FEASIBILITY STUDY OF SPARES MANUFACTURING FOR GARMENTS INDUSTRIES IN BANGLADESH.

A Project-Thesis

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Department of Industrial and Production Engineering
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Dhaka.

CERTIFICATE

This is to certify that the Project work was done by me and that this work has not been submitted elsewhere for award of any degree or diploma.

Countersigned.

Supervisor.

Candidate.

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ABSTRACT

A feasibility study on the manufacture of garments spares in Bangladesh has been accomplished. As a result of the experimental investigation and economical analysis of the study, the following have been established :-

Parts, which have high usage values and at the same time simple in shape are mainly H.S.S. cutters of different applications. Cold working operation on H.S.S. material in annealed state and hardening of the same after cold working, to attain the required hardness and structure, is possible using local facilities. A medium size workshop with the heat treatment facilities has been designed to meet the local requirement of three different cutters of similar shape and was proved to be economically viable.

CHAPTER - 1

INTRODUCTION

1.1 General Introduction

The Bangladesh garments making industry is relatively smaller in contrast with the textile industry. Garments for sale in domestic markets are being manufactured since the early 1960's but it was not until 1976 that the Country began to make garments for export (1).

There are a limited number of studies on garment industry in Bangladesh. In view of the growing importance as a foreign currency earner this sector needs detailed study as regards its trends of development, proper organisation, maintenance of machineries including the procurement of spare parts.

There are several types of delicate sewing machines in a garment industry. The machines contain various rotary and movable parts which take part in the cloth cutting and guiding operations. Consequently these parts wear out quickly and are subjected to replacement after regular intervals. The life of different parts are not the same. So a study is necessary to have an idea about the quickly replaceable items, frequency of replacement of these parts and causes of their wear.

Presently all the parts are imported and this makes the industry entirely dependent on procurement and availability of these parts from foreign sources. Moreover huge amount of foreign currency is spent for the procurement of these parts. It has also been observed that difficulties arise in the process of procurement of these spares. These problems would be overcome if these can be made locally.

Manufacture of the parts would require a knowledge of material, heat treatment condition, hardness etc. In the case of nonavailability of the exact material, their substitute is to be investigated for required properties of the spare parts and also a technological process has to be developed for the preparation of blank, machining operation, heat treatment and finishing operation.

1.2 Description of the Garments industry in Bangladesh.

For a knowledge on sewing machine spares one should have some general idea about the current, past and future state of garment industry. The industry is described from the standpoint of investors with attention directed to the conditions for further expansion that may be achieved, as the investors recognize opportunities. They take appropriate action in Bangladesh, where they pursue markets in competition with other relatively more developed countries where it is necessary to pay significantly higher wages than in Bangladesh.It is the wage advantage that essentially must be understood in order to appreciate the magnitudes of the country's potential. The comments here are intended only to provide a description of the industry's scope of development in the country but treatment of money, measures of performance are postponed here. Analytical explanation are also postponed.

1.3 Location of the industry within the country

The industry in Bangladesh is concentrated as to location in two urban areas where Dhaka is the major centre and Chittagong is the other preferred area. In the Dhaka area popular locations for garments plant are in Mirpur, Mohakhali, Dhanmondi, Airport road and old Dhaka.

Several factors contribute to this locational pattern. Firstly it is the importance of minimum time and secondly it is the expense for the transportation both of raw materials and finished products.

Dhaka and Chittagong are the two international transportation hubs of the country. In addition to transporting materials, the convenient movement of people such as overseas buyers is also necessary. Ready communication with overseas firms is plainly essential a requirement that also favours Dhaka and Chittagong.

An additional prime consideration is the need for frequent, convenient communication with the many government officials and bankers who are instrumental in regulating and financing the industry. The bonded warehousing system on which the industry depends operates with fewer inconveniences in Dhaka and Chittagong than elsewhere in the country.

Although labour is readily available almost every where in Bangladesh, garment workers must be trained and is convenient to the industry to have sizeable pools of trained worker in one or two communities rather than scattered around the country. The industry is also dependent upon a continuous supply of electricity; power supplies are closer to reliable in Dhaka and Chittagong than elsewhere but interruptions in power have been one of the banes of the industry and a continuing occasion for compaint to the authorities.

Finally, it may be noted that garment making is a quiet, clean, non-poluting industrial process. It is not on objectionable activity in any neighbourhood where manufacturing of any sort is acceptable.

1.4 Composition of output

Statistics on the quantities of output of the industry in Bangladesh are not yet being collected. Data on the type of garments manufactured are also not available. Interviews within the industry management indicate that output consists primarily of standard apparel, men's and boy's shirts, trousers and slacks, women's blouses and shirts, and different types of plain dresses.

Designer of fasion items are expected to come later if Bangladesh's reputation as a producer of standard items of acceptable uniform quality becomes well-established.

1.5 Raw materials input

All raw materials for the export industry fabrics, trim, packaging materials etc. are now imported from countries like Japan, S.Korea, and Taiwan. Since they are imported into bonded warehouse and are exported under the bonded procedure, no import duties are levied. Thus apart from the payment of nominal duties on machinary, the industry does not operate under the disincentives that beset industries using dutiable raw materials disincentives that stand as a handicap even if there are duty drawbacks as materials are re-exported.

Local fabrics and other materials do not as yet meet the price and quality requirements that must be met if they are to be acceptable within the export trade.

Most fabrics comes from Taiwan, Japan, Korea, Hong-Kong, Singapore, Malaysia, Indonesia, Thailand, The Philipines and India. Prices vary with count, colour, pattern, width etc.

The importance of quality of inputs to the industry is emphasized as observations are made on quality control.

1.6 Technology Input

There are a large number of machines in a exportize garment industry. A list of such machines has been given in chapter-II.

The industry is labour intensive and the equipments are easily maintained and repaired. Most sewing machines used in Bangladesh are manufactured by either Brother or Joki, some are made by the Singer. This statement is not intendent to imply that in Bangladesh equipment in the industry is serviced regularly for preventive maintenance purposes. It is often found that machines are run on dirty condition. More often the girls drive the machines without proper attention given to basic lubrication which is very important for extending the life of the machine.

Spare parts are subjected to high rates of import duty. Almost all the spares are brought from outside. There is no back up manufacturing company in Bangladesh for making the spares. But as the number of industries are going on increasing, they should be produced inside the country.

Repairs also cause a problem. There is no domestic repair facility and machines must be shipped to Hong Kong for repair. First, the apparel manufacturer must acquire a permit from the Chief Controller of Imports and Exports (CC IE) for the export cum- import of the damaged equipment. Upon it's return to Bangladesh manufacturer's are required to pay duty of 2.5% on freight cost.

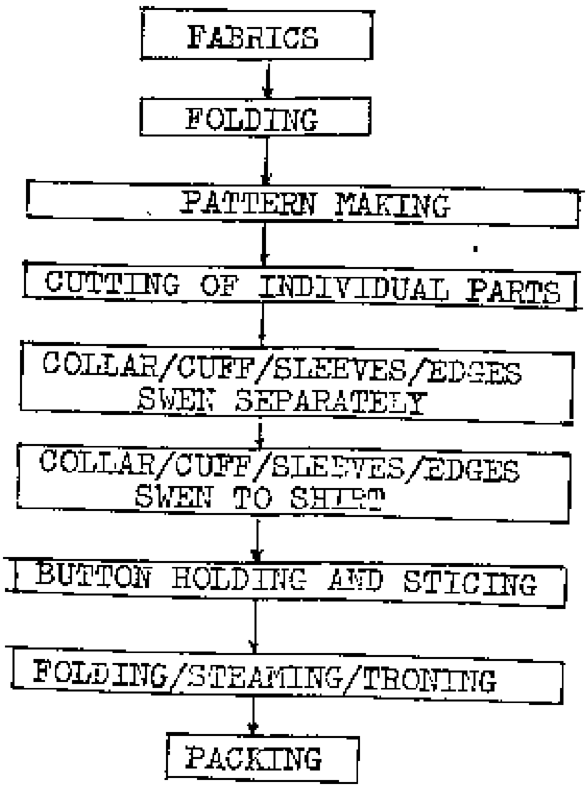
Another problem which is beyond the control of the companies themselves, may be noted. Frequent outages of electricity cause considerable lowering down of productivi raising the cost of production. Managers have complained of average outages of as many as two hours per shift.

