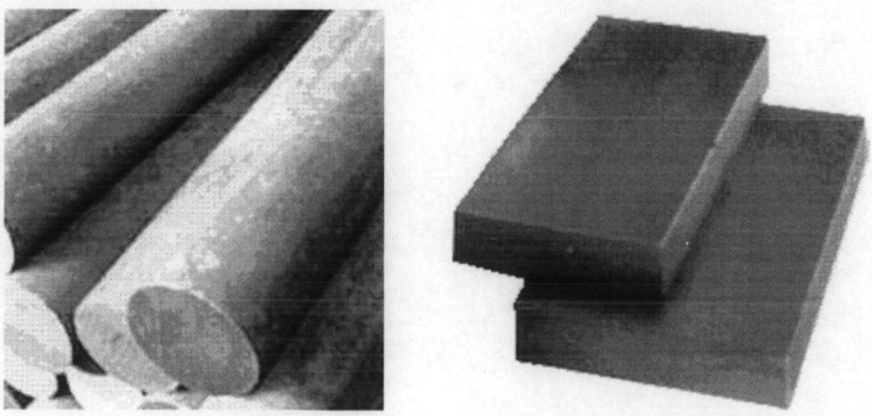

Figure 3.3: Examples of raw materials

3.2.2 Machining for steel plates

Milling machines are mainly used in this stage. There are three major phases for machining steel plates, which are:

3.2.2.1 Facing steel plates

One week is expended to convert a steel plate to one with facing.

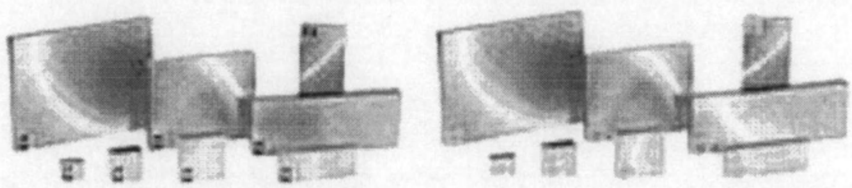

Figure 3.4: Examples of steel plates

3.2.2.2 Machining for mould base

In order to convert a steel plate with facing to a mould base, one to two weeks are needed, depending on the complexity and number of cavities required in a mould.

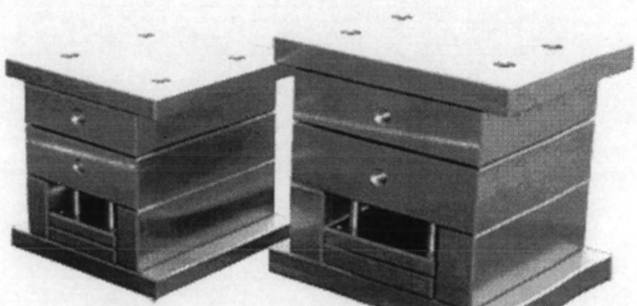

Figure 3.5: Examples of mould base

3.2.2.3 Machining for mould shoe

The mould plate from the previous step and other components shall be drilled and certain holes are enlarged for holding inserts, cooling tubes, and an ejector system. Drilling, reaming, and tapping steel plates are the main processes in this stage. Expenses and production time are used up in this process depending on the complexity and number of cavities. The plate size and the number of cooling tubes and air channels increase proportionately with the complexity and amount of cavities in the mould, as well.

3.2.3 Machining inserts for cores and cavities

Turning machines are mainly used in this stage. Sometimes, electrical discharge machines and milling machines are used for finishing miscellaneous parts. Similarly, complications and the number of cavities can affect cost and lead time of a project.

3.2.4 Assembly

For the assembling step, the mould shoe, inserts, and other components are assembled together. Checking the mechanism of mould opening and closing is carried out. Cost and time will increase with the number of cavities and the number of added elements.

3.3 Capabilities

There are three main types of semi-automatic equipment in the mould shop, which comprise of lathes, milling machines, and grinding machines. Moreover, there is one type of automatic equipment, which consists of Computer Numerical Control machines (CNC). More specifically, the CNC units are electrical discharge machines (EDM).

3.3.1 Lathe

There are five lathes in the department, which are semi-automatic machines. These are machine tools used for turning cylindrical forms on work pieces. Straight turning, tapering, facing, drilling, boring, reaming, and thread cutting are some of the more common operations performed on a lathe.

