TECHNO-ECONOMIC FEASIBILITY OF A
PLASTIC BASE INDUSTRY
FOR
SPECIALIZED PRODUCT

A PROJECT THESIS

BY

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DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING
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Md. Golam Rahman
The present work has been done to study the technical and economic feasibility in setting up a plastic base industry using contemporary technology considering technological limitations of the country.

A detailed market survey was done to select the appropriate or optimum mix that would make the project viable. Toys, mini fans, video cassettes were selected as products.

Technological aspect of the project includes developing the technological processes for the different components, selection of raw materials, selection and study of the machineries required, plant layout, etc.

Modernization of a locally produced injection molding machine is a major work of the present study. Hydraulic and electronic control systems were designed in details for this purpose, this enables in operating the machine in a semi-automatic mode.

An organization structure was proposed to run the industry smoothly. The structure includes 145 persons of which one director, one general manager, two manager, 10 engineers, 80 machine operators, and others.

Financial analysis was also done meticulously to investigate the economic feasibility of the project. Total project cost was estimated to be Tk.18,304,072 of which cost of machineries is Tk.14,522,072. Financial analysis shows that annual sales of Tk.47,705,000 will cross the break even point with a significant margin, which shows that the project is economically feasible.
1. INTRODUCTION
1.1. BACKGROUND OF STUDY:

With the gradual increase in the use of modern equipments and services, the use of plastics has increased remarkably. Almost in all the field of manufacturing; starting from head of a table pin to computer accessories; one will find plastic as one of the most important raw materials.

In many practical applications plastic are preferred to metals. For example, because of the light weight characteristics of plastics, V/STOL aircraft use plastics for the manufacture of their bodies. The bodies of Grand Prix racing car are invariably made of brittle plastics for safety reasons.

In the context of Bangladesh also, plastic is playing a very important role. But at present, in every stage of the production technology, the production capabilities are limited due to lack of knowledge and technical know-how in the field of plastic technology. For example, many of electronic equipments like televisions, radios, radio cassette players, toys, video cassettes, etc. are produced in Bangladesh; but for plastic components such as housing, cases, knobs, gears, spools, levers etc., needed for these products, the country is dependent on import. As a result, the electronic industries in the country is limited in designing
their own electronic products.

It was found that sheer weakness in the area of plastic technology is causing as a deterrent to the industrial development of this country. There are only a handful of plastic industries. Of these only few are producing plastic products using modern technology; while the rest produce products using orthodox technique; using such orthodox technology, one can not produce precision and good quality products competent for the international market.

With this in mind, a number of plastic products were studied, where a significant percentage or all of the components are made of plastics, An attempt was taken to design and set-up a plastic based small scale industrial unit in this regard. Comparison of a injection molding machine of orthodox technology to modern technology are shown below.

<table>
<thead>
<tr>
<th>Orthodox Technology</th>
<th>Modern Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>No hydraulic system manually operated</td>
<td>Hydraulically operated</td>
</tr>
<tr>
<td>No pressure control devices</td>
<td>Pressure are controlled</td>
</tr>
<tr>
<td>No temperature regulator and controlling device</td>
<td>Temperature are regulated and controlled</td>
</tr>
<tr>
<td>No cooling system</td>
<td>Has cooling system</td>
</tr>
</tbody>
</table>
1.2. OBJECTIVE OF STUDY

Following are the objectives of the present study:

1. The objective of the Study was to find out plastic product or a group of products viable to be produced in this country considering the market demand, with an ultimate goal to acquire and to infuse plastic production technology in the country.

2. Specifically it was intended to get some products with certain label of technical complexity and to mix the product in such a way to make the project feasible.

3. To conduct a market survey, acquiring of technical know-how of the production process from within or outside the country.

4. To study working principals of machines and their developments and installations.

5. To develop the project with view of modern production management technique, i.e. to study break even analysis, plant lay out, management information system, quality control method, organization structure and detail financial analysis.

6. To modernize a locally manufactured manually operated plastic injection molding machine to a semi-automatic machine.
1.3. METHODOLOGY:

In the present study effort was given in getting information and know-how from home and abroad. First of all the local market, plastic whole sale market, electronic market, various consumer markets etc. were surveyed. Products which have got major components with plastic base were taken under consideration. The marketability and local manufacturing capabilities of the products were studied.

A thorough survey and interview were carried out with the major plastic raw material whole sale traders. Various Local Industries were studied as well many foreign industries in Hongkong, Bangkok, India, and Taiwan.

In modernizing the locally used orthodox injection molding machine, a thorough survey on the orthodox machine was carried out in the road side workshops. After identifying the problems of the machine, hydraulic and electronic systems have been developed to overcome the problems.

The financial analysis was carried out with computer with the help of Quatro-Pro software.
2. TECHNICAL ASPECT OF THE PROJECT
2.1 PRODUCT MIX:

From the market survey it has been observed that there are many plastic products in the market which are locally manufactured but of poor quality. Following are the basic plastic products:

1) Tumbler
2) Bowl
3) Kitchen utensils
4) Utensils of toilets
5) Some spares of textiles
6) Electrical switches and components
7) Some hardware of plastics
8) Toys
9) Packing boxes
10) Lunch boxes
11) Other households

Above items are basically non-engineering types and simple in nature. Although these products are produced in the country for a long time, hardly any improvement in quality and technology has taken place. Most of these products are produced by orthodox injection molding technique.

Survey has been done and following engineering products were studied where plastics play a very vital role.
a) Telephone receiver sets  
b) Radio  
c) Television  
d) Radio cassette player  
e) Video cassette recorder / player  
f) Video cassettes  
g) audio cassettes  
h) Electrical household equipments  
i) Electrical fans  
j) Educational toys  
k) Electronic toys  
l) Watches  
m) Calculators  
n) Various business machines.

All of the above items are assembled or manufactured within the country in varied quantity either in Complete Knock Down (CKD) condition or Semi Knock Down (SKD) condition. Plastic components of the most of the above products are imported.

Radio sets have been produced in Bangladesh for last 20 years, But none of the model was completely designed and manufactured locally. Plastic components have to be imported for radio sets as well as for VCP, VCR and Television. Only Telephone Shilpa Sangstha Ltd. is producing the complicated plastic components of telephone sets locally.
One of the major materials of modern toys are plastics. Toys have got a huge export market in the developed countries and even in Bangladesh. Only due to lack of modern plastic technology good quality toys could not be produced locally. As a result 95% of toys in Bangladesh are imported, but such labor intensive industries could earn huge foreign currencies through exports. Video and audio cassettes have got good market in Bangladesh. There are few industries who are making cassettes. In fact they are assembling imported various plastic components and loading the magnetic tapes.

Table fan has good market demand. Modern table fans are mostly produced by plastics besides the motor. These type of table fans are all imported to the country.

Following sales and production situation are observed from the market survey of Mini Fan (Annexure I), Video Cassette (Annexure II) and Toys (Annexure III).
<table>
<thead>
<tr>
<th>ITEMS</th>
<th>SALES QTY PER YEAR</th>
<th>LOCALLY MANUFACTUR</th>
<th>SKD MANUFACTUR</th>
<th>CKD MANUFACTUR</th>
<th>IMPORTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINI FAN.</td>
<td>43,400</td>
<td>0</td>
<td>10,000</td>
<td>8,000</td>
<td>25400</td>
</tr>
<tr>
<td>VIDEO CASSETTE</td>
<td>580,000</td>
<td>0</td>
<td>400,000</td>
<td>180,000</td>
<td>0</td>
</tr>
<tr>
<td>TOYS</td>
<td>1,491,840</td>
<td>200,000</td>
<td>300,000</td>
<td>0</td>
<td>991840</td>
</tr>
</tbody>
</table>

From the above analysis it is observed that only a insignificant quantity of toys are manufactured locally, besides that video cassettes and Mini fans are produced from semi knock down and complete knock down condition.

Therefore studying the market demand, prices and also export potential following products have been chosen for the present project work.

1) Toys  
2) Video cassettes  
3) Mini fans
2.2 PRODUCTION PROCESSES

2.2.1. Production Process of Toys

The toys which are planned to be manufactured here are mostly educational types, having less moving parts and complicated mechanism. They consist mostly of plastic components. The production process are shown in details in the flow process drawing (fig no.2.1).

The basic raw material for these toys are various plastic compounds such as,

1. ABS
2. High impact polystyrene (HIPS)
3. General purpose polystyrene (GPPS)
4. High density polyethylene (HDPE),
5. Color dies for toys

At the beginning the plastic compound and the color pigments are mixed properly by mixture machine. Then these compounds are taken to the injection molding machine through drier and hopper, where the compounds are dried to remove the moisture from the plastic compounds.
FIGURE NO. 2.1
Production Process of Toy
In the injection molding machine the various parts of the toys are produced as per the molding dies. These parts are quality checked and sent to the assembly room for further processing.

Mechanical parts are produced in the Prefabrication unit. Usually some brackets, axle, hooks, etc., are produced by sheet metal press machine, and lathe machine. These parts are then cleaned and surface treated in the surface treatment shop. After quality checking the finished mechanical parts are sent to the assembly shop.

In the assembly shop the plastic and mechanical parts are assembled together, some stickers are also adhered on to the toy body as required. Then functional and visual quality checking are performed.

The next step is Blister packaging where specially made pvc formed sheet are required, which would also be made in the prefabrication unit by forming machine from pvc sheet roll of 0.2 mm thickness. The printed paper board would be supplied from the local printing industries. The printed paper board and pvc formed sheet are sealed by heat sealing machine keeping inside the toys accordingly. After that quality would be again checked and packed in printed packing box. Finally products are packed again in cartons and stored.
Fig. No 7.2
Components of a Toy (House).
Following are the list of the parts and components of a toy house, which are shown in figure no. 2.2.

1. shed
2. housing
3. base
2.2.2. Production Process of Video Cassette

Video cassette has been designed so that major components of video cassettes are of plastic along with some metallic parts will be manufactured locally whereas the magnetic tape and some other metallic parts will be procured from imports.

The raw materials are as follows:
1. Plastic compound (ABS)
2. High Impact Polysterol (HIPS)
3. Polysterol (PS)
4. Metallic bush, axles
5. PVC sheet for cover
6. Magnetic video tape
7. Leader tape
8. Screws
9. Spring metal sheet

The production of plastic parts will take place in the injection molding shop. The black ABS will be used as the raw material of most of the plastic components and polysterol will be used for transparent window. The plastic granules are first mixed and dried by mixture machine and drier respectively and then poured into hopper of the injection molding machine. Separate molding dies are used for making different parts. Following parts will be produced in the injection molding shop.
1. Cassette half upper
2. Cassette half bottom
3. Front cover
4. Transparent window
5. Reel hub
6. Flange
7. Fixing lock
8. Bracket
9. Bush
10. Pin

After being produced these plastic components from injection molding shop the parts are taken to the assembling shop. In the following process flow chart (Fig. no. 2.3) detailed step and operation of different positions are shown.

On the cassette half first the cleaning flag is glued and then position bush and pins are fixed manually and finally locks and brackets fixed.

Another flow starts with reel hub and flange where both are welded together with pin by ultrasonic welding machine to produce reel complete. In the next position two reels are joined with leader tape and clamp by tape clamping machine.

Then reel with leader tape is assembled with bottom half and is ready for assembling with cassette upper half.

Cassette half upper is welded with transparent window by ultrasonic
FIGURE No 2.3
Production process of Video Cassette
Machine and spring is also welded on to the cassette half upper and then it is assembled with the cassette bottom half manually. Spring and front cover is assembled on the cassette housing manually. Cassette body is completed by screwing with the pneumatic screw driver. Then the product is quality checked.

The next position is very important. The cassettes are loaded with magnetic tape in a specially made dust proof room. Then again it is checked for quality and it is packed and stored. Following are the list of parts and components of video cassette which are shown in figure no.2.4.

1. Cassette half upper
2. Window
3. Spring plate
4. Reel flange
5. Leader tape
6. Reel hub
7. Tape clamp
8. Spring
9. Break lever
10. Release lever
11. Cassette half bottom
12. Screws
13. Lock spring
Fig. No. 24

Components of a Video Cassette.
14. Lock plate
15. Guard panel spring
16. Guard panel
17. Video tape
18. Splice tape
19. Brake lever (r)
20. Guide roller
21. VHS pin
22. VHS pipe
23. Flap
2.2.3. Production Process of Mini Fan

The raw material required for Mini fan are as follows:

1. Plastic compounds (ABS, HIPS)
2. Color dies
3. Silicon iron sheet
4. Copper wire
5. Electric Switch
6. Steel bar
7. Aluminum bracket
8. Screws

The production process for mini fan is shown in details in the flow chart Fig no.2.5. It has started with three operation lines. First axle for motor is made from steel rod by a lathe machine and goes for next operation for armature core assembly. Another process line starts with sheet metal cutting. The silicon steel sheet is cut to strip at required width by a shearing machine. Then blanking of armature core and stator core are done by eccentric press machine. In the next position the blanked parts are quality checked and goes to the next position. Armature core and axle are assembled together to make the armature complete. The plastic bobbin which are produced by injection molding machine are wounded and quality control checked. After that stator is
FIGURE NO. 9.2.5
Production process of mini fan
completed with stator core and bobbin assembled by riveting. Finally the motor is assembled by assembling stator and armature with aluminum bracket and bearing to make the motor complete. Quality control checks the motor electrically. In the mean time various plastic components of fan are produced by injection molding machine, such as fan blade, base, front cover, back cover, grill, base etc. and quality checked. In the assembling line these components and motor are assembled together to make the fan complete. The quality control check functional and aesthetic aspect of fan and then the fan is packed in special box and stored.