1.7 Production Process

Production itself is a chain system. If in a line, one machine breaks down then the entire production line is stopped. Though it is a mass production system, it is very difficult to get efficient production. Division of labour is relatively specialized. However one arranges the production line to accomodate one or the another design requirement. There are as many as eight basic steps involved in the processes. These are depicted below:

PROCESS SEQUENCE FLOW CHART OF READYMADE

GARMENT INDUSTRY



Making pattern is perhaps the most "Critical" phase of the operation. Faulty patterns could (and probably always do) result in rejection of an entire order. The pattern is cut out of heavy paper bound.

1.8 Quality Control

As each of the stages of the garment making process, quality control is imperative. Control can be effective only if the plant is orderly, well managed, and organized such that errors can quickly be detected and corrected. In the absence of meaningfull control, entire orders can be rejected.

Quality control staff inspect the fabric as it is being unwound onto the cutting table. They look for faults in weaving, variation in colour, breaks in design, and other defects. This examination plus supervision of the quality of cutting represents 75% of total quality control effort in a garment making plant. Another 12% of control time is allocated to the sewing operation while the remaining time is directed to cleanliness, ironing, and packaging.

1.9. Aims and Objectives

The aims and objectives of the work were set as follows:

1. Study of the industry, its resources and existing technology.

2. Investigation of the existing machinery and determination of the fast replaceable spare parts and their material composition.

3. Selection of materials and processes of their heat treatment.

4. Determination of the operations that will be required to manufacture the parts.

5. Determination of economic viability of local manufacture of spares.

CHAPTER-II

STUDY OF THE EXISTING MACHINERY AND DETERMINATION OF THE FAST-REPLACEABLE SPARE PARTS AND THEIR MATERIAL COMPOSITION

2.1 Study of the existing machinery and their spares

There are a large number of machines in the industry. Many of them are sewing machines. But there are also some machines which are used for other purposes such as, Button-hole machine, Button Stitch machine etc. Though the machines are small in sizes, many of them are too complicated in structure and operation. An illustrative list of machinery for a garment factory is given in Table 2.1-1 below :

TABLE 2.1-1.

ILLUSTRATIVE LIST OF MACHINERY FOR A GARMENT FACTORY (1)

Sl.No.	Description & with specifications, if any	Any special feature
1.	Electric Straight cloth cutting machine	Abrasive brand shaper 10" blade.
2.	Electric cloth Drilling machine	Thermostatically controlled heater drillin needle.

Sl.no.	Description and with specificationsif any	Any special feature
3.	Electric Band knife cutter	120" blade
4.	Electric round knife cutter	Self sharpening System, 5" dia blade.
5.	High speed lock stitch machine	Single needle. Clutch motor 220V, 50 Hz, 250W.
6.	High-speed lock stitch machine	Single needle with edge trimming device.
7.	High-speed lockstitch machine	Single needle, "Needlefeed"
8.	High-speed lockstitch machine	Twin needle, "Needlefeed"
9.	Safety stitch machine	2 needle,5 thread
10.	Overlock machine	1 needle,3 thread
11.	Button sewing machine	Single, needle, fully automatic.
12.	Buttonhole machine	Single needle, fully automatic.
13.	Continuous fusing machine	Vacuum equipped, fully automatic
14.	Collar turning machine	
15.	Shirt folding machine	

Sl. No.	Description and with specifications, if any	Any special feature
16.	Shirt fronting machine	4 needle, double chainstitch, one folder
17.	Elastic inserting and attaching machine	4 needle, one folder
18.	Label cutting and printing machine	—
19.	Industrial iron	with water tank
20.	Cloth cutting machine	Straight
21.	Electric round knife cutter	Self sharpening blade
22.	Band knife cutter	—
23.	Cloth drilling machine	—
24.	Cloth clip	—
25.	Lock Machine	Single needle
26.	Lockstitch vertical trimming machine	single needle
27.	Lockstitch compound feed machine	single needle
28.	Safety stitch machine	Five thread
29.	Button sewing machine	Automatic
30.	Button holding machine	Automatic
31.	Collar turning machine	—
32.	Shirt folding machine	—
33.	Fusing machine	Fully automatic

Sl. No.	Description and with specifications, if any	Any special feature
34.	Shirt fronting machine	Four needle
35.	Label cutting machine	—
36.	Shirt packager	—
37.	Hand printer	—
38.	Industrial use iron	—
39.	Cleaning gun.	—

All the machines have been studied. In each machine there are many consumeable spare-parts. Due to time restriction of the present work it was not possible to study all the spares of every machine. The parts which suffer from heavy duty and are often subjected to change have been studied in the present context.

A list of the consumeable parts are given in Table 2.1-2 with their figures, the type of failure and other details. The approximate price and life of the parts have also been given. These were obtained from on interview with the machine operator and machine working in a factory. In this context the writer of this thesis has been studying in the factory for six months.

TABLE 2.1-2

Study of some spare parts which suffer from heavy duty

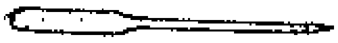
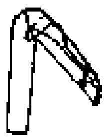
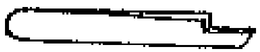
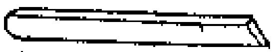
Name of spare parts	Part No. & Drawing	Name of the Parent machine	Approx. price Tk.	Approx. life (hr.)	Imported from	Cause of failure
Needle		KANSAI SPECIAL	4.00	8	Hong-Kong	The tip of the needle becomes dull due to continuous friction with cloth.
Looper		"	190.00	6570	"	The tip gradually wears due to friction with the needle and it looses its property fully.
Spreader		"	50.00	"	"	The tip of the spreader is hit by the needle.
Upper Knife	B-4108 -332- OOB 	Juki MO-357-358	10.00	120	"	After usingfor aninterval of time it looses it sharpness due to wear
Lower Knife		"	13.00	100	"	"
Bobbin	55623 	Singer	8.00	720	"	Needle strikes it. Wear due to friction.

TABLE 2.1-2 Continued. ..

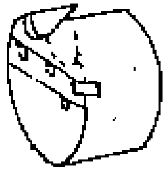
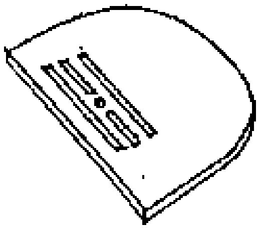
Sl. no.	Name of spare parts	Part No. & Drawing	Name of the parent machine	Approx. price Tk.	Approx. life (hr.)	Impor-ted from	Cause of failure
7.	Rotating hook Bobbin case with 540767 with 54767 504086 and 504087	544746 	Singer	130.00	4320	Hong-Kong	Needle strikes the tension spring and it becomes inactive, screw is sometime lost. The tip of the hook also wears.
8.	Throat plate (small needle holes) for 149031	52033-452 	"	20.00	1440	"	Needle strikes the plate. Pressure from presser feet makes it curve.

TABLE 2.1-2 Continued. ...

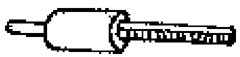
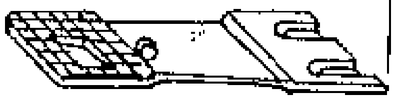
Sl. no.	Name of spare parts	Part No. & Drawing	Name of the parent machine	Approx. price Tk.	Approx. life (hr.)	Impor-ted from	Cause of failure
9.	Rotating hook and rotating hook bo-bbin case holder	545990 		100.00	4320	Hong-Kong	Sharpness of the hook becomes dull. Needle strikes and ultimately it becomes inactive.
10.	Needle set screw	504112 		2.00	2880	"	The screw thread breaks.
11.	Thread take-up	32758 		3.00	1440	"	It looses its tension.
12.	Tension stud	545898 		3.00	2880		The thread is cut.
13.	Feed plate	144659-01 	Indus-trial chain Stitch Butto-ning machine	100.00	8760	Japan	Needle strikes the plate and gradually it wears.

TABLE 2.1-2 Continued. ...

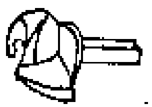
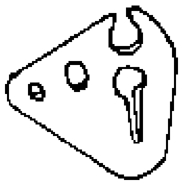
Sl. no.	Name of spare parts	Part No. & Drawing	Name of the parent machine	Approx. price Tk.	Approx. life (hr.)	Imported from	Cause of failure
14.	Feed Bracket	115087-0-01 	Industrial chain Stitch Buttoning Machine	200.00	8760	Japan	It breakes from certain impact.
15.	Rotary Looper	1150690-01 	"	800.00	4320	"	The tip of the looper becomes dull and ultimately its action ceases. cease.
16.	Thread release cam.	115171-01 	"	500.00	8760	"	Gradual frictional wear.
17.	Ball Pressing Leaf spring			60.00	"	"	It breaks some time at the middle position for bonding stress.