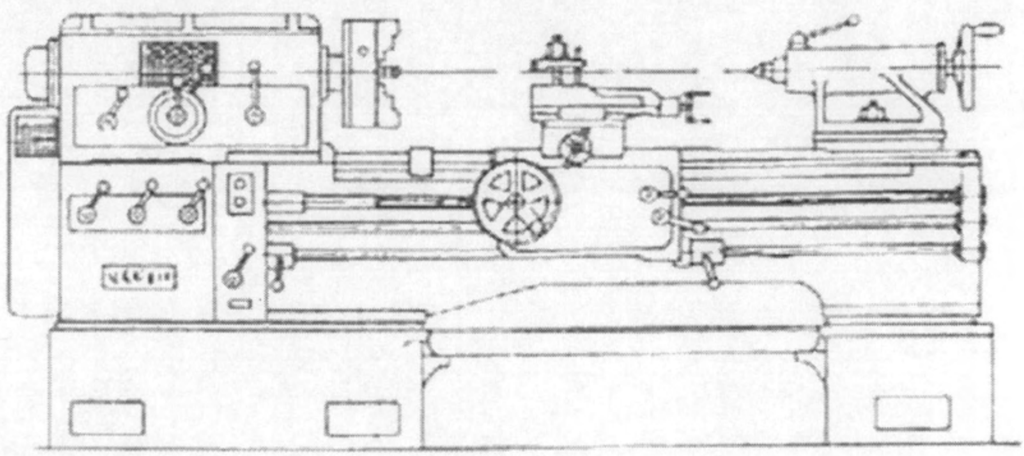

Figure 3.6: Lathe machine

3.3.2 Mill

It is a machine tool that can perform a wide variety of operations, such as drilling, reaming, boring, counter-boring, and spot facing. This equipment can also produce flat and counter surfaces, grooves, gear teeth, and helical forms.

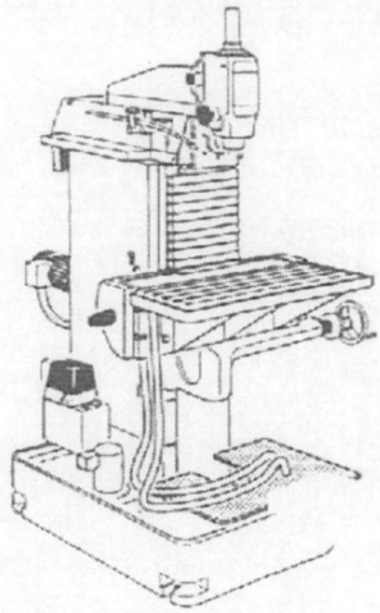

Figure 3.7: Milling machine

3.3.3 Grinder

A grinding machine is used to grind flat surfaces to precise dimensions and a polished finish. There are two units of this machinery in the department.

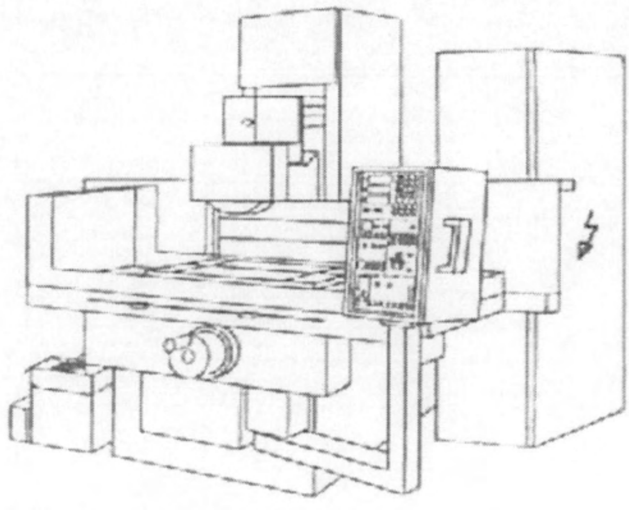

Figure 3.8: Grinder machine

3.3.4 Electrical discharge machines (EDMs)

The EDMs in the department are the vertical-ram type. They are used to remove metal by feeding an electrode down into the work piece and controlling a spark erosion process between the cutting tool and the work surface. In the mould department, there are three units of this machinery.