Following are the list of parts and components of a mini fan, which are shown in the figure no.2.6

1. Fan grill
2. Fan blade
3. Motor
4. Motor housing with back grill
5. Cable
6. Switch
7. Base stand
8. Bottom plate
9. Switch
10. Wing nut
Fig No. 26

Components of a Mini Fan.
2.3 **MACHINERIES AND EQUIPMENTS**

The machines and equipments are selected after detail study of each production process. Following major machineries are required for the project besides some tools and equipments.

1. Injection molding machine
2. Plastic Blower machine
3. PVC vacuum forming machine
4. Air compressor
5. Mold temperature controller
6. Crusher machine
7. Frelaxer
8. Material extractor robot
9. Mixture machine
10. Ultrasonic welding machine
11. PVC blister welding machine
12. Automatic VHS loader
13. Tape clamping machine
14. Hydraulic shearing machine
15. Eccentric press machine
16. Lathe machine
17. Universal milling machine
18. Bench drill
19. Grinding machine
20. Buffing machine
2.4. **PLANT LAYOUT**

As plant layout is an arrangement of facilities and services in the plant and it outlines the relationship between production center and departments, detailed plant layout flow types and factors are studied, shown in annexure ... In the study plant layout is done within the limitation for the following purpose.

i) Integrate the production centers into a logical, balanced and effective production unit.

ii) Facilitate satisfactory movement of materials and personnel and an efficient control mechanism of such transportation.

iii) Provide a logical distribution of functional facilities in the plant.

iv) Be adaptable to possible change in the plant's production program.

v) Ensure proper allocation and utilization of space to the production centers and to service departments.

vi) Allow convenience of operation both to operator and supervisors.

All these objectives cannot always be simultaneously attained, thus before arriving at a well balanced solution, the layout have been carefully analyzed and their advantages and disadvantages were studied in the light of these objectives.
2.4.1. Layout Analysis

Depending mainly on the type of production, the layout could be classified into three types.

Product layout: Product layout or line production, in which machines and auxiliary devices are located along the production flow line. The layout is suitable for continuous types of production and can employ one of the basic horizontal flow line or their combination.

Process layout: In which machines and services are grouped according to their characteristic functional purpose; for instance, all turning, welding, molding machines, painting etc., are performed in separate turning, welding, molding and painting sections. A process layout is usually employed in job and batch production.

Static product layout: It is layout by fixed position, in which the product is too big or too heavy to be moved from one process to the other and is consequently fixed in one place. The machines and men are brought to the product to perform the required operations. Shipbuilding is an example.

As per the production of the parts considered and technology, the layout is done mostly in the concept of Process layout.

The study is done with an assumption of the shown building area. So
with this building space, the design is constrained.
The Factory premise is a two-storied building. Considering the flow pattern of the proposed product manufacturing process, the layout and flow pattern have been designed.

1. Heavy machineries are installed in the ground floor, because of safety and installation convenience.
2. Each floor has its store facilities for easy material handling.
3. Mostly machines are installed as process layout, to keep the scope of product diversification and mostly job would be done as per batch order. In fact layout is made as a combination of product and process layout.
4. Adequate steps have been taken to avoid hazards. The electrical sub-station is isolated, compressor room is separated, the space for material movement is kept sufficiently.
5. Utility services are positioned in central position for easy access.
6. Obnoxious noise and gas producing part kept near the boundary for easy exhausting of gas and noise.
7. To meet the technological requirement like dust free room for certain product, the room is placed in further most corner so that least dust are carried into the room.
Fig No. 2/4

Plant Layout of the Proposed Project
(FIRST FLOOR)

- Flow of Raw Material
- Flow of working Process
- Flow of finished Goods
3. MODERNIZATION OF AN ORTHODOX INJECTION MOLDING MACHINE COMMONLY USED IN BANGLADESH
3.1 INTRODUCTION

The injection molding machine in Bangladesh are the orthodox machines which are indigenously manufactured and are widely used by the roadside workshops to produce various plastic products. An attempt has been taken to develop such machines for the improvement of product quality and efficiency. At this endeavor firstly a detailed study on the production of plastic product and the use of machines for this purpose was done. Basically two types of machines are in use:

1. Powered injection molding machine
2. Manual injection molding machine

There are few large scale production units, which are producing plastic products with modern powered injection molding machine from 45 to 300 ton capacity (clamping force) and using better quality material like ABS, hips, PS, etc. These produce products such as telephone sets, various kitchen utensils, tumbler, jug, pen, etc. These machines are all imported and highly capital intensive, and all the molding dies used are imported (The modern injection molding machine and molds are studied and its components are elaborated in the ANNEXURE VII.). Besides, the plastic infrastructure is based on the orthodox machines on the roadside
workshop. These machines are being in use for more than three decades, but hardly any improvement has taken place since then.

It is therefore the advantages, limitations, scope of improvement of these machines have been studied thoroughly.

3.2 _THE ORTHODOX INJECTION MOLDING MACHINE._

The machine consists of four part like the modern injection molding machine;

1. Frame or body
2. Clamping unit
3. Plunger unit
4. Injection chamber

The main characteristic of this machine is, the clamping unit and plunger unit are manually operated, whereas in the modern machines they are electrically powered and hydraulically operated.

The parts and components are shown in details in figure no. 4.1.

i) Frame:

This is usually made of two pieces of Steel U.Beams. As the machine is vertical type, the longer beam is welded upright on the smaller base beam. Other components are welded and screwed on the frame. The molding die is
Fig. No. 41

Orthodox Injection Molding Machine
ii) Plunger unit:

It is a Rack and Pinion mechanism to drive a ram or piston. This rack and pinion are mounted at the upper part of the machine. The pinion is fixed on a axle, which is mounted on the support frame through two ball bearings. The rack is also assembled and mounted with the pinion. When the pinion rotates the rack moves up and down. The lower part of the rack is connected to a piston and the axle of the pinion is fixed to handle, by which the pinion could be rotated. When the handle that is the pinion rotates in the clock wise direction, the piston moves downward to push the injection chamber. When the pinion rotates in anti-clock wise direction the piston moves upward.

iii. Clamping unit:

It is a simple mechanism of one end vise to grip the molding die tightly. On one side of the base a block is welded, through which a screw is passed infront of which a ram is mounted. The screw is rotated by a handle which acts as a lever and is fixed at the end of the screw.
iv. Injection Chamber:

It is a chamber where the plastic resins are melted and injected to the molding die. It is like a metallic tube, the upper side is like funnel to make ease in pouring plastic granules, and lower part has got small opening through which the melts is injected into the molding die. The chamber rests on to a coil spring which is supported by the frame. In the lower part an electrical heater is fixed.

During production, the molding die is first placed on the base and fixed by the clamping screw firmly. The plastic resins are poured into the injection chamber and the handle of the rack pinion is rotated in the clock wise direction, then the piston comes down and press the upper part of the chamber filled with plastic resin, first it press the resins to go further inside the chamber then the chamber itself starts moving downward and the opening mouth of the chamber touches the gate of the molding die. With the further pressure on the chamber the melt fills the mold cavity. After a while the handle is rotated in anti-clock wise direction. The piston goes up and chamber moves up also by spring pressure. The molding die is released by unscrewing the clamping screw.
Then the molding die is opened manually and part is removed from the die.
3.3 MODERNIZATION OF THE ORTHODOX MACHINE

To modernize the orthodox injection molding machine, firstly problems of the machine is to be analyzed carefully and then the improvements in designs to be proposed to enhance the quality of the product and efficiency of the machine. The cost, as the users are very much cost conscious, is considered as the criteria.

3.3.1. Problems of the Orthodox Machine

1. Conventional machine usually require more manpower. In this machine one person rotates the handle of plunger and another person fixes the clamping screw and places the molding die.

2. It is not possible to control the piston pressure conveniently, as there is no pressure adjustment mechanism.

3. The temperature of the heater can not be controlled and thus the melts are some times overheated or burnt.

4. The clamping force are not adequate and it is time consuming to operate. The mold die closing and opening is cumbersome.

5. Total mold cycle is longer.

6. The quality of the product can not be obtained upto a significant level. As every thing is manually adjusted, consistency the quality can not be obtained.

7. Relatively experienced operators are required for good quality products.
3.3.2. Modernization of the Machine

In the new machine, the basic structure remains same but the moving part is powered by hydraulic system. It has been designed with an assumption that the simplicity of the use will remain as before but would improve the production facilities.

The plunger unit, an hydraulic cylinder, and a piston are used, instead of rack and pinion mechanism to drive the piston. The pressure developed by the piston and travelling speed of the piston could be controlled by pressure and speed regulator.

The injection chamber also rested on coil spring but its electric heater is controlled by temperature controller. Specific temperature could be maintained by temperature controller.

The clamping unit is also hydraulically actuated and pressure could be regulated. The hydraulic system is run by a hydraulic pump, which is again run by a 3 hp motor. In the schematic diagram of the injection molding machine in Figure 4.2 shows all the components of the machine.

The working sequence will be as follows:

The main switch 6 will energize the motor and the hydraulic pump will start working. The switch 7 will set on the heater when the temperature sensing device will sense the heater 16 at a
Fig. No. 42
Mordernized Injection Molding Machine.
temperature below the preset range. After placing the mold and pouring the resin into the injection chamber the switch 5 should be pressed to start the injection cycle. First the clamping piston presses and clamps the molding die. Then the injection piston comes down to press the injection chamber which brings the injection chamber down and presses on the die at the gate. With the further increase of pressure the melt is injected into the molding die to fill the cavity of the molding die. The pressure withdraws after a preset time, which is set by timesetting switch 18. Firstly the clamping piston moves outward and then the injection piston moves up. The temperature of the heater is preset by the temperature regulator 7. After the end of the cycle the molding die is taken out to remove the part.
3.3.3. Design of Hydraulic System

Firstly the circuit of the hydraulic system of the machine is developed to meet the requirement of the working sequences of the newly developed injection molding machine. In the circuit diagram figure 4.3 and 4.4 the flow system of hydraulics and the necessary equipment are shown in details. There are two sets of pistons and cylinders which are actuated in a sequence as required by this circuit.

Description of the Hydraulic Circuit:

The heart of the system is the hydraulic pump (gear type) run by a 2 hp motor, which pulls oil from the tank through a filter and passes to the pipe lines at a definite pressure. After the pump there is a pressure control valve (7), which could be adjusted to a specific pressure, when the pressure rises more than the preset pressure in the line, the release valve opens and the oil flows back to the reservoir (13). Pressure of the main line could be monitored by pressure meter 4 after opening the manual check valve 3. Two direction four line solenoid operated valve 8 would control the flow of the fluid and thus will control the direction of the movement of the pistons. At the beginning of the cycle the solenoid (a) of valve 8 will be operated and as a result the direction of the oil would be towards the cylinder 11 (shown in figure 4.3) to push the piston outward direction that is will
close the clamps of the machine to grip the mold properly. This
flow rate of the oil will be controlled by the flow control
regulator 10 and thus the speed of the outward motion of the piston
could be regulated. When the piston would reach to its end or the
motion of the clamp is limited by the mold's width, the pressure
would gradually increase. When pressure of the line would increase
more than a specified pressure which is adjusted at the pressure
control valve 9, would open the flow towards the cylinder 12. The
oil pressure now will start to drive the piston downward to press
inside the injection chamber by the outer end of the piston.
The speed of the piston will be controlled by the regulator 10. The
oil in the other side of the cylinder would come out and pass
through the unidirectional valve of 9 and directional valve 8 and
go to the reservoir tank through a heat exchanger 6. The pressure
inside the cylinder 12 is limited by the maximum line pressure
which could be controlled by regulator 7. When the solenoid switch
(b) would be activated by timer switch or manual switch, the flow
direction of the hydraulic oil would be changed (shown in figure
4.4). Now the pressure line would first direct the other side of
the cylinder 11, as a result the piston of cylinder 11 would start
moving inward and the oil of the other side of the cylinder would
flow the unidirectional valve of 10 and pass through the
directional valve 8 and ultimately will go to the reservoir tank.
When it happens the clamping force withdraws. At the end of the
**PARTS LIST**

1. Motor
2. Pump
3. Check Valve
4. Pressure gauge
5. Oil Tilter
6. Heat Exchanger
7. Pressure Control regulator
8. Directional valve
9. Speed Control regulator
10. Cylinder & Piston
11. Reservoir Tank
12. Pressure Control Valve.