TABLE 2.1-2 Continued---

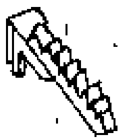
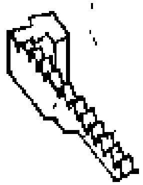
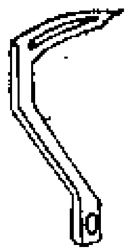
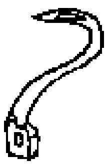
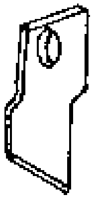
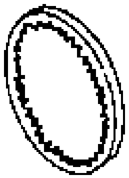
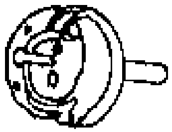
Sl. No.	Name of spare parts	Part No.& Drawing	Name of the parent machine	Approx. price Tk.	Approx. Life (hr.)	Impor-ted from	Cause of failure
18.	Diffe-rential feed dog. (7A)	B-1614-357-A00 	JUKI Model 357-358	60.00	17520	Hong-Kong	The continuous sliding action with the pressure feed wears the teeth of the feed dog and damaged.
19.	Feed dog. (main)	B-1625-357-000 	Overlock with safety stitch	120.00	17520	"	The continuous sliding action with the pressure feed wears the teeth of the feed dog and is damaged.
20.	Chain looper	B-2011-357-000 	"	300.00	2500	"	The sharpend of the looper becomes dull due to the sliding action with needle and is invalid.
21.	Upper Looper	B 2521 352-000 		100.00	8760	"	"

TABLE 2.1-2 Continued ...

Sl. No.	Name of spare parts	Part No. & Drawing	Name of the parent machine	Approx. price Tk.	Approx. Life (hr.)	Imported from	Cause of failure
22.	Lower Looper	B 2521-352000 		100.00	8760	Hong-Kong	The sharpend of the loope becomes dull due to the sliding action with needle and is invalid
23.	Cutter		Button hole Sewing machine	8.00	56	"	Continuous friction with cloth. At times it hits the scissor and its function is ceased.
24.	V-Belt		"	200.00	17520	"	After using long time it is torn.
25.	Rotary Hook		"	1500.00	8760	"	Its tip goes for a continous friction with different elements and ultimately becomes dull.

2.2. Analysis of some spare parts which suffer from heavy duty and preliminary selection of spares for investigation

There are thousands of parts in sewing machinery. After analysing Table 2.1-2 some parts have been selected for furthe investigation i.e. for knowing their materials and types of heat treatment necessary by testing hardness and studying metallographic structure.

In Table 2.1-2 the approximate life and approximate price of each part has been mentioned. From these given data the cos per hour life for each part can be found out. It is given in Table 2.2-1.

TABLE 2.2-1
Price per hour life of the parts

Sl.No. of the part	Name of the part	Approximate price (TK)	Approximate life (hr.)	Price per hour life (Tk/hr)
1	Needle	4.00	8	0.50
2	Looper	190 .00	6570	0.0428
3	Spreader	50. 00	6570	0.008
4	Upper knife	10.00	120	0.083
5	Lower knife	13.00	100	0.13
6	Bobbin	8.00	720	0.01
7	Rotating hook	130.00	4320	0.03
8	Throat plate	20.00	1440	0.014

Continued.

Sl. no.	Name of the part	Approx. price Tk.	Approx. life (hr.)	Price per hour life (Tk/hr)
9.	Rotating Hook and rotating hook bobbin case holder	100.00	4320	0.023
10	Needle set screw	2.00	2880	0.0008
11	Thread take up spring	3.00	1440	0.002
12.	Tension stud	3.00	2880	0.001
13.	Feed plate	100.00	8760	0.01
14.	Feed Bracket	200.00	8760	0.023
15.	Rotary looper	800.00	4320	0.185
16.	Thread release cam	500.00	8760	0.057
17.	Ball pressing leaf spring	60.00	8760	0.007
18.	Differential feed-dog	60.00	17520	0.0034
19.	Feed dog main	120.00	17520	0.007
20.	Chain looper	300.00	2500	0.12
21.	Upper looper	100.00	8760	0.0114
22.	Lower looper	100.00	8760	0.0114
23.	Cutter	8.00	56	0.143
24.	V-Belt	200.00	17,520	0.0114
25.	Rotary hook	1500.00	8760	0.1712

Now from Table 2.2-1 it is seen that the prices/working hour of the items of sl. no. 1,4,5,15,20,23 and 25 are relatively higher.

The spares for investigation were selected on the basis of the following criteria :

1) Wear rate or life.

2) Contribution per hour life.

3) Availability of material.

Now from contribution per hour item of sl. no.1 i.e. needle should have been selected first because of its highest contribution per hour life. But since the part is already being made in the country in sufficientquantities, it was excluded from selection.

From the point of view of contribution per hour life both the items of sl.no. 4 and 5 also should have been considered for study. But since the configuration of the two items and their functional properties almost the same and item of sl. no.5 has more contribution, it will be taken for investigation amongst these two.

Four other items were selected basing on the above reasoning. The items which are finally selected are as follows:

Name of the parts	Sl.No.
1.Chain looper overlock	20
2.Rotary looper of Button stitch	15
3.Lower knife overlock	5
4.Rotary hook, Button-hole	25
5.Cutter, Button-hole	23

2.3. Experimental method for studying micro-hardness and microstructure.

a. Experimental Methods.

For hardness

Specimen preparation:

The shape of the parts were such that it was not possible to take the hardness directly. First specimen was prepared from all the parts.

Small pieces were broken from each part. Now these small pieces were frozen in Backelite with the aid of the machine Buchler Ltd. Metallurgical apparatus, 2120 GREENWOOD ST. EVANSTON.

For structure

Specimen preparation: The same specimens as used for hardness tests were used. First these specimens were polished in emery paper of grades 2,1,0, 1/0, 2/0, 3/0, 4/0 respectively. Finally they were polished with GAMMA polishing alumina, These specimens were then etched with a solution containing 95% ethyl alcohol and 5% HNO_3.

The apparatus used for studying the structure was SHIMADRU Part no. 341--64278.

b. Experimental results :

Values of the microhardness for the selected parts are given in Table 2.3. below:

Table 2.3.

Microhardness values of the selected parts.

Spec. sl.no.	Name of the parts	Sl.no. according to table	Vicker's hardness
1	Lower knife overlock	5	1000
2	Rotary looper Button stitch	15	410
3	Chain looper over lock	20	175
4	Cutter button-hole	23	1000
5	Rotary hook Button hole	25	840

Lower knife overlock

It is evident from the Fig.1 of lower knife overlock that its structure is martensitic. It also contains some percentage of retained (untransformed) austenite. The material of the component may be some alloyed steel.

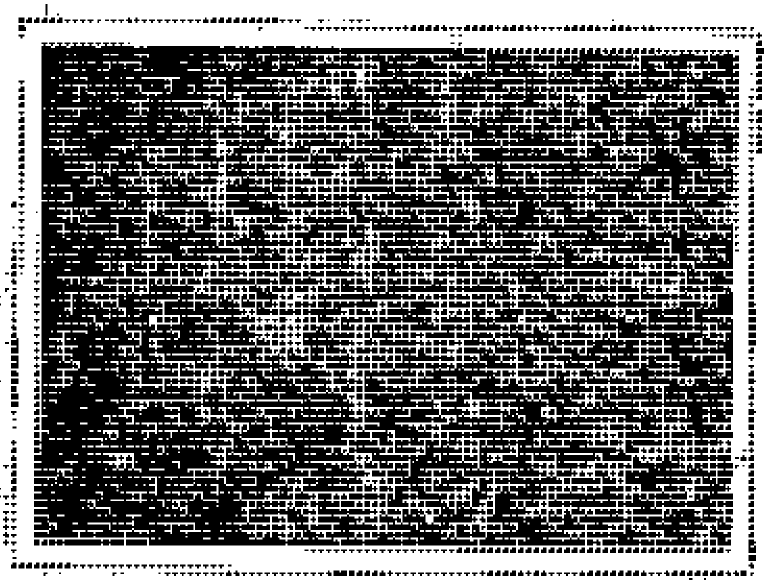


Fig.2.3.1 : Microphotograph of Specimen 1 prepared from Lower Knife overlock x 400.