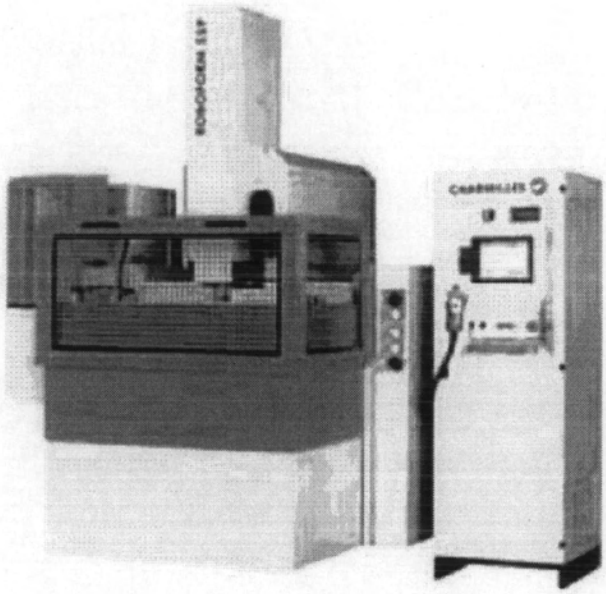

Figure 3.9: Electrical discharge machine

3.3.5 Human resources

The staff in the mould shop is made up of eleven persons, which may be classified as follows:

3.3.5.1 Manager

The manager has responsibilities to plan, design, and delegate tasks to his colleagues.

3.3.5.2 Machinists

There are eight machinists, who mainly operate lathe and milling machines in the mould shop. They have the skills to control mainly conventional machine tools.

3.3.5.3 Operator

There is one operator, who has responsibility for setting up EDMs and forming electrodes that are used in the EDM spark erosion process.

3.4 Implementation of the current process

The implementation of the current process will be illustrated by describing the details of a project to construct a mould for making plastic lids of ice cream cones. The manager assigned two machinists to take the responsibility for constructing this mould.

The relevant information needed for this research will be collected from the daily reports of the mould department. Working days of the department are six days per week, which are Monday to Saturday. Moreover, regular working time is eight hours per day, which are 8.00 – 12.00 and 13.00 -17.00. Occasionally, the department needs to operate overtime (17.30 – 21.00), which depends on the rate of progress of a project. In general, costs of the project arise mainly from material and labour expenses.

3.4.1 Requisition for a new mould

The request for a mould to manufacture a new product has been sent from the sales department to the mould department. The sales department provided information of the product as shown below:

3.4.1.1 A sample of the product

As shown in Figure below, it is a sample of a product from the customer.

Figure 3.10: A sample of the product

3.4.1.2 Specification of the type of plastic required

Type of plastic for this product is polypropylene (PP), which is a thermoplastic polymer. This material is used in a wide range of products, such as food packaging, plastic containers, and automotive components.

From the specification of PP, one of the important factors is the shrinkage value. It is the amount by which a molded product is smaller than the size of the cavity space. From experience, it is known that the shrinkage value of PP is in the range of 0.012-0.022 mm/mm.

3.4.1.3 Drawings

As shown in Figure below, it is the drawing of a product from the customer.

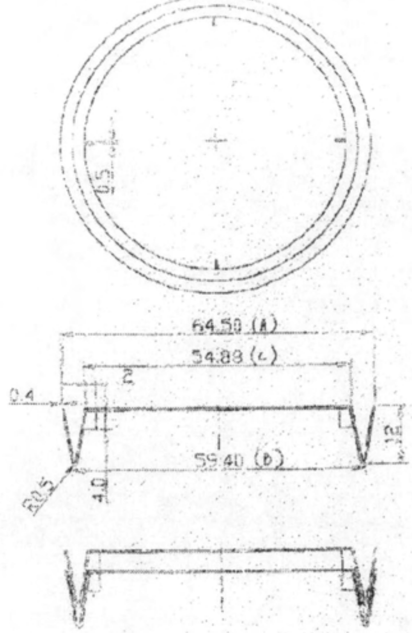

Figure 3.11: The product's drawing

3.4.1.4 Number of cavities

In order to produce the required quantities in the desired time, a larger number of cavities shall be provided. On the number of cavities, the customer requested eight cavities for this project.