---

**Fig No. 44**

Hydraulic circuit diagram of Injection Molding Machine.
Fig. No. 4:3
Hydraulic circuit diagram of Injection Molding Machine.

PARTS LIST
1. Motor
2. Pump
3. Check Valve
4. Pressure gauge
5. Oil Tilter
6. Heat Exchanger
7. Pressure Control regulator
8. Directional value
9. Speed Control regulator
10. Cylinder & Piston
11. Reservoir Tank
12. Pressure Control Value.
movement the pressure starts rising in the line and at a definite pressure the pressure regulator 15 opens the flow towards the other side of the cylinder 12 to move the piston of the cylinder upward. So the oil in the other side of the cylinder would be driven out through unidirectional valve at 10 and 16 and ultimately go to the reservoir tank through directional valve 8. When solenoid switch is disengaged the directional valve would go back to its neutral position and the oil would pass to the tank continuously and as a result there would be no pressure in the line.
3.3.4 Design of the Electrical System

The electrical system of this machine is designed to facilitate the following activity:

1. To power the motor which would drive the hydraulic pump.
2. To heat the injection chamber to a preset temperature and to control and regulate the temperature as required.
3. To start the injection cycle through solenoid switch and enable to end the cycle with the help of an electronic timer which would operate another solenoid switch.

In the circuit diagram in Figure 4.5 all the components in details are shown.

Description:
The electrical system operates at 220V AC. Switch 1 is the main switch which starts the motor of the hydraulic pump and provides power to switch on the heater unit. When the switch 2 is closed then a temperature control unit is activated. The sensor 12 which is placed at the injection chamber, senses the temperature of the injection chamber and gives high or low voltage to operate relay 5. When the temperature sensed at the injection chamber is lower than the preset temperature in the controller unit, then the coil of the relay 5 energizes and as a result the relay contacts closes and the heater circuit is closed to switch on the heater 6. When the
temperature of the injection chamber goes above the preset temperature then the temperature controller de-energizes the relay coil and as a result the contacts of the relay open up to switch off the heater.

Hydraulic control circuit gets power through the transformer 7 which gives power to the electronic timer circuit 10, which is again shown in details in Figure 4.6. The electronic circuit controls the start switch PB1 and the stop switch PB2 and also it has got time setting knobs SW2, SW3, SW4, SW5, SW6.

When PB1 is pressed, operation starts by engaging the relay contact s1 which in turn activates solenoid a1 of gate valve 8 which causes the outward movement of the plunger and the operation starts. After a definite preset time the electronic circuit disengages the relay contact s1 and engages relay contact s2, which activates the solenoid valve a2 of gate valve 8 and the withdrawal stroke of the hydraulic plunger starts. Thus a cycle is completed. Detail description of the electronic circuit is shown in the following pages.
Electrical circuit diagram of modernized Injection Holding Machine.

**PARTS LIST**

1. Main Switch
2. Heater Switch
3. Motor
4. Pump
5. Relay
6. Heater Coil
7. Transformer
8. Thermostat Control
9. Rectifier
10. Electronic Timer Circuit
12. Temperature Sensor

$S_1, S_2$ Solenoids
$S_1, S_2$ Relay contacts
3.3.5. Working Principle of Electronic Circuit:

Transformer T1 reduces the 240 V AC mains voltage to 18 V AC. Diodes D1 and D2 convert this 18 V AC to a "pulsating DC", which is developed across the resistor R1 and which has a high amplitude ripple content of exactly twice the mains frequency. For non-critical applications the mains frequency can be considered as highly stable. Therefore the 100 Hz ripple is used as the reference frequency for the timer. Diode D3 and capacitor C3 filters out the ripples to provide a smoothed DC of 12 volts for use as the B+ supply.

IC8/d and Q1 form a Schmitt Trigger which is gated by the 100 Hz ripple frequency. R2, R3 and C2 form a T-filter which removes the harmonics and other high frequency contents that may be present.

Each of IC1 and IC2 contain two divide-by-ten counters. IC1/a is a the 100 Hz pulses available at the output of the Schmitt Trigger to 10 Hz or 0.1 second pulses. IC1/b divides this again by ten to provide 1 second pulses. IC2/a, in conjunction with IC7/a and IC7/b form a divide-by-six counter as IC7/a and IC7/b decode the six-count and reset IC2/a. IC2/b further divides this by 10 to provide 1 minute pulses.
We now have the following pulses available at the different outputs of the integrated circuits:

<table>
<thead>
<tr>
<th>IC1/a</th>
<th>IC1/b</th>
<th>IC2/a</th>
<th>IC2/b</th>
</tr>
</thead>
<tbody>
<tr>
<td>pin 6</td>
<td>pin 14</td>
<td>pin 13</td>
<td>pin 6</td>
</tr>
<tr>
<td>0.1 sec</td>
<td>1 sec</td>
<td>0.1 min</td>
<td>1 min</td>
</tr>
</tbody>
</table>

The pulse of the required duration is selected through SW2 and fed to the input of IC4 as clock enable.

IC4 and IC5 are decade counters, each having ten decoded outputs. As IC4 and IC5 are in series, the total range available is 100 on a scale of 0 to 99. The outputs of IC4 and IC5 have thus been labeled as 0 to 9 and 00 to 99 respectively. IC4 is triggered by the negative going edge of the clock "enable" pulse. IC5 is clocked by the "carry" output of IC4. The pulse duration at these outputs is determined entirely by the setting of SW2.

IC8/a and IC8/b together form a flip-flop circuit which is controlled by the outputs of IC6/a and IC6/b. The output of this flip-flop is buffered by Q2 which in turn controls the relay. When the output of the flip-flop goes high, the relay is switched on, and when the output goes low, the relay is switched off. The on-time and off-time of this flip-flop is controlled by the outputs of
IC6/a and IC6/b, and can be manually overridden by PB1 (manual on) and PB2 (manual off).

IC6/a and IC6/b are NAND gates where the output of each IC goes low if all its three gates become high. Two of the gates of IC6/a are controlled by the outputs of IC4 and IC5. Similarly two of the gates of IC6/b are also controlled by the outputs of IC4 and IC5. SW3 to SW6 determine which of the output pins of IC4 and IC5 are actually connected to these gates. Therefore the on-time and off-time for these gates (in terms of number of pulses) are determined entirely by the settings of these switches. The third gates of IC6/a and IC6/b are controlled by the outputs of the flip-flop circuit constructed with IC8/b and IC8/c. This ensures that the off-time of the flip-flop is controlled entirely by the off-time selected by the selector switches. R11 with C7 and R13 with C8 are delay circuits which introduce a slight time delay to the pulses reaching the third gates of IC6/a and IC6/b to avoid the ambiguity that might arise out of equal times.

IC6/c and IC8/a form a monostable circuit which is triggered if either:

- the output of IC6/a goes low;
- the output of IC6/b goes low;
- PB1 is pressed; or
PB2 is pressed.

The output of this monostable resets all the counters. PB1 and PB2 are coupled to the input of the monostable through capacitors (C4 and C5). Thus the pressing of any of these switches is signalled to the monostable in terms of a short duration pulse, irrespective of how long the switch is kept pressed.
The switch settings as shown in the diagram are:

- SW2 - 0 to 99 seconds range
- SW3 - pulse number 2 from IC4
- SW4 - pulse number 1 from IC5
- SW5 - pulse number 7 from IC4
- SW6 - pulse number 8 from IC5

Pulse number 1 is available from IC4 after it receives 1 pulse in its input pin 13, pulse number 2 from IC4 is available after it receives 2 pulses in pin 13, and so on. The same relationship exists for IC5. It has also been mentioned that IC5 is triggered by the "carry" pulse at pin 12 of IC4. As a carry in IC4 occurs after it receives 10 pulses in its input pin 13, it follows that pulse number 1 of IC5 is equivalent to 10 pulses into IC4, pulse number 2 of IC5 is equivalent to 20 pulses into IC4, and so on. Thus the on-time, as determined by SW5 and SW6, is 8 pulses from IC5, which is equivalent to 80 pulses into IC4, plus number 7 into IC4, which is equivalent to 7 pulses into it, making for an on-time of a total of 87 pulses into pin 13 of IC4. Similarly the off-time, which is determined by the settings of SW3 and SW4, can be calculated as equivalent to 12 pulses into IC4.
The 99 seconds range selected by SW2 means that a setting of 99, as determined by either the SW3-SW4 pair or the SW5-SW6 pair, will be equal to 39 seconds. This becomes clear when we consider that at this setting of SW2, IC4 is receiving the 1 second pulses generated by the Schmitt Trigger and divider circuit. Thus IC4 will receive 99 pulses in 99 (1 sec x 99) seconds. The actual on-time and off-time in this example thus work out to be 37 seconds and 12 seconds.

When SW1 is closed, thus powering the circuit on, C6 is in the discharged state, holding the inputs to the monostable and the flip-flop low. This makes sure that the flip-flop (and therefore the relay) is in the “off” state and all the counters are reset to 0. The control inputs to IC6/a and IC6/b (from the flip-flop) is low and high respectively. When C6 becomes sufficiently charged through R9, the inputs to the monostable and flip-flop goes high and the timer starts normal operation. The counters IC4 and IC5 count up the seconds. The sequence of events can be shown in tabular form as:
1. 0th second -- Switch on

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop output</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>Low</td>
<td>Input1</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Input2</td>
<td>Low</td>
<td>Input2</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

2. 2nd second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop output</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>High</td>
<td>Input1</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Input2</td>
<td>Low</td>
<td>Input2</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>
3. 7th second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop output</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>Low</td>
<td>Input1</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input2</td>
<td>Low</td>
<td>Input2</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

4. 10th second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop output</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>Low</td>
<td>Input1</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Input2</td>
<td>High</td>
<td>Input2</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>
### 5. 12th second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>High</td>
<td>Input1</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Input2</td>
<td>High</td>
<td>Input2</td>
<td>Low</td>
<td>Off</td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>Low</td>
<td>Counting</td>
</tr>
</tbody>
</table>

### 6. 17th second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>High</td>
<td>Input1</td>
<td>High</td>
<td>Off</td>
</tr>
<tr>
<td>Input2</td>
<td>High</td>
<td>Input2</td>
<td>Low</td>
<td>Counting</td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>
7. 20th second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop.</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td>output</td>
</tr>
<tr>
<td>Input1</td>
<td>Low</td>
<td>Input1</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Input2</td>
<td>Low</td>
<td>Input2</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

8. 22nd second -- Same as in the 2nd second.

9. 27th second -- Same as in the 7th second.

10. 30th second -- Same as in the 20th second.

11. 32nd second -- Same as in the 2nd second.

12. 37th second -- Same as in the 7th second.

13. 40th second -- Same as in the 20th second.

14. 42nd second -- Same as in the 2nd second.

15. 47th second -- Same as in the 7th second.

16. 50th second -- Same as in the 20th second.

17. 52nd second -- Same as in the 2nd second.

18. 57th second -- Same as in the 7th second.

19. 60th second -- Same as in the 20th second.

20. 62nd second -- Same as in the 2nd second.

21. 67th second -- Same as in the 7th second.
22. 70th second -- Same as in the 20th second.
23. 72nd second -- Same as in the 2nd second.
24. 77th second -- Same as in the 7th second.
25. 80th second

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop output</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>Low</td>
<td>Input1</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Input2</td>
<td>Low</td>
<td>Input2</td>
<td>High</td>
<td>Off</td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>High</td>
<td>Counting</td>
</tr>
</tbody>
</table>

26. 82nd second -- Same as in the 2nd second.

27. 87th second -- beginning

<table>
<thead>
<tr>
<th>IC6/a</th>
<th>IC6/b</th>
<th>Flip-flop output</th>
<th>Relay</th>
<th>Counters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>Control</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Input1</td>
<td>Low</td>
<td>Input1</td>
<td>High</td>
<td>Off</td>
</tr>
<tr>
<td>Input2</td>
<td>Low</td>
<td>Input2</td>
<td>High</td>
<td>Counting</td>
</tr>
<tr>
<td>Output</td>
<td>High</td>
<td>Output</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>
As can be seen, at the beginning of the pulse of the 87th second, all the inputs to IC6/b went momentarily high, causing its output to become low. The low output of IC6/b:

(a) toggled the flip-flop, causing its output to go from high to low; and

(b) triggered the monostable to cause all the counters to be reset to zero.

The low output of the flip-flop caused:

(a) the relay to be switched on;

(b) the control input of IC6/a to become high; and
the control input of IC6/b to become low.

It can now be shown, through a similar analysis in tabular form, that the after the next 12 seconds all the inputs to IC6/a will become momentarily high, so that its output goes low, so that the monostable will again be triggered to reset all the counters to zero, and the flip-flop will again be toggled so that:

(a) its output will go from low to high;
(b) the relay will be switched off;
(c) the control input of IC6/a will become low; and
(d) the control input of IC6/b will become high.