Rotary looper of Button stitch :

The photograph below shows the presence of pearlite and ferrite. The material may be hypoeutectoid steel.

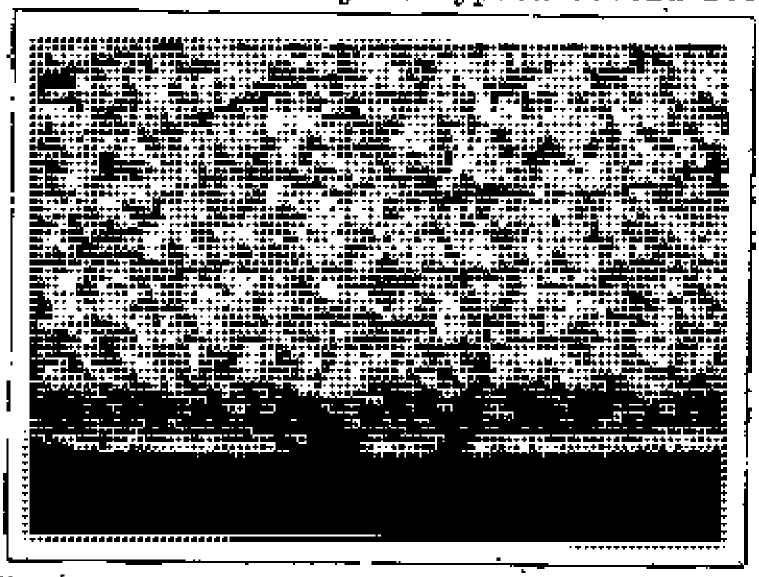


Fig.2.3.2 Microphotograph of specimen 2 prepared from rotary looper of button stitch x 100.

Chain looper overlock

From its microstructure below it seems to be pearlite steel with excess ferrite and cementide. The back spots throughout the picture may be for dirt after etching. If it would be cementide it would be on the grain boundary.

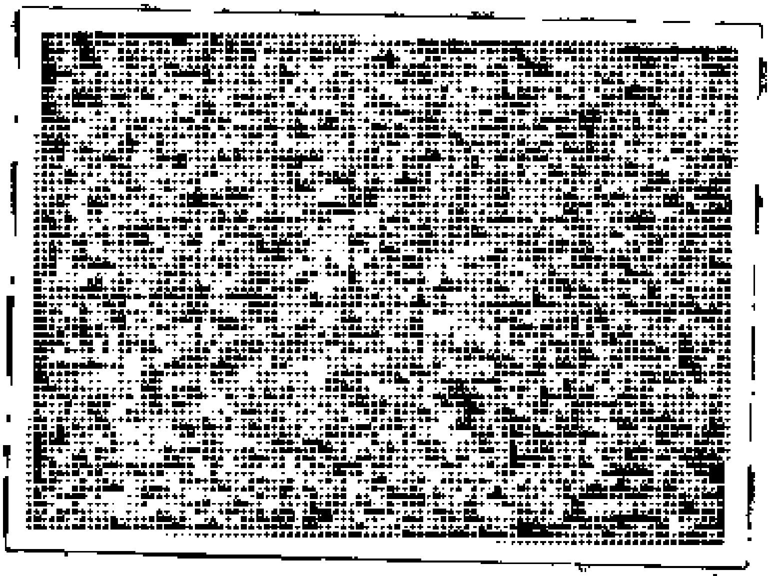


Fig.2.3.3. Microphotograph of specimen 3 prepared from chain looper overlock x 100.

Cutter Button-Hole :

Two specimens were made from this part. One from the top another from the base to test whether the material has same composition throughout or its tip is specially hardened. From the microstructure Fig.2.3.4-1 and Fig.2.3.4-2 it is found that the two have almost the same composition and it is the same as that of overlock knife. It contains martensite along with retained austenite.

The material is supposed to be an alloyed steel.

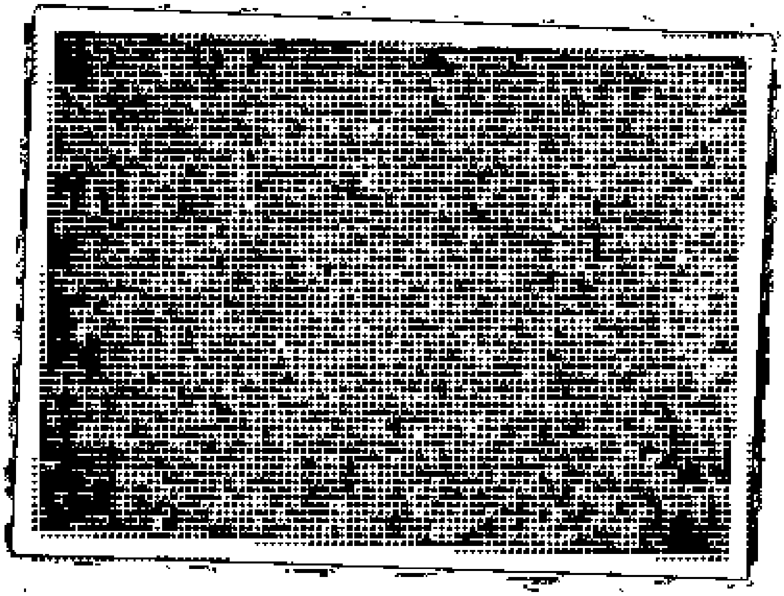


Fig.2.3.4-1. Microphotograph of specimen 4 prepared from tip of cutter Button-hole x 400.

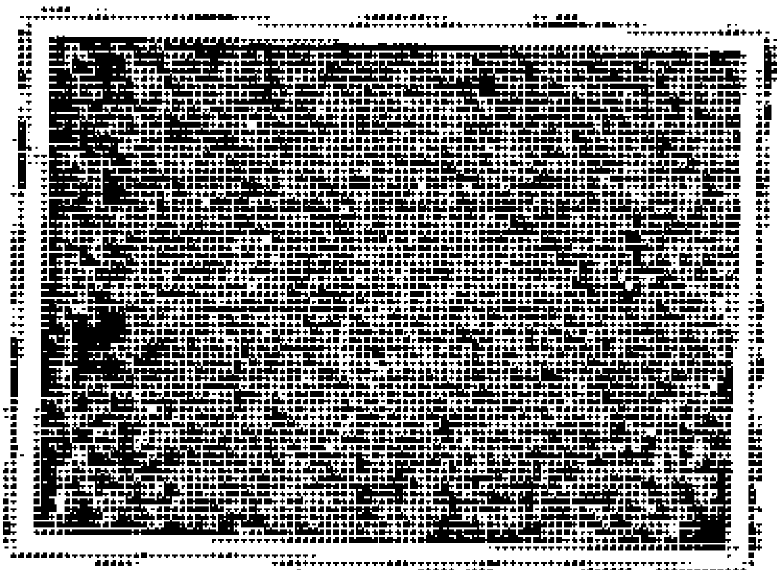


Fig.2 ...rophotograph of specimen 4 prepared from ...se of the cutter Button-Hole x 400.

Rotary hook Button hole

From its microstructure Fig. 2.3-5 it is found that there is fine pearlite(dark) and martensite (light). The material may be high carbon steel.

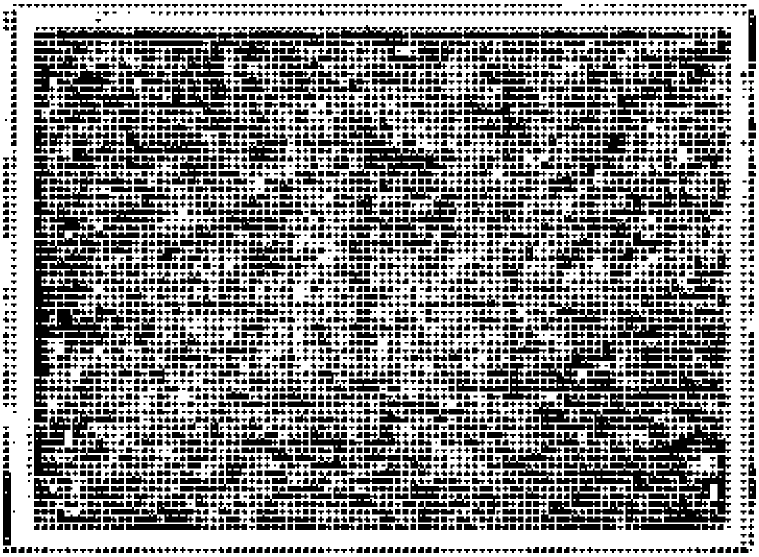


Fig.2.3.5 : Microphotograph of specimen 5 prepared from Rotary Hook-Button-Hole x 100.