3.4.2 Mould design

From the information provided in the previous step, the hand sketch of an eight-cavity mould for injecting plastic lids was designed roughly by the manager. Materials, components and processes required for the mould construction would be estimated from his experience, in order to calculate production cost and lead time.

3.4.3 Estimation of production cost and time

For the estimation of production cost and time, 230,000 baht and a lead time of 2 months were calculated by the department manager. It consisted of only labour cost and materials cost, which were approximately 50,000 baht for labour expenses and 180,000 baht for materials.

Where, Lead time of the project was 2 months
Working days of the department were 6 days per week
Total wages for two machinists were 884 per day

Thus; Labour cost $= 2 \times 26 \times 884$
$= 45{,}968$ baht

3.4.4 Comparison of production cost and time with suppliers

At this point, two subcontractors quoted prices of 300,000 baht with a lead time of 3 months, and 330,000 baht with lead time 2.5 months. By comparing the in-house production cost and time with the same variables at subcontractors as demonstrated in Table 3.1 below, the manager decided to construct this mould within the company.

Origin of mould	Lead time (months)	Cost (Baht)
Company X	2	280,000
Subcontractor A	3	300,000
Subcontractor B	2.5	330,000

Table 3.1: Comparison of fabrication time for one set of plastic mould between in-house and subcontractor mould departments

3.4.5 Process of in-house production

3.4.5.1 Order raw materials

Finishing plates, steel rods, and components are ordered for use in constructing the eight-cavity mould for the plastic lid. One week and 180,000 baht are expended in this process.

3.4.5.2 Machining the steel plates

3.4.5.2.1 Facing the steel plates

There was no production in this stage because the finishing plates had been ordered in the previous step.

3.4.5.2.2 Machining the mould base

One week and one day were expended for this process.

3.4.5.2.3 Machining the mould shoe

This step consisted of drilling openings in the mould base for holding inserts, cooling tubes, and an ejector system, whereby six weeks and four days were expended for the procedure. However, this process was not operated continuously. The machinist had to wait for completion of machining the inserts, because these components had to be checked for clearances with the openings in the mould base.

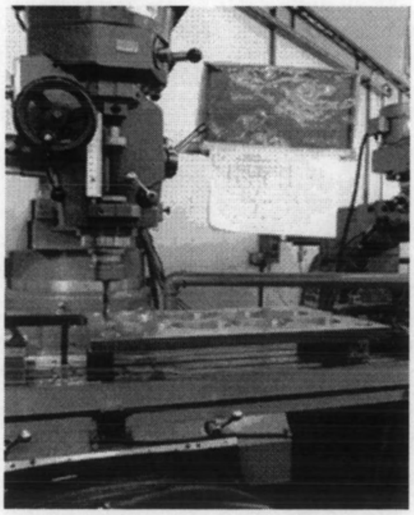

Figure 3.12: Machining the mould shoe

3.4.5.3 Machining inserts for cores and cavities

There were six shapes of inserts for each cavity. It meant that forty two pieces of inserts were needed to be machined in this process. Here, the machinist had to fabricate inserts one shape at a time. Moreover, the clearance between inserts and the mould shoe needed to be checked closely, and this was a slow painstaking task. As a result, twelve weeks were expended for this phase of the process.

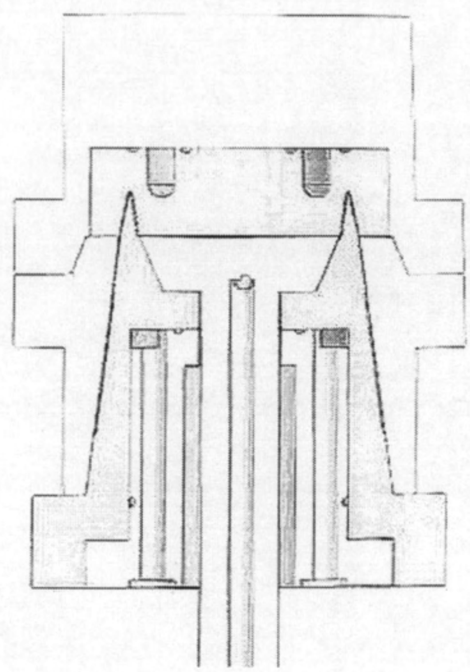

Figure 3.13: A set of inserts for cores and cavities

3.4.5.4 Assembly

Two days were required for assembling the mould shoe, inserts, and other components together. Finally, checking the mechanism of mould opening and closing was performed, as well.