In the "free-running" mode (selected by SW7), the foregoing sequence (starting after switch on) will continue to be repeated. In the "one-shot" mode, input2 of IC6/b is permanently held low, so that its output is always high. This effectively disables the off-time toggle function of the timer. When the timer completes its on-time cycle, it goes permanently into off-time, until reset by either pressing PB1, or switching power to the timer off and on again.

It may also be noted that at power switch on, the timer always starts in the off-time mode, thus avoiding an inadvertent energizing of the relay at power on. Of course, if SW5 and SW6 are set in such a way as the off-time is "00" then the relay will be
energized immediately after power on. But this is a case which is equivalent to putting the timer on constant on-time, which will hardly be a logical way of operating the timer. If it is desired to start the timer cycle in the on-time mode, PB1 should be pushed after power on. Similarly, if the timer is to be put in the off-time mode before it completes its on-time cycle, PB2 should be pushed.

**PARTS LIST OF THE TIMER**

<table>
<thead>
<tr>
<th>Resistors:</th>
<th>Value</th>
<th>Watt</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>1 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R2 &amp; R3</td>
<td>10 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R4</td>
<td>47 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R5</td>
<td>10 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R6</td>
<td>1 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R7 to R9</td>
<td>1 M</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R10</td>
<td>10 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R11 &amp; R12</td>
<td>100 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R13</td>
<td>10 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R14</td>
<td>100 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
<tr>
<td>R15</td>
<td>10 K</td>
<td>0.5W</td>
<td>5%</td>
</tr>
</tbody>
</table>
### Capacitors:

<table>
<thead>
<tr>
<th>Value</th>
<th>Volt</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 μF</td>
<td>50 V</td>
<td>Disk ceramic</td>
</tr>
<tr>
<td>0.1 μF</td>
<td></td>
<td>Polyester</td>
</tr>
<tr>
<td>220 μF</td>
<td>16 V</td>
<td>Electrolytic</td>
</tr>
<tr>
<td>0.01 μF</td>
<td></td>
<td>Polyester</td>
</tr>
<tr>
<td>10 μF</td>
<td>16 V</td>
<td>Electrolytic</td>
</tr>
<tr>
<td>0.01 μF</td>
<td></td>
<td>Polyester</td>
</tr>
<tr>
<td>0.001 μF</td>
<td></td>
<td>Polyester</td>
</tr>
<tr>
<td>0.01 μF</td>
<td></td>
<td>Polyester</td>
</tr>
</tbody>
</table>

### Diodes:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 to D3</td>
<td>1N4001 or similar</td>
</tr>
<tr>
<td>D4 &amp; D5</td>
<td>1N814 or similar</td>
</tr>
<tr>
<td>LED1</td>
<td>TIL209 or similar</td>
</tr>
</tbody>
</table>

### Transistors:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 &amp; Q2</td>
<td>BC108 or similar</td>
</tr>
</tbody>
</table>

### Integrated Circuits:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1 &amp; IC2</td>
<td>4518</td>
</tr>
<tr>
<td>IC4 &amp; IC5</td>
<td>4017</td>
</tr>
</tbody>
</table>
IC6 - 4023
IC7 & IC8 - 4011

Switches:

SW1 - Double pole toggle switch
SW2 - Single pole 4 position rotary switch
SW3 to SW6 - Single pole 10 position thumb-wheel switch
SW7 - Single pole toggle switch
PB1 & PB2 - Single pole "make" push button

Others:
Transformer (T1) - 240 V/18 V, center tap, .5 VA
Relay - Single pole 280 ohms coil, 240 V, 5 A

Power cord, 3-pin plug and clamp, 3-pin power outlet socket, plastic case 196 x 113 x 60 mm, printed circuit board.
3.3.6 Power and Load Calculation

Flowrate of Hydraulic oil:

Let

Diameter of each cylinder : D ft
Length of the cylinder : L ft
Volume of each cylinder : V cft
Internal volume of the pipe : V cft.

The cylinder which has been found and selected has got the following dimensions:

\[ \text{Diameter } D = 4 \text{ inch } - \frac{1}{3} \text{ ft.} \]

\[ \text{Length } L = 9 \text{ inch } - \frac{3}{4} \text{ ft.} \]

\[ \text{So, Volume } V = \frac{\pi (D)^2}{4} L = \frac{\pi \times \left( \frac{1}{3} \right)^2}{4} \times \frac{3}{4} - 0.06541 \text{ CFT} \]
Volume of Two cylinder = $2 \times 0.05541 \text{ cft} = 0.1108 \text{ cft}$.

Maximum working speed of a cycle = 15 sec

Total pipe length = 26 ft.

Internal diameter = 1/6 inch

\[
\frac{\pi \times \left(\frac{1}{72}\right)^2}{4} \times 26 \text{ cft} = 0.00393
\]

Total volume of oil require/cycle

= Volume of two cylinder + Volume of oil in the pipeline

= 0.1108 + 0.00393

= 0.1347 cft/cycle

= 0.1347 cft/15 sec

Oil Flow rate per minute = 0.1347 x 4 cft

= 0.538 cft/minute

= 15.23 liter/minute

= 3.35 Gallon/minute.

Clamping force calculation:

A two horse power motor and pump are selected for the studied injection molding machine. To find out the maximum pressure that
could be developed by this pump with requisite flowrate of oil the
following equation is used:

\[
HP = \frac{Qhw e}{550}
\]

Where

\[
\begin{align*}
HP & = \text{Horse Power} \\
Q & = \text{Flowrate of oil in cft per second} \\
h & = \text{Pressure head in ft} \\
e & = \text{efficiency of the pump} \\
w & = \text{specific weight of oil} = 49.6 \text{ lbs/ft}^3
\end{align*}
\]

\[
h = \frac{HP \times 550}{Q \times w e} = \frac{3 \times 550 \times 60}{49.6 \times 0.53 \times 0.85} = 5940 \text{ft}
\]

\[
h = 4430.5 \text{ ft}.
\]

It's known;

1 ATU = 34.780 ft of hydraulic oil = 37.78 ft

\[
h = 4430.5 \text{ ft} = 4430.5 / 37.78 \text{ ATU} = 117.27 \text{ ATU}
\]

Again 1 ATU = 14.7 psi

Maximum pressure could be developed in the pipeline

\[
117.27 \times 14.7 = 1723.9 \text{ psi}
\]

Clamping force could be find out by the following formula

\[
\text{Force} = \text{Pressure} \times \text{Area}; \ F = P \times A
\]
Checking of Pipe Line design

Maximum pressure inside the pipeline could be find out by the following equation, where as

\[
P = \frac{\sigma \cdot \pi \cdot e}{4 \cdot r} - \frac{12000 \times \frac{1}{16}}{\frac{1}{4}} - 3000 \text{lb/} \text{inch}^2
\]

The designed pipe could withstand a pressure of 3000 psi where as the maximum pressure could be attained in the pipe line is only 2054 psi.

Therefore the pipeline in this dimension can be used.

Safety factor = \frac{3000}{1723} = 1.74
4. ORGANIZATION STRUCTURE OF THE PROPOSED PROJECT
Organization structure has to be developed to maximize the organizational performance and satisfaction. Every member of the organization has a job description that says what he is supposed to do. The organization has rules telling what all other employees can and cannot do. There is an authority hierarchy that defines who everyone's boss is and the formal channel through which the communications are to pass. These are the examples of structural characteristic. Before development of the structure, the components, forcing factors, types of organization structure and their trait are studied in detail.

4.1. COMPONENTS OF ORGANIZATION STRUCTURE

An organization's structure is made up three components.

1. Complexity
2. Formalization
3. Centralization

1. Complexity:

Complexity can be again broken down into three parts, Horizontal differentiation, Vertical differentiation and Spatial differentiation. 

Horizontal Differentiation considers the degree of horizontal
separation between units, i.e., the nature of task they perform, and their education and training. It can be stated that the larger the number of different occupations within an organization that require specialized knowledge and skills, the more horizontally complex the organization is.

**Vertical Differentiation** refers to the depth of the structure. As differentiation increases, and hence complexity, as the number of hierarchical levels in the organization also increases. The more levels that exist between top management and operatives, the greater the potential for communication distortion, the more difficult it is to coordinate the decisions of managerial personnel, and the more difficult it is for the top management to oversee closely the actions of operatives.

**Spatial Differentiation.** An organization can perform the same activities with the same horizontal and vertical arrangement in multiple locations. Yet, this existence of multiple locations increases complexity. Therefore, the third element in complexity is spatial differentiation, which refers to the degree to which the location of an organization's offices, plants, and personnel are geographically dispersed.
2. **Formalization**:
Formalization refers to the degree to which job within the organization are standardized. If the job is highly formalized, then there are explicit job descriptions, many organizational rules, and clearly defined procedures covering work process in organizations. Where formalization is low, job behaviors are relatively nonprogrammed and employee have a great deal of freedom to exercise discretion in their work. It is generally true that the narrowest of unskilled jobs - those that are the simplest and the most repetitive in nature - are most amenable to high degrees of formalization. The greater the professionalization of a job, the less likely it is to be highly formalized.

Formalization not only differs with whether the jobs are unskilled or professional, but also by level in the organization and by functional department. Employees higher in the organization are increasingly involved in activities that are less repetitive and require more unique solutions. The discretion that managers have increased as they move up the hierarchy so that formalization is lowest at the highest level of the organization.

3. **Centralization**:
Centralization refers to the degree to which decision making is concentrated at a single point in the organization. Typically, it
is said that if top management makes the organization's key decisions with little or no input from lower-level personnel, then the organization is centralized. In contrast, the more that lower-level personnel provide input or are actually given the discretion to make decisions, the more decentralized the organization.

4.2. INFLUENCING FACTORS:

Before studying the various forms of structure, the factors and forces that influence the form are to be studied. Following are the major influencing forces:

Size:
When size increases, an organization hires more operative employees, it will attempt to take advantage of the economic benefits from specialization. The result will be increased horizontal differentiation. Grouping like functions together will facilitate intergroup efficiencies, but will cause intergroup relations to suffer as each performs its different activities. Management, therefore, will need to increase vertical differentiation to coordinate horizontal differentiated unit. This expansion in size is also likely to result in spatial differentiation. All of these will increase the complexity.
Technology

The term technology refers to how an organization transfers its inputs to outputs. Every organization has one or more technologies for converting financial, human, and physical resources into products or services. For instance, a car manufacturing organization predominantly uses an assembly-line process to make its products. On the other hand, colleges may use a number of instruction technologies—e.g., the popular formal lecture method, the case analysis method, the experimental method, the programmed learning method, and so forth. The technology tends toward either routine or non-routine activities.

Technology has a strong relationship with the organization structure. The routine technology is positively associated with low complexity. The greater the routineness, the fewer the number of occupational groups. Similarly, as the work becomes more sophisticated, customized, and non-routine, more problems occur that require management's attention. Closer supervision results and, with it, more vertical levels are necessary in the structure. The technology formalization relationship is stronger. Routines to be associated with the presence of rule of manuals, job descriptions, and other formalized documentation.

Routine technologies should be associated with centralized control if there is a minimum of rules and regulation. However, if formalization is high, routine technology can be accompanied by
decentralization. So, one would predict that routine technology would lead to centralization, but only if formalization is low.

Environment

An organization's environment represents anything outside the organization itself. The environment-structure relationship has received a large amount of attention. The reason is simple: Organization must adapt to their environment if they are to survive. They must identify and follow their environments, sense changes in those environments, and make appropriate adjustments as necessary. The degree of environmental uncertainty is the determinant of structure. If uncertainty is high, the organization will be designed along flexible lines in order to adapt to rapid changes. If uncertainty is low, management will opt for a structure that will be most efficient and offer the highest degree of managerial control—characterized by high complexity, high formalization, and centralization.

Power Control

The power control explanation states that an organization's structure is the result of a power struggle by internal constituencies who are seeking to further their interests. Like all decision in an organization, the structural decision is not fully rational. Managers do not necessarily choose those alternatives
that will maximize the organization's interest.
The power control, therefore, argues that those in power will
choose a structure that will maintain or enhance their control.

4.3 FORMS OF STRUCTURE:
It is possible, by mixing and matching the three structural
dimensions, to form a variety of structural forms. The more popular
of these forms are:
1. Simple structure
2. Bureaucratic structure
3. Functional structure
4. Product structure
5. Adhocratic structure

All the forms of structure may again be classified into two general
models: Mechanistic structure and Organic structure.
Mechanistic structure is characterized by high complexity, high
formalization, and centralization.
An Organic structure is just opposite. It is flexible and adaptive,
characterized by low complexity, low formalization, and
decentralization. No organization is purely mechanistic or purely
organic.
The Simple structure.

It is low in complexity, has little formalization, and has authority centralized in a single person. Following example shows a simple structure.