2.4 Discussion on Results :

The cost contribution and the life of the individual spares that have been mentioned here give the approximate values as these have been taken from the purchase order and six months work of only one garments industry.

For structural investigation, the pictures taken were not clear. This is due to the fact, these pictures have been taken in ordinary film not in micro-film. So the exact constituents can not be predicted from the pictures. However the predictions are more or less true.

Five items have been taken here for investigation. Now due to the limited scope of the present work it is not possible to take all the five items. Rather, the production procedure of one of the items was worked out concretely to prove the feasibility of manufacture of the other items. Only variation will be the cost due to different production systems and the variation of dies, jigs and fixture.

Amongst the five items the rotary looper should have been selected for production as it is in the highest position from the "cost contri...

But the design of die for this item would be very complicated. So instead of this, "cutter of botton-hole" will be selected here for production. The production procedure is given in Chapter IV. Again before production procedure, the material is to be selected first and its mechanical property should be known for fabrication. These have been discussed in Chapter III.

CHAPTER - III

MATERIAL SELECTION AND THE CYCLE OF HEAT TREATMENT FOR SPARE PARTS TO BE LOCALLY MADE

3.1 Material selection criteria

For material selection the following factors are to be taken into consideration :-

(1) The raw material selected should be adequately available locally.

(2) The material selected must meet service requirements.

(3) The material should be processable using local facilities.

(4) The service requirements must be met at minimum cost.

3.2 Material selection procedure

A routine procedure will be used for selecting material to assure that some important factor is not neglected.

The quite obvious, but often overlooked first step is to list all the functional requirements that the material will meet. These are as follows :

(a) Strength

(b) Hardness

(c) Ductility

(d) Formability

(e) Hardenability

(f) Impact resistance

(g) Availability

(h) Machinability

(i) Cost and so on

Additional factors to be considered :

i) A very careful consideration should be given to the analysis of prior failures of a product. Quite often unfortunately such failure analysis information never seems to be got into the hands of designers.

ii) The extent to which materials can be standardized.

3.3. Analysis for selection of material.

Here the part which has been selected for production is for cutting cloths. The damage of it is only due to wear. The part should be made sufficiently hard so that it is wear resistant. From this point of view high speed steel can be selected. High speed steels are distinguished among other tool-steels for their high heat resistance i.e. the capacity to retain their martensite structure and corresponding high hardness, strength and wear resistance at the high temperature of the cutting edges at the high cnttimg speeds.

Again the cost of this material is relatively higher than any other tool-steel.But for this part under consideration amount of material per piece required is relatively low. From these considerations high speed steel was taken here as raw material.

3.4. Availability of H.S.S.

High speed steel which is imported to the country is not generally in normalized form. It is in the heat treated form. If large scale use can be made then it will be possible to import in he normalized form. But this has to be specially imported and that may be considered for longterm project. For the present study the raw material chosen is hardened H.S.S. But availability of raw material in normalized form will reduce the cost of production for future projects.

3.5. Heat Treatment Cycle

High speed steel has been taken for working. Since it is in the heat treated form, it is to be annealed first to make it ductile for forming operations and after forming it has to be hardened again.

3.5.1. Annealing:

Annealing reduces the strength and hardness thus improves the machinability. By reducing the grain-size, relieving internal stresses and equilizing the structure annealing raises the ductility and toughness in comparison to whose obtained after casting. The theoretical annealing cycle of H.S.S. is given in Table - 3.1

Table 3.1

Theoritical Annealing Cycle of H.S.S.(3)

Grade	Forging Temperature		Annealing procedures	As annealed Hardness, BHN
	Initial	Finishing		
P180 2	1170	900	1.Heat to 860-880, cool in furnace at rate of 20 to 25 degree per hour	255
P14Ø4	1150	900		255
P9Ø5	1150	900		241
P9K10	1150	900	2.Heat to 860 to 880 hold 2 to 3 hours. Cool in furnace to 740-760,hold 6 to 8 hours, cool further with furnace	241
P18K5Ø2	1170	900		
P10K5Ø5	1150	900		

Instrument required :

A furnace capable of a raisingthe temperature upto 900°C and having controlled cooling system.

Job Dimension:

The size of the specimen was 3/8" square and 1" long.

Actual annealing cycle

Procedure :

The material selected (H.S.S.) was subjected to annealing at 850°C. Though the temperature varies with the different grades and as it is unknown that what grade has been taken, but the annealing temperature (850°C) taken is almost average of the annealing temperature of all the grades.

It required 6 hours to raise the temperature upto 850°C. Here the rate of cooling was 35 deg c/hr. Though it could not be maintained uniform from its begining to the end but the total time required to cool to normal temperature was 24 hours (average rate 35 deg c/hr.).

Results:

Hardness:

Hardness of the annealed part in 29 R_c

Structure:

The microstructure of the annealed material is given in fig. 3.5-1.

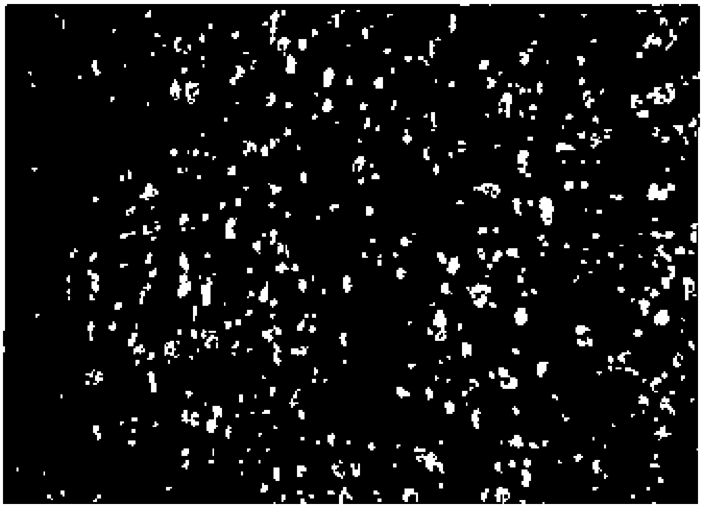


Fig.3.5-1 Micro photograph of annealed H.S.S. x 400.

Discussion:

The cooling rate was made slow for spherodizing of carbides. It provided for the decomposition of the austenite into the ferrite-carbide structure, and for spherodizing, coalescence of the carbides being formed.

But the electrical furnace that was used for this experiment had no provision of controlled cooling. So, after reaching 850° it was stopped and the specimen was allowed to cool gradually.

3.5-2 Hardening:

By increasing the strength and hardness, hardening imparts heat resistance (red hardness) to the part, followed by several tempering operations. The hardening temperatures of the different grad es are different. Quenching medium may be oil or salt bath. The theoretical hardening cycle for different grades of H.S.S. is given in Table - 3.2.

Table 3.2 (3).

Theoretical hardening cycle for different grades of H.S.S.

Grade	Hardening: 1st. prehea-ting	Hardening: 2nd pre-hea-ting	Hardening: Final heating	Quen-ching medium	Hard-ness after quen-ching, R_c	Retained austanite after quen-ching %	Triple temp-ering hol-ding time one hour Temperature °C	ard- ess fter empe- ing,
	temperature °C							
P18Ф2	400-500	830-860	1280-1290	1. Oil 2. Salt bath (KNO_3 + ($NaNO_3$) at 400-500°C and then in air	63-64.5	35	580-600	6[illegible].5-66
P14Ф4			1250-1260		62-64	39		64.5-66
P9Ф5			1250-1250		-	-		64.5-66
P9K10			1230-1240		63-64.5	30		64.5-66
P18K5Ф2			1280-1290		63.5-64.5	21		64.5-66.5
P10K5Ф5			1230-1240		63-64	35		64.5-67

Theoretical holding time:

Holding time at the hardening temperature should be sufficient for dissolving the part of the carbides that are soluble in the austenite at this temperature. On the other hand, holding time should be as short as possible to prevent oxidation, decarburization and grain growth. For tools of a diameter (thickness) of 10 to 50 mm, the time should be 8 or 9 seconds per millimeters of diameter or minimum thickness when heated in molten salts ($BaCl_2$) and 12 to 14 seconds per millimeter for furnace heating.