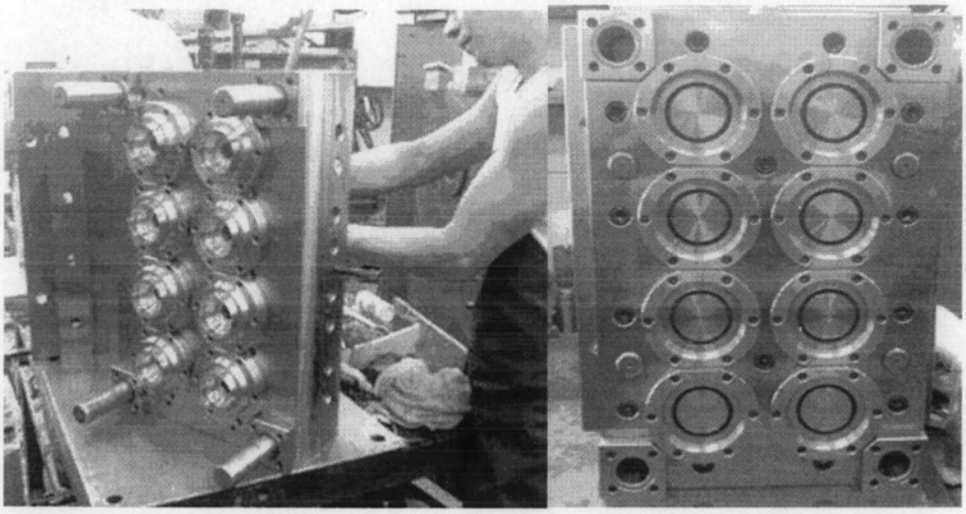

Figure 3.14: Assembly for core side and cavity side

The entire process could be summarised by the diagram as shown in Figure 3.15 below.