Following five conditions are noted when usually simple structure takes place:

1. When organization is small or is in its formative stage of development.
2. When the environment is rapidly changing but is easily comprehensible.
3. When organization faces high hostility or crisis.
4. When senior manager is also the owner.
5. When the senior executive either wants to hoard power or his subordinates thrust the power upon him.

The Bureaucratic structure.

This structure is highly complex, highly formalized. Whether they are centralized or decentralized typically depends on the type of people they employ. If employees are professionals or hold specialized skills, the bureaucracy will be decentralized. Otherwise, authority is typically kept centralized.

It has got the following characteristics:

1. Division of labor.
2. Well defined authority and responsibility.
3. High formalization
4. Impersonal nature.
5. Employment decisions based on merit
6. Career tracks for employees.
7. Distinct separations of members' organizational and personal lives.

The Functional Structure

The distinguishing feature of the functional structure is that similar and related occupational specialties are grouped together. Activities such as marketing, accounting, manufacturing and personnel are grouped under a functional head. The functional structure maximizes the economics from specialization. It performs best with single product or service then multiproduct.

The Product structure.

In addition to organizing by function, the product structure organizes as per product lines. For example the product manager is responsible for all facets surrounding the product. Instead of the marketing manager having fifteen product lines to oversee, each product structure will have its own marketing manager with sole responsibility for his or her division's product.
The Adhocratic Structure.

The adhocratic structure is an organic type, it is essentially a flexible, adaptive, responsive system organized around unique problems to be solved by relative strangers with diverse professional skills.
4.4 ANALYSIS OF THE DESIGNED STRUCTURE

Designed organization structure for this project is a combination of functional and product structure. All the functional groups like marketing, commerce and finance, production, engineering, quality control and production planning and control are grouped together. In this way it is a functional type of structure but again marketing department has got individual sales man on product basis and in the assembly line different products are produced by different groups of workers and supervisors, here it is a case of product structure.

The proposed organization would produce products with some degree technical flavored and would require technically skilled and specialized personnel; thus the structure would become complex to some degree and certain degree of horizontal and vertical differentiation would exist.

Due to the technology content in the production activity it would have a certain extent of routine and repetitive tasks. This would justify more of a formalized structure in characteristic. Decision making has been decentralized to the functional groups.

In this organization structure " works planning " department will work as staff department. They don't have any command capacity but
Fig No. 54
Designed Organization Structure.
they develop the production plan, machine loading, time and motion study or work and set up the quality criteria etc. they have indirect form of decision making capacity. Whereas production department would do routine job of production, as per schedule made by production planning and control department.
5. FINANCIAL ANALYSIS OF THE PROPOSED PROJECT
3.1 INTRODUCTION

Financial analysis of the proposed project was done to investigate the economic feasibility of the project. It was carried out in details. The flow diagram of financial analysis showed the various steps of the mathematical manipulation and analysis.

The above stated financial analysis consists of following estimation, evaluation calculation and analysis:

1. Project cost
2. Sales estimate (price and quantity)
3. Raw material calculation
4. Production cost
5. Administrative and selling expense
6. Projected income statement
7. Cash flow analysis
8. Break even analysis
9. Investment profitability analysis
10. Net present value method
11. Internal rate of return.

5.2 FLOW DIAGRAM OF FINANCIAL ANALYSIS:

In the flow diagram an attempt was made to show the various steps of the above mentioned estimate, mathematical manipulation and analysis, which is shown in the following figure.
FLOW DIAGRAM OF FINANCIAL ANALYSIS

Following flow diagram shows the steps of the financial analysis were calculated in the chapter.

PROJECT COST → SALES ESTIMATE PRICE AND QUANTITY → PRODUCTION COST → RAW MATERIAL CALCULATION

ADMINISTRATIVE AND SELLING EXPENSE → PROJECTED INCOME STATEMENT

PROJECTED INCOME STATEMENT → CASH FLOW ANALYSIS

CASH FLOW ANALYSIS → BREAK EVEN ANALYSIS

INVESTMENT PROFITABILITY ANALYSIS

<table>
<thead>
<tr>
<th>NET PRESENT VALUE METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEARLY NET CASH INFLOW</td>
</tr>
<tr>
<td>YEARLY NET CASH OUTFLOW</td>
</tr>
<tr>
<td>NET PRESENT VALUE OF THE PROJECT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERNAL RATE OF RETURN METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERNAL RATE OF RETURN CALCULATION</td>
</tr>
</tbody>
</table>
5.3 **PROJECT COST**

Project cost has been estimated after being thorough survey of various cost elements of the project meticulously. Project cost is shown in details in the table 6.1.

**Land and building**: In this project the land and building are rented on long term lease basis, instead of own purchased and construction one. Here advance for lease rent is considered as the fixed cost for the project.

**Machinery and equipment**: Machineries and equipments are selected by thorough study of the different production processes and their technological requirements. The prices are obtained for local and foreign machineries and equipments through correspondence. The detailed costs of the machineries and equipments are shown in ANNEXURE V. The freight and insurance cost are all included in the cost of machineries and equipments. The duty and taxes have been estimated according to the present tariff rate of the Government. Installation cost of the machineries include the cost of foundation and grouting for heavy machines, compressed air line design and construction cost, water line construction cost etc.
**Electrical Installation:**

Power substation cost has been estimated on the basis of the quotations received for the equipments which are approved by the Power Development Board of Bangladesh.

A detailed electrical wiring plan was made according to plant layout, and thus the cost of Electrical wiring has been estimated.

**Furniture, fixture and office equipments:**

Cost of the furniture and office equipments was assessed by analyzing the office layout, organogram, information system and product mix.

**Preliminary and pre-operation cost:**

This cost involves the travelling and visits for procurement of machines and raw material sourcing and wages and salaries for first two months during installation period.

**Working capital:**

It is the capital required to run a factory for one order, which would include the wages salaries, rent, utilities cost, raw material cost for one cycle and other miscellaneous cost. The cycle period is assumed to be three months.
<table>
<thead>
<tr>
<th>SL NO</th>
<th>PARTICULARS</th>
<th>COST IN TAKA</th>
<th>COST IN TAKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BUILDING (Advance against Rent)</td>
<td>720,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MACHINERIES &amp; EQUIPMENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>IMPORTED MACHINERIES</td>
<td>11,577,926</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>IMPORT DUTY AND CLEARING C</td>
<td>2,335,596</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>L/C COMMISSION, INSURANCE PRE-SHIPMENT INSPECTION ETC.</td>
<td>233,559</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>INSTALLATION OF MACHINERIES</td>
<td>275,000</td>
<td>14,522,072</td>
</tr>
<tr>
<td>3</td>
<td>ELECTRICAL INSTALLATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>POWER SUBSTATION 200 KVA</td>
<td>930,000</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>ELECTRICAL WIRING</td>
<td>165,000</td>
<td>1,095,000</td>
</tr>
<tr>
<td>4</td>
<td>FURNITURE, FIXTURE AND OFFICE EQUIPMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>OFFICE FURNITURE</td>
<td>160,000</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>FACTORY FURNITURE</td>
<td>180,000</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>COMPUTER &amp; PERIPHERALS</td>
<td>175,000</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>TELEPHONE</td>
<td>30,000</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>CEILING FAN</td>
<td>72,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PRELIMINARY AND PRE-OPERATION COST</td>
<td></td>
<td>350,000</td>
</tr>
<tr>
<td>6</td>
<td>WORKING CAPITAL</td>
<td></td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

**TOTAL PROJECT COST** | **TAKA** | **18,304,072**
5.4 SALES ESTIMATE

Video cassette:
From the market survey it was found that there is a yearly consumption of video cassette over 580,000 pcs. None of them are completely manufactured locally. They are either manufactured from complete knock down (ckd) or Semi knock down (skd) imported parts and components. As a completely manufactured product locally the cost would be competitive and take a major market share. Fairly 360,000 pcs video cassettes at Tk.80.00 per piece sales could be estimated for the first year.

Mini fan:
There are no manufacturer for mini fans in the country. Only small amount of mini fan are assembled from skd and ckd condition. There is a potential market of about 40,000 pcs per year, and would be easily sold at Tk.280.00 per piece.

Toys:
Although there are one or two toy manufacturer in the country, the market demand is very high. An estimate of 600,000 pcs of different types of toys can be made. A conservative sales estimate for the project has been made shown in the table 6.2.
## SALES ESTIMATE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT PRC IN TAKA</th>
<th>QTY</th>
<th>AMOUNT IN TAKA</th>
<th>TAKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIDEO CASSETTE</td>
<td>80.00</td>
<td>360,000</td>
<td>28,800,000</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL VIDEO CASSETTE SALES</td>
<td></td>
<td></td>
<td></td>
<td>28,800,000</td>
</tr>
<tr>
<td>MINI FAN SALES</td>
<td>260.00</td>
<td>21,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL MINI FAN SALES</td>
<td></td>
<td></td>
<td></td>
<td>5,880,000</td>
</tr>
<tr>
<td>SALES FORECAST OF TOYS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUZZLE</td>
<td>25.00</td>
<td>10,000</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td>BUILDING BLOCK</td>
<td>45.00</td>
<td>35,000</td>
<td>1,575,000</td>
<td></td>
</tr>
<tr>
<td>CARS</td>
<td>38.00</td>
<td>100,000</td>
<td>3,800,000</td>
<td></td>
</tr>
<tr>
<td>DOLL</td>
<td>35.00</td>
<td>80,000</td>
<td>2,800,000</td>
<td></td>
</tr>
<tr>
<td>LETTER SET</td>
<td>46.00</td>
<td>50,000</td>
<td>2,300,000</td>
<td></td>
</tr>
<tr>
<td>GAMES</td>
<td>68.00</td>
<td>25,000</td>
<td>1,700,000</td>
<td></td>
</tr>
<tr>
<td>PISTOL</td>
<td>40.00</td>
<td>15,000</td>
<td>600,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>315,000 PCS</td>
</tr>
<tr>
<td>TOTAL TOYS SALES</td>
<td></td>
<td></td>
<td></td>
<td>13,025,000</td>
</tr>
<tr>
<td>TOTAL SALES</td>
<td></td>
<td></td>
<td></td>
<td>47,705,000</td>
</tr>
</tbody>
</table>
5.5. **SALES PLAN:**

The proposed production capacity of video cassette, mini fan and toys are as below:

<table>
<thead>
<tr>
<th>Product</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video cassette</td>
<td>500,000 pcs per year.</td>
</tr>
<tr>
<td>Mini fan</td>
<td>30,000 pcs per year.</td>
</tr>
<tr>
<td>Toys</td>
<td>450,000 pcs per year.</td>
</tr>
</tbody>
</table>

It may be assumed that, 70% of the maximum production capacity could be utilized in the first year and it will increase 10% each year up to possible maximum production volume.

Sales plan of next four years is shown in the table no 6.3.
# TABLE 8.3

## SALES PLAN

<table>
<thead>
<tr>
<th>ITEM</th>
<th>1ST YR SALES</th>
<th>2ND YR SALES</th>
<th>3RD YR SALES</th>
<th>4TH YR SALES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPACITY UTILIZATION</strong></td>
<td>70%</td>
<td>80%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>VIDEO CASSETTE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALES</td>
<td>28,800,000</td>
<td>32,914,286</td>
<td>37,028,571</td>
<td>41,142,857</td>
</tr>
<tr>
<td>QTY</td>
<td>360,000</td>
<td>411,420</td>
<td>462,857</td>
<td>514,286</td>
</tr>
<tr>
<td>MINI FAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALES</td>
<td>5,880,000</td>
<td>6,720,000</td>
<td>7,560,000</td>
<td>8,400,000</td>
</tr>
<tr>
<td>QTY</td>
<td>21,000</td>
<td>24,000</td>
<td>27,000</td>
<td>30,000</td>
</tr>
<tr>
<td>TOYS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALES</td>
<td>13,025,000</td>
<td>14,885,714</td>
<td>16,746,420</td>
<td>18,607,143</td>
</tr>
<tr>
<td>QTY</td>
<td>315,000</td>
<td>360,000</td>
<td>405,000</td>
<td>450,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>47,705,000</td>
<td>54,520,000</td>
<td>61,335,000</td>
<td>68,150,000</td>
</tr>
</tbody>
</table>
5.5. RAW MATERIAL CALCULATION

Raw material calculation for video cassettes, mini fans and toys was done as per bill of material of each product and estimated sales quantity. The prices of raw materials are estimated from local and international market prices as per availability. The quantity was calculated with 3 percent wastage allowance. Detailed raw material costing is shown in the following Table 6.4.
### TABLE 6.4