Instrument required:

A furnace capable of raising the temperature upto 1300°C and having the facility of holding at any temperature for a particular time.

Actual Hardening cycle:

Procedure:

The material was subjected to hardening at 1250°C. The hardening temperature varies with different grade but the difference is not markable.

It required about 1 hour to raise the temperature upto 1250°C. The preheating of 1st stage and 2nd stage can not be maintained correctly when the work was done. Holding time of 15 minutes was maintained at the hardening temperature. Then the job was quenched in oil.

Results:

Hardness:

Hardness after hardening was 56 R_c

Structure : (4)

The microstructure of the hardened part is given in Figure 3.5-2.

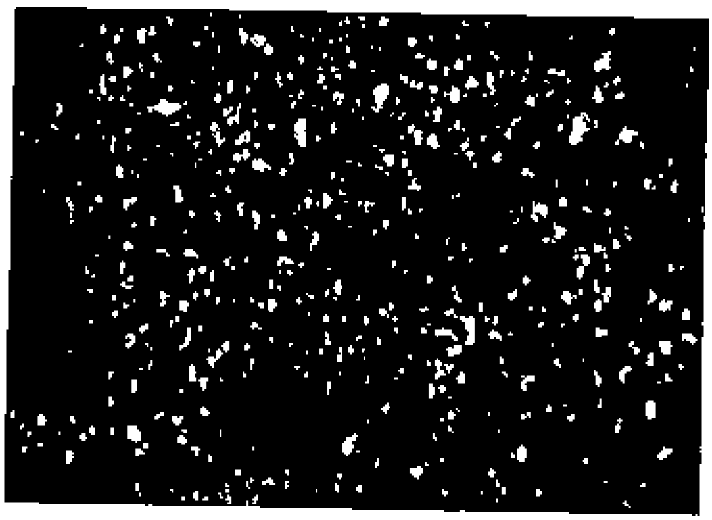


Fig.3.5-2. Micro photograph of Hardened H.S.S. x 400.

3.6 Discussion:

The hardening temperature . was 1250°C. Such high temperature is required to dissolve the ferrits carbide that results due to the annealing to the greatest possible extent and to obtain an austenite highly alloyed with chromium, tungsten, molybdenum and vanadium. This enables a martensite to be obtained after hardening that has a high resistance to self tempering.

It is seen from Fig.3-5-2 that even at this high temperature, only a part of the carbides have been dissolved. About 50 percent of those in the structure of Fig. 3.5-1 seems to be present here. From the Figure 3.5-1 it is found that the structure contains a large amount of ferrite -carbide and inspite of heating to quite high hardening temperature (1250°C) carbides have retained their fine grain in Fig. 3.5-2.

This structure (Fig.3.5-2) can be compared with the microstructure of the original sample which was taken for experimental purpose. The microstructure of the original sample is shown in Fig.3.5-3.

Fig. 3.5-3 Microphotograph of the original part x 400.

In this figure (Fig.3.5-3) it is found that the percentage of retained austenite is very less, though it is very difficult to justify the exact percentage as the photograph taken is not clear. The hardness of the original part was 60 R_c.

Now the reason for the retaining of ferrite-carbide in Fig. 3.5-2, the preheatings at two stages which were not maintained may be responsible.

The highly alloyed austenite obtained in heating for hardening has high stability. Therefore, it is quenched in oil. The austenite undergoes the martensite transformation upon further cooling.

After quenching, the structure of the high-speed steel consists of highly alloyed martensite, containing some percentage of carbon, undissolved surplus carbides and retained austenite. The higher the hardening temperature, the lower the temperatures of the martensite points and the greater the amount of retained austenite. Retained austenite lowers the cutting capacity of the steel, and there should not be any in the finished part.

For this conversion of austenite into martensite totally, hardening should alwaye be followed by tempering. But for the lack of facility, it was not possible to go for tempering.

Hardening is followed by tempering at 550°-570°C, which transforms the retained austenite into martensite and leads to precipitation hardening, resulting from the partial decomposition of the martensite and the precipitation of disperse carbides. This increases the hardness(called secondary hardness). In holding at the tempering temperature carbides are separated out of the retained austenites as a result of which it becomes less alloyed. Hence, upon subsequent cooling, this austenite has undergone to the martensite transformation. After a single tempering operation, only a part of the retained austenite is transformed into martensite. Several tempering operations (usually three) at 550° - 570°C are resorted to transform all of the retained austenite into martensite and to temper the newly formed martensite. The holding time for each tempering operation is from 45 to 60 minutes.

To reduce the amount of retained austenite, certain tools of simple shape are cooled to -80°C directly after hardening (to avoid stabilization of the austenite). Sub-zero treatment transforms over one-half of the retained austenite into martensite. It is followed by one or two tempering operations at the commonly accepted temperaturee. Sub-zero treatment and subsequent tempering shorten the heat treatment cycle, but require additional equipment (refrigerating chamber). After hardening, the hardness of the steel may be 62-63 R_c and after tempering, it is 63-65 R_c.

The cutting capacity and hardness of tools in this case can also be increased by low-temperature cynading at 550°C - 560°C.

Finally as the hardening can not be done in proper way so it was not possible to raise the hardness as expected. Yet hardness was reached upto 56 RC which is not quite abnormal. It will be able to impact the cutting properties. So production can be set with this material, which is discussed in detail in chapter-IV.

CHAPTER - IV

SEQUENCE OF OPERATIONS IN MANUFACTURING THE PARTS LOCALLY

4.1. Factors considered

The process of forming the parts depends on lot size and type of product. For lot production the process of manufacturing will be quite different from that of the process for mass production. Both these process are discussed below.

4.2 Forming Process:

a. For lot production :

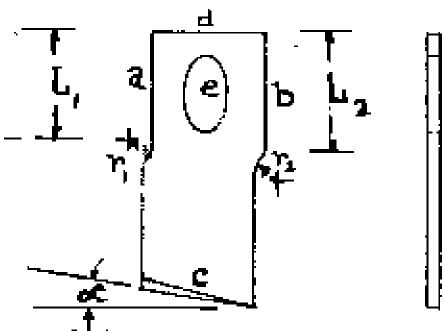
Before going to actual operations, which will be carried out to fabricate the part, the basic requirements of the job are to be determined. The basic requirements would be obtained from the detail drawings and the job orders. To produce one workpiece by machining following considerations will be involved :

a) Size and shape of the workpiece

b) Tolerances

c) Material from which the part is to be made

d) Number of pieces to be produced



1 Drawing of the cut[illegible] [illegible]tonhole.

The following specifications are considered in the manufacture of the blade shown in Fig. 4.2.1.

1) A thin sheet of length 1½", breadth 5/8" and thickness 1/16" ± .001".

2) Two contours on two longitudinal edges a and b having a cut of radius r_1 and r_2 with their centres at a distance of L_1 and L_2 from the top respectively.

3) A cut at an angle α with the base horizontal axis.

4) A slot e of 3/8" x 1/4" on the top end.

5) The closest linear tolerance is 0.001" and the single angular tolerance is ± 0.1°.

6) Hardness of the part should be around 60 R_c.

From the information obtained from the part drawing and the job order, following conclusions regarding the manufacturing process may be drawn. Firstly, since the part is thin, for its manufacture, corresponding blank size may not be locally available; so it is apparent that first forming operation will be required and for lot production, the use of roll type forming operation would not be justified, instead presses may be used. The thickness will be reduced upto 1/16". Then a piece of 1½" x 5/8" will be cut by milling machine with disc cutter. Next the exact outer contour of edges a and b can obtained in a milling machine. The tool to be used is and end cutting tool. The nose radius of the tool used should be equal to the radius required to cut. In this process it will be possible to shape 25 pieces at a time. The slot'e'at the top can also be cut by milling. The sharp edge'c,'should be made by grinding with fine abrasive wheel. After hardening the part final operation carried out will be polishing.

As the production requirements of the job have been given, the next step is to set up a route sheet. This sheet lists the operations which must be performed in order to produce the part, in their sequential order and the tooling which will be required for each operation. As the route of the part has been determined, the planning of each operation in the processing sequence can easily be done.

In the route sheet the first operation will be to make thin sheet of 1/16" by mechanical press. Then 25 pieces of 1½" x 5/8" is to be cut by milling machine. The next operation is milling of outer contour edges 'a,' b, 'c' and slot cutting. After milling, grinding operation will be done which will be followed by heat treatment. Finally the parts will be polished by polishing wheel. The route sheet is given in Table 4.1.