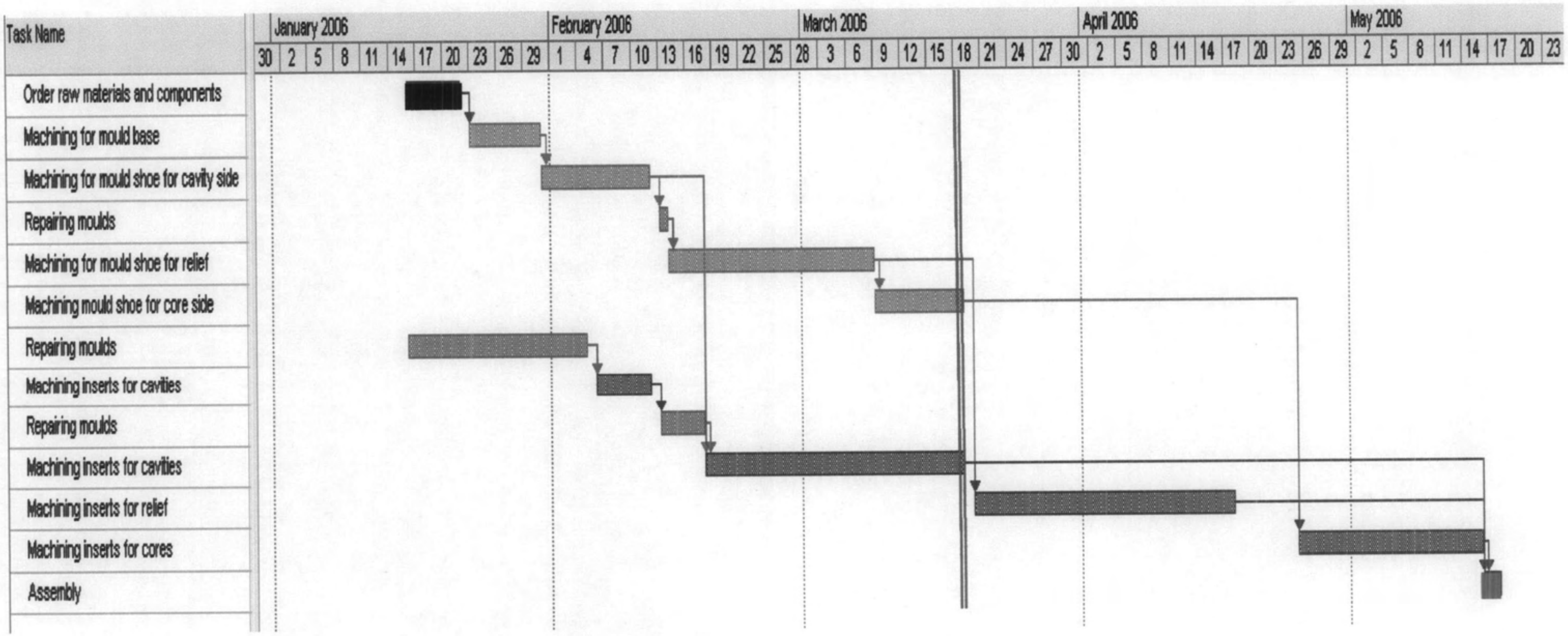

Figure 3.15: A Gantt chart for construction of the mould for injecting plastic lids

Legend -

Black: Order raw materials and components Red: Repairing moulds Green: Machining steel rods Blue: Machining steel plates Pink: Assembly

As shown in Figure 3.15 above, this project was delayed by 2 months, and it operated over budget by approximately 45,000 Baht, which was due mainly to labour cost. Obviously, a delay in the mould fabrication was a problem that could adversely affect the delivery schedule of finished goods, which in turn might result in customer dissatisfaction.

3.5 Problem analysis

Although the manager of the department has extensive experience in the processes of mould fabrication, there is still a huge problem in the manufacturing process, which is *a long lead time*. This problem can be an obstacle for the company to finish a project on time in order to achieve customer satisfaction.

In order to analyse problems raised in section 3.5 above, cause and effect diagrams shall be utilized. They help the department to understand root causes of various problems. To identify root causes of a long lead time, the company held a meeting to discuss the causes and effects in this project, which were based on the experience and recorded data from making moulds in the department.

3.5.1 Cause and effect diagrams

The causes and effects of a long lead time in mould fabrication may be shown schematically as follows:

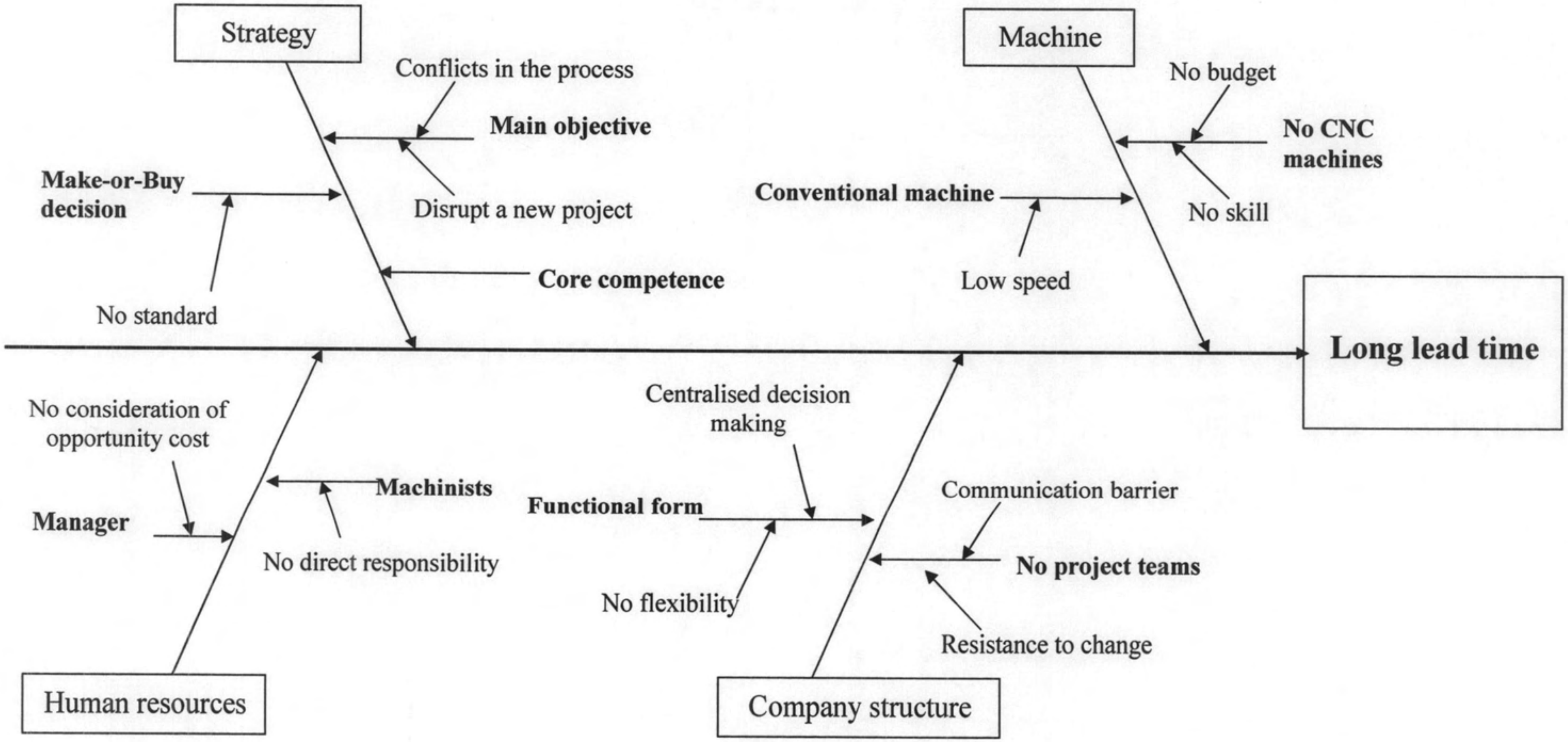

Figure 3.16: Cause and effect diagram for long lead times

The underlying problems of long lead times shall be discussed in greater detail in the following paragraphs.

3.5.1.1 Lack of standardisation for the Make-or-Buy decision-making

To make new moulds, all work processes are initiated by the manager of the mould department. In the current process, the experiences of the manager of the mould department would strongly influence his decision to proceed with fabrication or to outsource the new mould.

In addition, the manager usually aims to construct complete moulds in-house in order to keep every staff member busy. Thus, there is lack of consideration of production time and the savings in material cost versus production time that may be saved, which is clearly an opportunity cost.

3.5.1.2 Centralised decision-making and lack of delegation

From the organizational structure of Company X, which is a functional form, management has centralized decision-making and operates the business with specialists focusing on particular areas of technology. Employees have the opportunity to develop expertise in their areas of specialization. On the other hand, disadvantages of a functional organization that can hinder teamwork are lack of flexibility, barriers of communication among departments, and the propensity for change is low.

As mentioned earlier, the manager controlled all work processes in the department. The present method is to design a work piece or mould by this person, without use of equipment that can help him to calculate more accurately and with greater speed. He designates a person from each function concerned to be responsible for a related task area. For instance, employees carry out their activities narrowly following their functional objectives. They perform their tasks without concern for others' work that may be related to the project. Moreover, since the staff is allowed little flexibility, they are unable to decide how to approach their work. Once a task is completed, the staff wait for orders from the manager for the next assignment.

In the present environment, it is difficult to have different functional operators working together by setting up project teams to execute projects due to communication barriers in the company. For example, the operator of the milling machine has responsibility for converting a plain steel plate or a steel plate with facing to a mould base, and the operator of the lathe has responsibility for turning some components.

3.5.1.3 The maintenance of existing moulds is a primary objective of the mould department

A basic function of the department is to repair moulds in order to service the production line. However, the department needs to build new moulds as well, which can create some conflicts in the process. When there is a mould that needs maintenance or repair, staff need to rotate from making a new mould to fix a broken mould. As a result, it can possibly disrupt a new project, which leads to the delay of a new mould.

3.5.1.4 Lack of a computer numerical control machine (CNC) for lathing and milling operations

For the machining process, the company has only semi-automatic equipment in the mould shop. As illustrated in Figure 3.16 above, lathe and milling machines in the main processes are neither modern nor state-of-the-art. Equipment for making moulds to be used in the manufacturing processes is not modern and cannot make moulds that have high precision components in a short time.