#### RAW MATERIAL CALCULATION

#### RAW MATERIAL FOR MINI FAN

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>UNT PRCT TK</th>
<th>QTY</th>
<th>UNIT</th>
<th>AMOUNT TK</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS PLASTIC COMPOUND</td>
<td>51,660</td>
<td>3</td>
<td>TON</td>
<td>154,980</td>
</tr>
<tr>
<td>SILICON SHEET</td>
<td>25,400</td>
<td>4</td>
<td>TON</td>
<td>101,600</td>
</tr>
<tr>
<td>STEEL BAR 9 MM</td>
<td>40,000</td>
<td>1</td>
<td>TON</td>
<td>32,000</td>
</tr>
<tr>
<td>BUSH</td>
<td>7</td>
<td>30,000</td>
<td>PCS</td>
<td>210,000</td>
</tr>
<tr>
<td>COPPER WIRE</td>
<td>460</td>
<td>3,000</td>
<td>KG</td>
<td>1,380,000</td>
</tr>
<tr>
<td>ALUMINIUM BRACKET</td>
<td>25</td>
<td>30,000</td>
<td>PCS</td>
<td>750,000</td>
</tr>
<tr>
<td>SCREWS</td>
<td>8</td>
<td>15000</td>
<td>SETS</td>
<td>120,000</td>
</tr>
</tbody>
</table>

**TOTAL** 2,748,580

#### RAW MATERIAL OF VIDEO CASSETTE

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>UNT PRCT TK</th>
<th>QTY</th>
<th>UNIT</th>
<th>AMOUNT TK</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS PLASTIC COMPOUND</td>
<td>51,660</td>
<td>56</td>
<td>TON</td>
<td>2,682,628</td>
</tr>
<tr>
<td>SMALL PLASTIC PARTS</td>
<td>8</td>
<td>360,000</td>
<td>SET</td>
<td>2,680,000</td>
</tr>
<tr>
<td>SMALL METALLIC PARTS</td>
<td>7</td>
<td>360,000</td>
<td>SET</td>
<td>2,520,000</td>
</tr>
<tr>
<td>MAGNETIC TAPE</td>
<td>42</td>
<td>288,000,000</td>
<td>1000FT</td>
<td>12,096,000</td>
</tr>
<tr>
<td>PLASTIC COVER</td>
<td>3</td>
<td>360,000</td>
<td>PC</td>
<td>1,080,000</td>
</tr>
</tbody>
</table>

**TOTAL** 21,453,628
# RAW MATERIAL FOR TOYS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>UNIT PRICE TK</th>
<th>QTY</th>
<th>UNIT</th>
<th>AMOUNT TK</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS PLASTIC COMPOUND</td>
<td>51,660</td>
<td>3</td>
<td>TON</td>
<td>154,980</td>
</tr>
<tr>
<td>HIGH IMPACT POLYESTER</td>
<td>34,686</td>
<td>27</td>
<td>TON</td>
<td>940,658</td>
</tr>
<tr>
<td>PVC SHEET .2MM THICK</td>
<td>3,700</td>
<td>100</td>
<td>ROLL</td>
<td>370,000</td>
</tr>
<tr>
<td>PAPER COVER</td>
<td>6</td>
<td>315,000</td>
<td>PCS</td>
<td>1,827,000</td>
</tr>
<tr>
<td>PRINTED STICKER</td>
<td>4</td>
<td>315,000</td>
<td>PCS</td>
<td>1,102,500</td>
</tr>
</tbody>
</table>

**Total**                                                                 4,395,338
5.7. PLANNED RAW MATERIAL REQUIREMENT

Raw material estimate was done as per sales estimated for the next four years. Cost of the raw material was considered to be constant during the next four years. Forecasted raw material cost estimate is shown in the following Table 6.5.
## Table 6.5

**Forecasted Raw Material Consumption**

<table>
<thead>
<tr>
<th>Total Raw Material</th>
<th>Capacity Utilization</th>
<th>1st Year (Taka)</th>
<th>2nd Year (Taka)</th>
<th>3rd Year (Taka)</th>
<th>4th Year (Taka)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70%</td>
<td>80%</td>
<td>90%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>MINI FAN</td>
<td>2,748,580</td>
<td>3,141,234</td>
<td>3,533,889</td>
<td>3,926,543</td>
<td></td>
</tr>
<tr>
<td>VIDEO CASSETTE</td>
<td>21,458,626</td>
<td>24,524,146</td>
<td>27,569,655</td>
<td>30,655,183</td>
<td></td>
</tr>
<tr>
<td>TOYS</td>
<td>4,395,338</td>
<td>5,023,243</td>
<td>5,651,148</td>
<td>6,279,054</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>26,602,546</td>
<td>32,688,624</td>
<td>36,774,702</td>
<td>40,880,760</td>
<td></td>
</tr>
</tbody>
</table>
5.8. **PRODUCTION COST ANALYSIS**

Following analysis shows the production cost would incur in next four years to produce the following quantity of goods.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIDEO CASSETTE</td>
<td>360,000</td>
<td>411,429</td>
<td>462,857</td>
<td>514,286</td>
</tr>
<tr>
<td>MINI FAN</td>
<td>21,000</td>
<td>24,000</td>
<td>27,000</td>
<td>30,000</td>
</tr>
<tr>
<td>TOYS</td>
<td>315,000</td>
<td>360,000</td>
<td>405,000</td>
<td>450,000</td>
</tr>
</tbody>
</table>

Detailed production cost of four years of the above quantities of production are shown in the following Table 5.6.

Depreciation of machineries and office equipments is calculated using straight-line method for a life cycle of ten years with no salvage value.

Wages and salaries are shown in detailed in annexure IV.
### TABLE 6.6

**PRODUCTION COST**

<table>
<thead>
<tr>
<th>COST HEAD</th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAW MATERIAL</td>
<td>28,602,546</td>
<td>32,688,624</td>
<td>36,774,702</td>
<td>40,860,780</td>
</tr>
<tr>
<td>PACKING MATERIAL</td>
<td>810,840</td>
<td>926,574</td>
<td>1,042,509</td>
<td>1,158,343</td>
</tr>
<tr>
<td>SPARES</td>
<td>60,000</td>
<td>66,000</td>
<td>72,000</td>
<td>78,000</td>
</tr>
<tr>
<td>WAGES &amp; SALARIES</td>
<td>3,699,600</td>
<td>4,063,560</td>
<td>4,476,516</td>
<td>4,924,168</td>
</tr>
<tr>
<td>POWER/WATER</td>
<td>540,000</td>
<td>594,000</td>
<td>648,000</td>
<td>702,000</td>
</tr>
<tr>
<td>RENT</td>
<td>720,000</td>
<td>720,000</td>
<td>720,000</td>
<td>720,000</td>
</tr>
<tr>
<td>FREIGHT</td>
<td>145,000</td>
<td>159,500</td>
<td>174,000</td>
<td>188,500</td>
</tr>
<tr>
<td>INSURANCE ON STOCK</td>
<td>35,753</td>
<td>40,861</td>
<td>45,966</td>
<td>51,076</td>
</tr>
<tr>
<td>DEPRECIATION OF MACHINERY AND OFFICE EQUIPMENT</td>
<td>1,560,000</td>
<td>1,560,000</td>
<td>1,560,000</td>
<td>1,560,000</td>
</tr>
<tr>
<td>REPAIR AND MAINTENANCE</td>
<td>10,000</td>
<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
</tr>
<tr>
<td>OTHER OVERHEAD</td>
<td>120,000</td>
<td>130,000</td>
<td>135,000</td>
<td>140,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>36,303,739</td>
<td>40,961,219</td>
<td>45,655,695</td>
<td>50,390,866</td>
</tr>
</tbody>
</table>
5.9. ADMINISTRATIVE AND SELLING EXPENSE

This expense includes the director's remuneration and marketing expenses. Here a rough estimate was made for advertising, giveaways, distributors' commission etc. Details are shown in the following Table 6.7.

5.10. PROJECTED INCOME STATEMENT

The projected income statement was made on the basis of production cost, sales revenue and selling and administrative expenses. This project would enjoy a tax holiday for a period of five years. Bond purchased thirty percent of profit. The details are shown in the following Table 7.8.
<table>
<thead>
<tr>
<th>COST HEAD</th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIRECTOR'S RENUMERA</td>
<td>480,000</td>
<td>480,000</td>
<td>480,000</td>
<td>480,000</td>
</tr>
<tr>
<td>ADMIN. SALARIES</td>
<td>600,000</td>
<td>630,000</td>
<td>660,000</td>
<td>690,000</td>
</tr>
<tr>
<td>POSTAGE AND TELEX &amp;</td>
<td>890,000</td>
<td>960,000</td>
<td>960,000</td>
<td>960,000</td>
</tr>
<tr>
<td>STATIONERY AND PRINTING</td>
<td>120,000</td>
<td>126,000</td>
<td>132,000</td>
<td>138,000</td>
</tr>
<tr>
<td>TRAVELLING AND CONV</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>SELLING AND DISTRIBUTION</td>
<td>150,000</td>
<td>157,500</td>
<td>165,000</td>
<td>172,500</td>
</tr>
<tr>
<td>PRODUCT DEVELOPMENT</td>
<td>150,000</td>
<td>157,500</td>
<td>165,000</td>
<td>172,500</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td>100,000</td>
<td>100,000</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2,760,000</td>
<td>2,811,000</td>
<td>2,862,000</td>
<td>2,913,000</td>
</tr>
</tbody>
</table>
## Table 6.8

**Projected Income Statement**

<table>
<thead>
<tr>
<th>PARTICULARS</th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Revenue</td>
<td>47,705,000</td>
<td>54,520,000</td>
<td>61,335,000</td>
<td>68,150,000</td>
</tr>
<tr>
<td>Less Production Cost</td>
<td>36,303,739</td>
<td>40,961,219</td>
<td>45,855,655</td>
<td>50,930,866</td>
</tr>
<tr>
<td>Gross Profit</td>
<td>11,401,261</td>
<td>13,558,781</td>
<td>15,679,305</td>
<td>17,750,134</td>
</tr>
<tr>
<td>Less Admin. &amp; Selling</td>
<td>2,760,000</td>
<td>2,811,000</td>
<td>2,882,000</td>
<td>2,913,000</td>
</tr>
<tr>
<td>Net Profit Before Tax and Interest</td>
<td>8,641,261</td>
<td>10,747,781</td>
<td>12,817,305</td>
<td>14,846,134</td>
</tr>
<tr>
<td>Financial Expense</td>
<td>1,500,000</td>
<td>1,500,000</td>
<td>1,500,000</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Net Profit Before Tax</td>
<td>7,141,261</td>
<td>9,247,781</td>
<td>11,317,305</td>
<td>13,346,134</td>
</tr>
<tr>
<td>Tax: Tax Holiday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Profit After Tax</td>
<td>7,141,261</td>
<td>9,247,781</td>
<td>11,317,305</td>
<td>13,346,134</td>
</tr>
<tr>
<td>Less Bond Purchase S</td>
<td>2,142,378</td>
<td>2,774,334</td>
<td>3,395,192</td>
<td>4,003,840</td>
</tr>
<tr>
<td>Net Profit After Bond</td>
<td>4,998,883</td>
<td>6,473,447</td>
<td>7,922,114</td>
<td>9,342,294</td>
</tr>
<tr>
<td>Return on Bonds</td>
<td></td>
<td>230,306</td>
<td>520,547</td>
<td>633,530</td>
</tr>
<tr>
<td>Net Profit</td>
<td>4,998,883</td>
<td>6,703,753</td>
<td>8,450,660</td>
<td>10,235,823</td>
</tr>
</tbody>
</table>
5.11. CASH FLOW ANALYSIS

In the cash flow analysis, the depreciation value is again added to the net profit and liabilities considered to be nil. In application, bond is purchased and financial expenses such as interests and amortized value are paid off as shown in Table 6.9. Cash surplus is observed. Details are shown in the table.
### TABLE 6.9

**CASH FLOW ANALYSIS**

#### A. SOURCE

<table>
<thead>
<tr>
<th>PARTICULARS</th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>NET PROFIT</td>
<td>8,641,261</td>
<td>10,747,761</td>
<td>12,817,305</td>
<td>14,846,134</td>
</tr>
<tr>
<td>DEPRECIATION</td>
<td>1,560,000</td>
<td>1,560,000</td>
<td>1,560,000</td>
<td>1,560,000</td>
</tr>
<tr>
<td>RETURN ON BOND</td>
<td></td>
<td>230,306</td>
<td>528,547</td>
<td>633,550</td>
</tr>
<tr>
<td>CURRENT LIABILITIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL SOURCE OF FUN</strong></td>
<td>10,201,261</td>
<td>12,538,087</td>
<td>14,905,852</td>
<td>17,299,664</td>
</tr>
</tbody>
</table>

#### B. APPLICATION

<table>
<thead>
<tr>
<th>PARTICULARS</th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOND PURCHASE</td>
<td>2,142,378</td>
<td>2,774,334</td>
<td>3,395,192</td>
<td>4,003,840</td>
</tr>
<tr>
<td>FINANCIAL EXPENSES</td>
<td>1,500,000</td>
<td>1,500,000</td>
<td>1,500,000</td>
<td>1,500,000</td>
</tr>
<tr>
<td>FIXED INVESTMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURRENT ASSET</td>
<td>Not significant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL APPLICATION</strong></td>
<td>3,642,378</td>
<td>4,274,334</td>
<td>4,895,192</td>
<td>5,503,840</td>
</tr>
</tbody>
</table>