Table - 4.1.

ROUTE - SHEET

NAME OF THE PART - BLADE

PART NO.........

MATERIAL- ANNEALED H.S.S.

Operation number	Description of operation	Equipment/Machine	Tooling
1.	Making thin sheet of 1/16"	Mechanical press	Press die
2.	Cuttoff to 1½" x 5/8" dimension (25 pieces at a time)	Milling machine (with fixture)	disc type milling cutter
3.	Milling outer contour edges a,b and c and slot cutting e (25 pieces at a time)	Milling machine (with fixture)	Side and end milling cutter
4.	Grinding	Grinding machine tool with fixture	Grinding wheel
5.	Heat treatment to 1250°C oil quenched	Electrical furnace	-
6.	Polishing all surface	Grinding machine	Polishing wheel
7.	Checking hardness (sample pieces)	Rockwell hardness tester	-

Note :

It is seen from the drawing (ref. Table 2.1.2) that for the manufacturing of items such as upper knife(Sl.4) and lower knife (Sl.5) the same operations will come excluding the slot cutting. The material requirement per piece is almost same for item of Sl.no.23.

b. For Mass production:

For mass production rolls type forming operation will be used. Raw materials are annealed high-speed steel bars.

As there is a restriction in the reduction in thickness of the bar normally 1 to 10% per pass, it will be more convenient for operation to choose the bar as thin as possible. The maximum reduction perpass is limited by either ductility of the material, or by the surface condition and diameter of the rolls, which determine whether the material will be drawn through the rolls. If too large a reduction per pass is attempted, the bar will simply not be pulled into the rolls. For high production, it will be better to line up a series of rolls so that each succeeding pair is speeded slightly closer together and rotate correspondingly faster. This enables the bar to move continuously through the plant until the final thickness is achieved.

The alternate procedure is to use a single pair of rolls and reverse their direction of rotation after each pass. The rolls are brought closer together after each pass and the bar reciprocates many times between the rolls before the final thickness is achieved. Much power is consumed and heavy forces are induced in the roll-drive mechanisms when they are reversed. To avoid this disadvantage , the three high rolling mill was developed. In this mill a third roll is employed and the bar is raised and lowered after each pass as illustrated in Fig. 4.2-2.

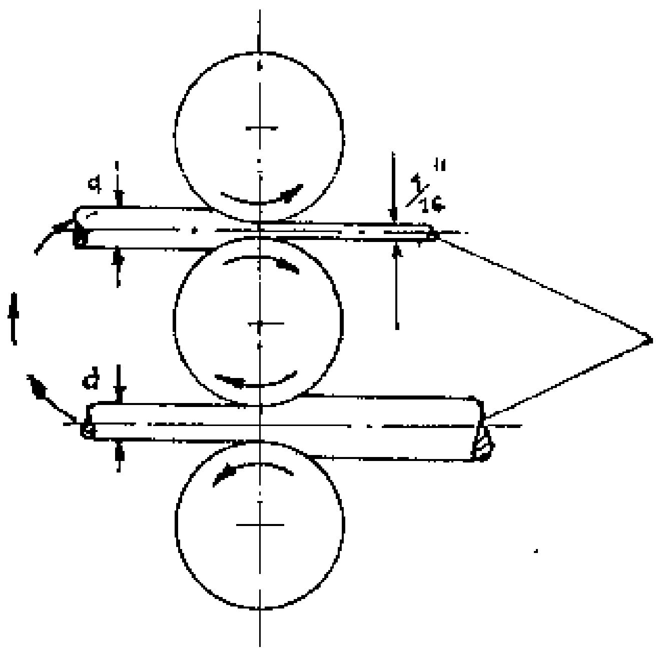


Fig. 4.2.2. Three high reversing rolls.

Here the thickness will be reduced upto 1/16" +0.001".

Now the operation applied will be blanking and pierching. The two operatoㅁs can be done simultaneously with compound die.

Here the punch and die have to be made first. The shape of the punch for blanking will be as the outer contour of the work-piece with 0.002" allowances (for finishing).

The pierching punch for slotting would be fixed along with the blanking die to the punch holder and the pierching die along with the blanking punch would be attached to the die shoe so that during operation the pierching punch fits into the piercing die with 0.01" clearance.

Thus making two operations simultaneous, it reduces :

1. Operating time
2. Excess die and punch cost

A schematic view of the compound blanking and piercing die is given in Fig. 4.2-3.

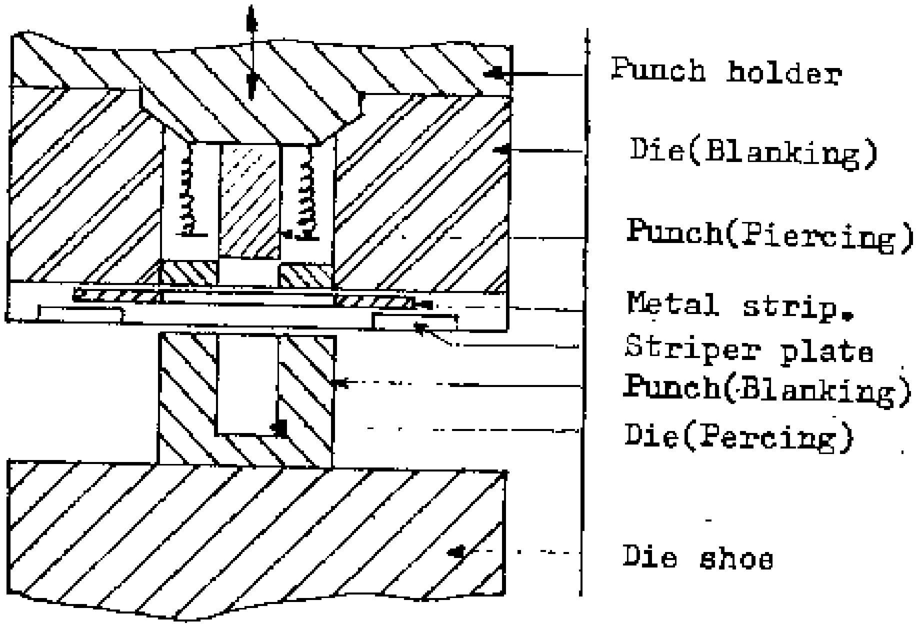


Fig. 4.2.3 : Blanking and pierching Die.

CHAPTER - V

ECONOMIC ANALYSIS : A CASE STUDY

5.1 Factors considered

The production of cutter of button hole involve several machining operations using a variety of machine tools. Cutting costs, grinding costs and tool changing costs will be the major influencing factors of total production cost per piece. To avoid material handling cost, it is assumed that the thin sheets are stacked near the machine ready to be grapsed by the operator and the operator will stack the machined piece conveniently near the machine.

5.2 Determination of cost for the Cutter of button hole of first variant.

The first operation in the route sheet is to make the thin sheet of 1/16" ± .001". But for analysis it is expected that the material will have to be obtained in the sheet form of thickness 1/16" ± .001. The cost required for this operation is included in material cost.

The following costs are to be considered to calculate the cost of produced parts :-

1. Material cost

II. Cost involved in milling machine.

III. Grinding cost

IV. Heat treatment cost

V. Polishing cost

A case study of cost calculation of a particular garments industry is given below.

I. MATERIAL COST :

Material cost has been taken as the average of market price.

Cost/Kg of annealed H.S.S.	=Tk.425
Wt. of one piece blade is approx.	6.5 gm.
Cost/piece for material only	= Tk.2.77
Now the cost per piece be	Tk.3.60
to get it in the sheet form (1.3 times)	....(11)

II. COST INVOLVED IN MILLING MACHINE :

Here both the cost of milling machine and cost of tool will have to be considered. From the cutting condition it will be better to cut 25 pieces at a time. The thickness for 25 pieces will be almost 1½". If more than these are taken then problem will be with the jigs and fixture.

Time required in milling machine for 25 pcs.

Job clamping, leading and unloading time including entering, tool approach and engage time (idle)

= = 7 Min.(11)

Actual cutting time

Vertical + longitudinal cutting of a and b 5 + 5	= 10 Min.
Edge(C) and slot (e) cutting	= 5 Min.
Cutting time required to cut with disc cutter	= 3 Min.
Auxiliary cutting time	= 5 Min.
Milling time	= 30 Min.