**CASH SURPLUS (A-B)**

<table>
<thead>
<tr>
<th></th>
<th>1ST YEAR</th>
<th>2ND YEAR</th>
<th>3RD YEAR</th>
<th>4TH YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6,559,863</td>
<td>6,263,753</td>
<td>10,010,660</td>
<td>11,795,823</td>
</tr>
</tbody>
</table>
5.12. **BREAK EVEN ANALYSIS**

The break even point (BEP) in terms of sales revenue has been calculated. Following assumptions have been considered in calculating the BEP Sales:

a) Sales has been assumed 70% of the production capacity, which is planned for first year production.

b) As the project has multiple products, the product mix is considered as basic product and the sales revenue is taken from the total first year sales of the sales plan.
# Break Even Analysis

**Total Sales of the First Year:** 47,705,000

<table>
<thead>
<tr>
<th>Cost Head</th>
<th>Fixed Cost</th>
<th>Variable Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Material</td>
<td>28,602,546</td>
<td></td>
</tr>
<tr>
<td>Packing Material</td>
<td>810,840</td>
<td></td>
</tr>
<tr>
<td>Spares</td>
<td>60,000</td>
<td></td>
</tr>
<tr>
<td>Service Utilities</td>
<td>540,000</td>
<td></td>
</tr>
<tr>
<td>Repair &amp; Maintenance</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>720,000</td>
<td></td>
</tr>
<tr>
<td>Insurance on Stock</td>
<td></td>
<td>35,753</td>
</tr>
<tr>
<td>Depreciation</td>
<td>1,560,000</td>
<td></td>
</tr>
<tr>
<td>Other Overhead</td>
<td></td>
<td>120,000</td>
</tr>
<tr>
<td>Wages and Salaries</td>
<td>600,000</td>
<td>3,699,600</td>
</tr>
<tr>
<td>Directors' Remuneration</td>
<td>480,000</td>
<td></td>
</tr>
<tr>
<td>Postages/TLX/TEL</td>
<td>980,000</td>
<td></td>
</tr>
<tr>
<td>Stationeries &amp; Printi</td>
<td>50,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Travelling and Conv</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Product Development</td>
<td>150,000</td>
<td></td>
</tr>
<tr>
<td>Financial Cost</td>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>L/C Comm/Insurance/ETC</td>
<td></td>
<td>300,000</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td>100,000</td>
</tr>
</tbody>
</table>

**Total:** 4,670,000 34,448,739
PROFIT VOLUME RATIO

\[
\text{SALES REV. - VAFL COST} \quad \frac{\text{SALES REVENUE}}{47,705,000 - 34,448,739} \quad 47,705,000
\]

\[= \quad \text{P.V RATIO} \quad 0.278 \]

BREAK EVEN POINT (SALES)

\[
\frac{\text{FIXED COST}}{\text{P.V RATIO}} \quad = \quad \frac{4,670,000}{0.278}
\]

\[= \quad \text{BEP SALES} \quad 16,805,621 \quad = \quad 35.23\% \]

BEP (CASH)

\[
\frac{\text{FIXED COST} - \text{DEPRECIATION}}{\text{P.V RATIO}}
\]

\[
\frac{4,670,000 - 156,000}{0.277879909186}
\]

\[= \quad \text{BEP (CASH)} \quad 11,191,865 \quad = \quad 23.46\% \]
5.13. INVESTMENT PROFITABILITY ANALYSIS

The Investment Profitability Analysis is the measurement of the profitability of the resources put into a project, more directly the return on the capital no matter what the sources of financing. Thus, investment profitability analysis is an assessment of the potential earning power of the resources committed to a project without taking into account the financial transaction occurring during the project's life.

Different methods may be used as a basis on which to assess the investment profitability of a project. In this study following two methods were used in analyzing the investment profitability of the said project.

i) Net present value

ii) Internal rate of return

5.13.1. Net Present Value

The net present value of a project is defined as the difference between the present values of its future cash inflows and outflows. This means that all annual cash flows should be discounted to the
zero point of time at a predetermined discount rate.

The expression is

\[ PV = D \times \frac{1}{(1 + i)^n} \]

where

- \( PV \) = Present value
- \( D \) = Future sum of money
- \( i \) = interest rate per year
- \( n \) = number of years

The Net Present Value (NPV) was determined by the summation of the present values of each year net cash flow.

The net cash inflow is shown in the Table 6.11 and net cash outflow is shown in the Table 6.12.

The net present value (NPV) was calculated and shown in Table 5.13.

where

- \( n \) = project life considered 10 years.
- \( i \) = interest rate per year considered 18%

In the analysis it is found that net present value is much greater than the invested amount. Which evidently shows that the project is viable.
## TABLE NO 6.11

**YEARLY NET CASH INFLOW.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales</th>
<th>Working capital</th>
<th>Salvage value</th>
<th>Bond interest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>47,705,000</td>
<td></td>
<td></td>
<td></td>
<td>47,705,000</td>
</tr>
<tr>
<td>2</td>
<td>54,520,000</td>
<td>230,306</td>
<td></td>
<td></td>
<td>54,750,306</td>
</tr>
<tr>
<td>3</td>
<td>61,335,000</td>
<td>528,547</td>
<td></td>
<td></td>
<td>61,863,547</td>
</tr>
<tr>
<td>4</td>
<td>68,150,000</td>
<td>893,530</td>
<td></td>
<td></td>
<td>69,043,530</td>
</tr>
<tr>
<td>5</td>
<td>68,150,000</td>
<td>1,496,409</td>
<td></td>
<td></td>
<td>70,646,409</td>
</tr>
<tr>
<td>6</td>
<td>68,150,000</td>
<td>1,971,206</td>
<td></td>
<td></td>
<td>70,121,206</td>
</tr>
<tr>
<td>7</td>
<td>68,150,000</td>
<td>2,448,007</td>
<td></td>
<td></td>
<td>70,596,007</td>
</tr>
<tr>
<td>8</td>
<td>68,150,000</td>
<td>2,920,806</td>
<td></td>
<td></td>
<td>71,070,806</td>
</tr>
<tr>
<td>9</td>
<td>68,150,000</td>
<td>3,395,605</td>
<td></td>
<td></td>
<td>71,545,605</td>
</tr>
<tr>
<td>10</td>
<td>68,150,000</td>
<td>1,000,000</td>
<td>619,204</td>
<td>3,670,404</td>
<td>73,839,608</td>
</tr>
</tbody>
</table>

|           | 660,182,025 |
### Table No 6.12

#### Yearly Net Cash Outflow

<table>
<thead>
<tr>
<th>Year</th>
<th>Project cost</th>
<th>Cost of Prod</th>
<th>Admin &amp; Sell exps</th>
<th>Finance Exp Bond Purchase</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>18,304,072</td>
<td>2,760,000</td>
<td>1,500,000</td>
<td>2,142,378</td>
<td>40,608,450</td>
</tr>
<tr>
<td>1</td>
<td>36,303,739</td>
<td>2,516,286</td>
<td>1,500,000</td>
<td>2,448,432</td>
<td>53,828,450</td>
</tr>
<tr>
<td>2</td>
<td>40,961,219</td>
<td>3,548,571</td>
<td>1,500,000</td>
<td>2,754,486</td>
<td>56,894,264</td>
</tr>
<tr>
<td>3</td>
<td>36,303,739</td>
<td>2,760,000</td>
<td>1,500,000</td>
<td>2,142,378</td>
<td>40,608,450</td>
</tr>
<tr>
<td>4</td>
<td>40,961,219</td>
<td>3,548,571</td>
<td>1,500,000</td>
<td>2,754,486</td>
<td>53,828,450</td>
</tr>
<tr>
<td>5</td>
<td>45,655,695</td>
<td>3,942,857</td>
<td>1,500,000</td>
<td>3,060,540</td>
<td>57,854,264</td>
</tr>
<tr>
<td>6</td>
<td>50,390,866</td>
<td>3,942,857</td>
<td>1,500,000</td>
<td>3,060,540</td>
<td>58,894,264</td>
</tr>
<tr>
<td>7</td>
<td>50,390,866</td>
<td>3,942,857</td>
<td>1,500,000</td>
<td>3,060,540</td>
<td>58,894,264</td>
</tr>
<tr>
<td>8</td>
<td>50,390,866</td>
<td>3,942,857</td>
<td>1,500,000</td>
<td>3,060,540</td>
<td>58,894,264</td>
</tr>
<tr>
<td>9</td>
<td>50,390,866</td>
<td>3,942,857</td>
<td>1,500,000</td>
<td>3,060,540</td>
<td>58,894,264</td>
</tr>
<tr>
<td>10</td>
<td>50,390,866</td>
<td>3,942,857</td>
<td>1,500,000</td>
<td>3,060,540</td>
<td>58,894,264</td>
</tr>
</tbody>
</table>

Taka 574,792,724
# NET PRESENT VALUE METHOD

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Inflow</th>
<th>Cash Outflow</th>
<th>Net Cashflow</th>
<th>P/V of $1 at 18%</th>
<th>P/V of Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>18,304,072</td>
<td></td>
<td></td>
<td>1.000</td>
<td>(16,104,072.00)</td>
</tr>
<tr>
<td>1</td>
<td>47,705,000</td>
<td>42,706,117</td>
<td>4,998,883</td>
<td>0.647</td>
<td>4,234,053.69</td>
</tr>
<tr>
<td>2</td>
<td>54,750,306</td>
<td>48,963,937</td>
<td>5,666,369</td>
<td>0.718</td>
<td>4,800,812.81</td>
</tr>
<tr>
<td>3</td>
<td>61,863,547</td>
<td>53,458,752</td>
<td>8,404,794</td>
<td>0.609</td>
<td>5,118,519.54</td>
</tr>
<tr>
<td>4</td>
<td>69,043,530</td>
<td>58,894,264</td>
<td>10,149,266</td>
<td>0.516</td>
<td>5,237,021.28</td>
</tr>
<tr>
<td>5</td>
<td>69,848,409</td>
<td>58,804,264</td>
<td>10,752,145</td>
<td>0.437</td>
<td>4,699,687.54</td>
</tr>
<tr>
<td>6</td>
<td>70,121,208</td>
<td>58,894,264</td>
<td>11,226,944</td>
<td>0.370</td>
<td>4,153,969.40</td>
</tr>
<tr>
<td>7</td>
<td>70,596,007</td>
<td>58,894,264</td>
<td>11,701,743</td>
<td>0.314</td>
<td>3,674,347.40</td>
</tr>
<tr>
<td>8</td>
<td>71,070,806</td>
<td>58,894,264</td>
<td>12,176,542</td>
<td>0.266</td>
<td>3,238,860.26</td>
</tr>
<tr>
<td>9</td>
<td>71,545,805</td>
<td>58,894,264</td>
<td>12,851,341</td>
<td>0.225</td>
<td>2,846,551.80</td>
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<tr>
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<td>73,839,608</td>
<td>58,894,264</td>
<td>14,945,344</td>
<td>0.191</td>
<td>2,854,560.77</td>
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<tr>
<td></td>
<td>660,182,025</td>
<td>574,792,724</td>
<td>85,389,301</td>
<td></td>
<td>22,753,412.54</td>
</tr>
</tbody>
</table>
5.13.2. Internal rate of return:

In the internal rate of return method the discount rate is unknown, unlike the net present value method in the application of which the discount rate is given outside the project. By definition, the internal rate of return is the rate of discount that reduces the net present value of a project to zero.

When applying the internal rate of return, one starts with an assumption that \( NPV = 0 \) and tries to find out the discount rate that will make the present value of the cash inflows of the project equal to the present value of the cash outflows.