(Cutting time has been calculated considering the minimum vertical feed 8.3 mm/min and minimum longitudinal feed 25 mm/min.) .... (10)

Considering 8 working hours a day within this 8 hours, 2 hours for worker's rest. The actual working time is 6 hours a day.

Hence the no. of pieces produced a day		$= \frac{25 x 6 x 60}{30}$
		= 300 pcs.
Now machine cost including overhead		= Tk.8.00/hr.
Labour rate including overhead (Direct labour cost)		= Tk.10.00/hr.
	Total	Tk.28.00/hr.
Hence cost/day	= 28x6	= Tk.168.00

Again the actual cutting time with end mill for 25 pcs. is 10 + 5 = 15 min.

This is approximately 1/2 (half) of the tool life.

Hence one tool regrind covers one hour.

(The tool life has been considered 33 min.)

Cost of tool = Tk.22.00 (for one regrind) .... (11)

Cost of tool/day = Tk. 22 x 6 = Tk.132.00/-

III. Grinding cost:

Setting time = 5 min for one set.

Grinding time (edge C) = 10 min.

Total 15 min.

Time required to grind all pieces (300) of one day =

$$\frac{300}{25} \times 15/60$$

= 3 hour.

Here machine cost including Over heads		= Tk.15 /hr.
Direct labour cost	(11)	= Tk.10/hr.
	Total	= 25/hr.

Hence cost involved ingrinding = 25 x 3 = Tk.75.00/day.

iv) Heat treatment cost per day :

Cost of heater (Electrical) with overhead/day	= Tk.85.00
Cost of electricity/day	= Tk.10.00
Labour charge/day (with Over head)	= Tk.50.00
Total	Tk.145/

V. Polishing cost :

Here idle time = 5 min. (for one set of 25 pcs)

Actual polishing time 10 min

= 15 min.

Time required for polishing the product of one day (300 pcs) is

$$\frac{300}{25} \times \frac{15}{50} = 3 \text{ hours.}$$

It is found that the total time required for grinding and polishing is (3 + 3) = 6 hours which is equal to the effective hours of one day. So both the grinding and polishing can be done on the same machine.

Polising cost/day = Grinding cost/day = Tk.75.00

All the component costs for 300 pieces is given in Table- 5.1

TABLE 5.1

COST ANALYSIS FOR 1ST VARIANT

Material cost of products/day	
(300 x 3.60)	= Tk.1080/-
Milling cost/day	= Tk. 168/-
Tool cost/day	= Tk. 132/-
Grinding and polishing/day	= Tk. 150/-
Heat treatment cost per day	= Tk. 145/-
Administrative overhead/day (indirect labour rate)	= Tk. 260/-
Miscellaneous/day	= Tk. 50/-
Total	Tk.1985/-

Cost/piece = 1985/300 = Tk.6. 62/-

The market price of each piece is found to be Tk.8.00

Hence profit/day = (300 x 8.00 - 300 x 6.62)

= Tk.415.00

Profit/Month = Tk.415 x 24 = Tk.9960.00

(Considering 24 working days per month).

Total approximate capital requirement .

One milling machine	= Tk.300000/-
One grinding machine	= Tk.300000/-
One electric furnace	= Tk.150000/-
Others	= Tk.120000/-
Total	Tk.8,70,000/-

Hence investing taka 8,70,000/-, a before tax gross profit of Tk.9960 can be obtained per month, giving an internal rate of return of 8.31% assuming a life of 10 years and 12.78% for a life of 20 years. These would suggest that the investment is not worthwhile.

5.3 Determination of cost of items upper knife, lower knife and cutter of button hole of second variant.

From Table 2.1-2 it is found that the life of items of sl.4 and sl.5 is double the life of the item sl.23. Hence the consumption of items of sl. no.4 and 5 together will be approximately equal to the consumption of item of sl. no. 23. The material required for each piece will be almost same (P.49 of Chapter, IV). So the fabrication of 300 pieces (150 + 150) of the items of sl. no. 4 and 5 can be included.

In variant 1 the electric heater is underused. So items of sl. no. 4 and 5 can be heat treated using the same furnance.The total administrative cost will increase a little due to this extension with respect to variate-I (Table 5.1).

It can be observed from the drawing of these parts (Table 2.1-2) that the time required in each operation (milling, grinding or polishing) for items of sl.4 and 5 will be either same or less than required for item no. 23.

So the machines which will be required in addition are one milling machine and one grinding machine (variant-1).

Now combining the cost of these 3 items (sl.no. 23, 4,5) the total production cost of variant-2 is calculated with reference to Table 5-1 and placed in Table 5.2.

Table 5.2

COST ANALYSIS FOR 2ND VARIANT

Material cost of products/day (600) pcs.		Tk.2160/-
Milling cost/day		Tk. 336/-
Tool cost/day	=	Tk. 264/-
Grinding + polishing coat/day	=	Tk. 300/-
Heat treatment cost/day	=	Tk. 145/-
...istrative overhead/day	=	Tk. 360/-
...aneous/day	=	Tk. 50/-
	Total cost	Tk.3555/-

This is the cost required to fabricate 600 pieces a day. Now the selling price of 600 pieces of items of sl. no.23,4 and 9 is approximately 300 x 8.00 + 150 x 10.00 + 150 x 13.00 = Tk.5850/-.

Profit/day	= (5850-3555)	= Tk.2295/-
Profit/month	= 2295 x 24	= Tk.55080/-

(Considering 24 working days/month).

Total approximate capital requirement is

2 milling machine 3,00000 x 2	=	Tk.600,000/-
2 grinding machine 3,00000 x 2	=	Tk.600,000/-
One electric Heater 150000	=	Tk.150,000/-
Others	=	Tk.150,000/-
	Total	Tk.1500,000/-

Hence investing Tk. 15,00,000, net profit of Tk.55080/- can be obtained per month giving an internal rate of return of 42.93% for 10 years life span. The investment is thus highly worthwhile.

The profit at this rate can be considered satisfactory for the small workshop which has been designed for this purpose. So the local manufacture of the parts can be considered feasible.

Now among the two variants it is found that 2nd variant is more satisfactory and feasible than variant-1.

CHAPTER - VI

CONCLUSIONS AND SCOPE OF FUTURE WORK

6.1 Conclusions

From the results of the experimental investigations the following conclusions can be drawn :

1. In the light of rapid growth of the garments industry in Bangladesh, the need for local manufacture of spares, which can save a lot of foreign currency and also ensure timely supply of spares, is realized.

2. From the studies it is seen that there are some complicated parts which are very difficult to fabricate locally due to the non-availability of proper technical facilities. But there are some parts, the manufacturing process, metal content and heat treatment condition are such that they can be locally manufactured.

3. The parts for investigation have been selected on the basis of three criteria.

1. Simplicity in construction.

II. Availability of raw material and technology.

III. High usage value.

4. The material of the items selected for initial manufacturing were found to be high speed steel, which facilited the choice of high speed steel as raw material.

5. It has been found that raw material H.S.S. is available in the country generally in hardened condition in the form of different cutting tools.

6. Experimental results show that it is possible to soften this hardened H.S.S. in order to impart required shape with the existing local facilities.

7. The raw machined part can be heat treated to attain the required working hardness and material structure using existing local facilities.

8. For actual manufacturing of the selected items two possible methods can be employed-lot production and mass production.

9. For local requirement lot production is sufficient. If any attempt is taken to export then mass production will be more justified.

10. Lot production can be designed for a single product (variant-1) or a group of products with similar configuration (variant-2).

11. From the economic analysis it is clear that 2nd variant is more satisfactory and feasible than first variant. This variant will facilitate the manufacture of three items at the rate of 600 pieces/day with a net profit of Tk.55,080/- with an investment of Tk.15,00,000/-.

6.2 Scope of future work.

The result of economic analysis and the experimental work will encourage future development and improvement in this direction. Nevertheless the following shortcomings might have been observed in the work :

The experimental work was done using only high speed steel as work material. Although these results met the requirements, there remains scope of future study by changing the compoeition of work material.

In this work the value of cutting time was taken from the minimum cutting speed of the machine, there remains a scope of further study to find out the optimum cutting speed and the cutting time. This will reduce the cutting time and will make the production more economic.

During heat treatment it was not possible to give required preheating time and the cooling rate also could not be controlled as required. There is a scope of study to make the experimental results more satisfactory with more sofisticated apparatus.

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