Internal rate of return calculation is shown in the table 6.14. In the study the discount rate is found 38.3%, which is much higher than the maximum interest rate prevailing in the country. Therefore the project is feasible.
## Internal Rate of Return

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NET CASH FLOW</th>
<th>NPV AT 18%</th>
<th>NPV AT 35%</th>
<th>NPV AT 39.5%</th>
<th>NPV AT 39.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(18,304,072)</td>
<td>(18,304,072)</td>
<td>(18,304,072)</td>
<td>(18,304,072)</td>
<td>(18,304,072)</td>
</tr>
<tr>
<td>1</td>
<td>4,998,863</td>
<td>4,236,941</td>
<td>3,702,876</td>
<td>3,583,428</td>
<td>3,580,862</td>
</tr>
<tr>
<td>2</td>
<td>6,666,369</td>
<td>4,602,046</td>
<td>3,666,789</td>
<td>3,435,811</td>
<td>3,430,990</td>
</tr>
<tr>
<td>3</td>
<td>8,404,794</td>
<td>5,115,417</td>
<td>3,416,062</td>
<td>3,096,025</td>
<td>3,089,376</td>
</tr>
<tr>
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<td>10,149,266</td>
<td>5,234,879</td>
<td>3,055,622</td>
<td>2,680,019</td>
<td>2,672,348</td>
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<tr>
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<td>10,752,145</td>
<td>4,698,862</td>
<td>2,397,874</td>
<td>2,035,280</td>
<td>2,028,000</td>
</tr>
<tr>
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<td>11,226,944</td>
<td>4,158,814</td>
<td>1,654,637</td>
<td>1,523,408</td>
<td>1,516,872</td>
</tr>
<tr>
<td>7</td>
<td>11,701,743</td>
<td>3,673,470</td>
<td>1,431,805</td>
<td>1,138,233</td>
<td>1,132,538</td>
</tr>
<tr>
<td>8</td>
<td>12,176,542</td>
<td>3,239,425</td>
<td>1,103,707</td>
<td>648,044</td>
<td>644,191</td>
</tr>
</tbody>
</table>

\[16,896,182 \quad 2,327,400 \quad 37,278 \quad (8,895)\]
Internal Rate of Return Calculation:
The trial and error calculation is time consuming. To avoid tedious calculation, the following formula may be used to arrive at the internal rate of return.

\[ i_r = \frac{PV(i_2 - i_1)}{PV + NV} \]

Where

\[ i_r = \text{internal rate of return} \]
\[ PV = \text{positive value of NPV at the lower discount rate}. \]
\[ NV = \text{negative value of NPV at the higher discount rate in absolute terms}. \]
\[ i_1 = \text{lower discount rate at which NPV is still positive but close to zero}. \]
\[ i_2 = \text{higher discount rate at which NPV is already negative but close to zero}. \]

\[ i_r = 38.2 + \frac{14,671(38.3 - 38.2)}{16,671 + 32,552} \]
6. CONCLUSION AND SCOPE OF FUTURE WORK
6.1 CONCLUSION

From the present work the following conclusions may be drawn:

1. In the present work a detailed market survey was done to select a product mix with certain degree of complexity in order to study the techno-economical feasibility of setting up a plastic base industry in Bangladesh.

2. Machineries for production of the selected products were selected, their working principles were analyzed and a detailed plant layout was done for their installation.

3. A locally produced manually operated injection molding machine has been modernized to be operated in a semi-automatic mode. Hydraulic and electronic control systems have been developed for this purpose.

4. Production processes for different components of plastic products have been worked out in details. An organizational structure was developed to run the industry smoothly which includes 145 personnel.

5. Financial analysis shows that net present value of the project is Tk.22,753,412 with an initial investment of Tk.18,104,072. Break
even of sales for the project is only 35.23% and internal rate of return is 38.23% which indicates the high profitability of the project.

6.2 SCOPE OF FUTURE WORK

Further study could be done on the development of cheap injection molding machine, which could be manufactured locally. In that case the structural design of the machine could be changed and the hydraulic system could be further improved.

In the field of the plastic industry a further study could be done on mold making facilities. At present CAD/CAM are widely used in developing the injection molding die design. Blow type injection molding machine may be studied further to produce products like toys and bottles etc.
REFERENCES

12. Victor L. Streeter and E. Benjamin Wylie "Fluid Mechanics"

## ANNEXURE I

### MARKET SURVEY OF 6" MINI FAN

<table>
<thead>
<tr>
<th>MAJOR WHOLE SELLER'S</th>
<th>QTY SOLD/YEAR</th>
<th>PRICE TAKA/PC</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric view</td>
<td>7,000</td>
<td>Tk 480 - Tk 510</td>
<td>IMPORTED FROM HONGKONG, TAIWAN</td>
</tr>
<tr>
<td>R. Rahman Market</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nawabpur, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Electric Agency</td>
<td>6,500</td>
<td>Tk 510 - Tk 515</td>
<td>SKD IMPORTED</td>
</tr>
<tr>
<td>Nawabpur, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rahman Electronics</td>
<td>7,200</td>
<td>Tk 490 - Tk 500</td>
<td>IMPORTED TAIWAN, SINGAPORE</td>
</tr>
<tr>
<td>Nawabpur, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jubalda Electronics</td>
<td>7,000</td>
<td>Tk 490 - Tk 520</td>
<td>IMPORTED CHINA, TAIWAN</td>
</tr>
<tr>
<td>Moti Electric Market</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nawabpur, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good Year Electric</td>
<td>3,500</td>
<td>Tk 430 - Tk 490</td>
<td>LOCAL, IMPORTED</td>
</tr>
<tr>
<td>Nawabpur Road, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alami Electric</td>
<td>6,200</td>
<td>Tk 490 - Tk 510</td>
<td>IMPORTED, LOCAL SINGAPORE, HONGKONG</td>
</tr>
<tr>
<td>Nawabpur Road, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J.R Fan Co.</td>
<td>6,000</td>
<td>Tk 430 - Tk 500</td>
<td>IMPORTED FROM CHINA HONGKONG, SINGAPORE</td>
</tr>
<tr>
<td>Nawabpur Road, Dhaka</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>48,400</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## MARKET SURVEY OF VIDEO CASSETTE

<table>
<thead>
<tr>
<th>MANUFACTURER'S NAME</th>
<th>MODEL</th>
<th>PRICE</th>
<th>SELL'S QTY</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsa Electronics</td>
<td>Marsha</td>
<td>95</td>
<td>84,000</td>
<td>Locally produced body</td>
</tr>
<tr>
<td>Baitul Mukarram, Dhaka.</td>
<td></td>
<td></td>
<td></td>
<td>SKD import from Hongkong, Taiwan</td>
</tr>
<tr>
<td>Rose Valley</td>
<td>Monex</td>
<td>95</td>
<td>42,000</td>
<td>Import from Hongkong</td>
</tr>
<tr>
<td>Stadium Market</td>
<td>Gold Star</td>
<td>105</td>
<td>66,000</td>
<td>Singapore</td>
</tr>
<tr>
<td>Kamal Enterprise</td>
<td>Esquire</td>
<td>120</td>
<td>84,000</td>
<td>Import from China</td>
</tr>
<tr>
<td>Stadium Market</td>
<td>Pioneer</td>
<td>110</td>
<td>28,000</td>
<td></td>
</tr>
<tr>
<td>Video connection</td>
<td>Konica</td>
<td>90</td>
<td>44,000</td>
<td>Imported from Hongkong</td>
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<tr>
<td>Gulshion</td>
<td></td>
<td>90</td>
<td>24,000</td>
<td></td>
</tr>
<tr>
<td>Popy Electronics</td>
<td>Fujie</td>
<td>97</td>
<td>72,000</td>
<td>Import from Singapore</td>
</tr>
<tr>
<td>Baitul Mukarram</td>
<td></td>
<td>97</td>
<td>24,000</td>
<td>Taiwan, Hongkong</td>
</tr>
<tr>
<td>Chak Bazar</td>
<td>Sunny</td>
<td>90</td>
<td>24,000</td>
<td>Import</td>
</tr>
<tr>
<td>Chak Bazar</td>
<td>AMA</td>
<td>88</td>
<td>24,000</td>
<td>Import</td>
</tr>
<tr>
<td>Chak Bazar</td>
<td>VCM</td>
<td>90</td>
<td>18,000</td>
<td>Import</td>
</tr>
<tr>
<td>Chak Bazar</td>
<td>Orchid</td>
<td>88</td>
<td>30,000</td>
<td>Import</td>
</tr>
<tr>
<td>Chak Bazar</td>
<td>Poney</td>
<td>97</td>
<td>24,000</td>
<td>Import</td>
</tr>
<tr>
<td>Chak Bazar</td>
<td>Swan</td>
<td>97</td>
<td>20,000</td>
<td>Import</td>
</tr>
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</table>

**Total produced quantity** 580,000
## ANNEXURE III

### MARKET SURVEY OF TOYS

(Number of items sold per year by each wholesale stores)

<table>
<thead>
<tr>
<th>TYPES</th>
<th>U CAR GAMES</th>
<th>DOLL</th>
<th>ANIMAL HOUSE</th>
<th>PISTOL</th>
<th>TRAIL</th>
<th>PUZZLE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>STORES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODERN STORE</td>
<td>P 83,000</td>
<td>3,200</td>
<td>40,000</td>
<td>30,000</td>
<td>12,000</td>
<td>7,000</td>
<td>21,000</td>
</tr>
<tr>
<td>HABIB ENTERPRISE</td>
<td>P 91,000</td>
<td>6,540</td>
<td>53,000</td>
<td>35,000</td>
<td>10,500</td>
<td>5,400</td>
<td>19,500</td>
</tr>
<tr>
<td>DULAL STORE</td>
<td>P 91,800</td>
<td>2,800</td>
<td>39,000</td>
<td>29,000</td>
<td>11,200</td>
<td>6,700</td>
<td>21,500</td>
</tr>
<tr>
<td>VARIETY STORE</td>
<td>P 78,200</td>
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ANNEXURE V

Flow system

As the flow of materials through the plant is one of the major factors that determines the type of layout, and the flow of materials governs the cost of the material handling, the amount of work in progress, the capital and space tied up by work in process, and the length of the total production time. The flow of material has been thoroughly studied. Indeed flow system can be classified into horizontal and vertical flow.

Horizontal type of flow has got following five basic types of flow pattern;

1. I-flow or line flow

![Fig No. 2.7]

2. L-flow is similar to the I-flow and mainly adopted when and I-line cannot be accommodated in the available space.

![Fig No. 2.6]
3. U-flow has both the feeding to and ejection from the line at the same end.

![Fig No. 2.9](image)

4. S-flow is adopted when the production line is so long that zigzagging on the plant floor is necessary.

![Fig No. 2.10](image)
5. 0 - flow is used when operations are carried out on a rotary table, or a rotary handling system.

The basic flow lines are frequently used in various combinations in industry, following are the examples:

In the studied production process where several flow lines feed assembly lines, the logical pattern of integration can be likened
to a river, where several estuaries combine into the main stream. The industry under consideration is to be located in a two storied building, so it should have also vertical flow. In fact flow pattern would be a combination of horizontal and vertical flow. The flow pattern is shown in figure no 2.13 and 2.14.

Factors of Layout

Following factors have been analyzed in deciding Layout plan on the basis of flow pattern.

i) Hazards: nature of risks due to moving parts, projecting machine elements, suspended weights, air pollution at the production centers; other physical and chemical risk; other precautionary measures taken for safety of personnel and plant.

ii) Type of production are considered whether job, batch,

iii) Type of operations
iv) Sequence of operations:

v) Integration of production

vi) Type of product

vii) Type of Inspection;

viii) Management policy; Plan for future expansion.
ANNEXURE VI

CONSTRUCTION OF INJECTION MOLDING MACHINE:

The machine would be used in the Injection Molding Shop. This machine consists of four main units:

i) Injection unit
ii) Closing unit
iii) Drive and control unit
iv) These three parts are again mounted on the fourth unit called machine bed.

i) Injection unit

The main components of this unit are injection cyylinder, injection screw, heater coil and a nozzle. The function of the injection unit are as follows:

a) To fill the injection cylinder with the plastic granules.
b) To rise the temperature of the preset level.
c) To mix the melt homogeneously and to develop required pressure.
d) To inject the melt inside the mold.
e) To control the material flow, and
f) To give back pressure for a specific holding time.

ii) Closing Unit

The main functions of the closing unit are:
Fig. No. 31
Molding Machine Function
a) Closing and opening of molding die.
b) Holding the injection pressure.
c) To eject the molded part from the die.

iii) Drive and Control unit:
The driving unit is a hydraulic system, the movement of the injection and closing unit are activated by hydraulic system. It also controls the pressure and regulates various timing of movements.
CONSTRUCTION OF MOLDING DIES

Injection molding dies are the tools which enable to produce high precision plastic products depending on the quality of the dies. Following are the most important components of a simple injection molding die.

a) Injection gate
b) Out kicker
c) Cooling channels
d) Runner plate
e) Cavity plate
f) Punch plate
g) Ejector housing
h) Ejector plate

PROBLEMS OF MOLDING DIES IN BANGLADESH

Following are the problems of the molding dies of Bangladesh.

1. Molding dies of Bangladesh are of very poor in quality.
2. Standard Injection molding dies can't be produced locally.
3. Only handful of molds for manual injection molding machine are made here.
5. Locally made molds have no cooling system.
Fig. No 32

Plastic Injection Mold.
6. No automatic kickout system

7. When the product size is big or complicated, such molds are not possible to make.

8. Surface finish of the products are not good.

9. Local molds can not be used for automatic injection molding machine.

10. Multi fold molds can not be produced.

11. Multi layer or multi color products can not be produced.

12. High speed production can not be obtained.

REASONS FOR BAD QUALITY MOLDS:

1. No proper mold designer available.

2. No appropriate machining facilities are available, such as Electrical discharge machine, Profile cutting machine, NC control boring machine; Ultra sonic polishing machine.

3. Appropriate metals are not available for some standard parts like bushes, guides, runner, plates, heated nozzle etc.

4. No proper training in the field of mold design and no body knows about the use of CAD/CAM.