THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY
PATIALA

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

INCREASED EFFICIENCY
THROUGH
PLANNING AND IMPROVED MATERIAL HANDLING

PUNJAB TRACTORS LIMITED
TRACTORS DIVISION
PHASE—IV, S. A. S. NAGAR

Prepared by

SANJEEV KUMAR SHARMA
178/85, INDUSTRIAL ENGG. DEPARTMENT

Punjab Tractors Ltd.,
Tractor Division,
SAS Nagar.

July 15, 1988

Shri S.K.Satsangi,
Head Placement and Co-ordination,
Thapar Institute of Engg. and Tech.,
Patiala - 147001.

Dear Sir,

I feel obliged to submit for your kind appraisal my first work term report titled "INCREASED EFFICIENCY THROUGH PLANNING AND IMPROVED MATERIAL HANDLING" prepared for department of Industrial Engineering of M/S Punjab Tractors Ltd., SAS Nagar.

Tractor division of Punjab Tractors Ltd.,manufactures tractors under the brand name of "SWARAJ".

The Industrial Engineering department is headed by Mr. M.S.Nagendra, Manager, and is primarily responsible for safe and smooth running of the factory to achieve required target of production. This department is also responsible for process planning, improvement in layouts, calculation of efficiencies of men and machine and time study.

I am immensely pleased to acknowledge my deep sense of gratitude to Mr. M.S.Nagendra, Manager, I.E.Deptt., for his inspiring guidance and constant encouragement in the execution of my projects. His untiring efforts and critical evaluation of work has enabled me to complete this work term success fully. I also feel highly indebted to Mr.Darbara Singh, Mr. Ajay Gupta, Mr.Balbir Singh, Mr. R.D.Verma and Mr. T.K.Goel for their ungruding help and cooperation.

This report has been prepared and written by me on the basis of my daily diary and the work assigned to me from time to time. Further, it has not received any academic credit at this or any other institution.

Yours faithfully,

Sanjeev K. Sharma.

Roll No. 178/85

(SANJEEV K. SHARMA)

SWARAJ TRACTOR DIVISION

Works
Phase IV, S.A.S. Nagar,
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Tel: 8-7212 - 15 & 8-7237
Telex: 0395-222
Grams: SWARAJ

SWARAJ

No.14/92/10N/
1st July, 1988.

TO WHOM IT MAY CONCERN:

Certified that Mr. Sanjiv Kumar Sharma, a student of Thapar Institute of Engineering & Technology, Patiala has undergone practical training at our Works from 1.1.1988 to 30.6.1988.

During this period he has undertaken a project with us viz:-

1. To improve the layout of the battery area and estimate the standard time for charging a battery.
2. To stream line feeding and handling of sheet metal components in the Paint Shop.
3. Shaft Line (II) (Conveyorisation & load balancing)
4. To design a pneumatic lift for lifting of the trolley of gear box assembly.
5. To balance the assembly operations for conveyorisation of the Assembly Line till Engine coupling with Gear Box.

ASSISTANT MANAGER - PERSONNEL

rc*

PUNJAB TRACTORS LTD

INDUSTRIAL ENGG DEPTT

PROJECTS

Period-(1.1.88- 30.6.88)

			Remarks
1.	Orientation	1.1.88- 20.1.88	
2.	To improve the layout of the battery area and estimate the standard time for charging a battery.	21.1.88- 15.2.88	Implemented.
3.	To stream line feeding and handling of sheet metal components in the Paint Shop.	16.2.88- 15.3.88	Implemented.
4.	Shaft Line(II)(Conveyorisation& load balancing)	16.3.88- 31.4.88	Considered for implementation.
5.	To design a pneumatic lift for lifting of the trolley of gear box assembly.	1.5.88 - 15.5.88	Being implemented.
6.	To balance the assembly operations for conveyorisation of the Assembly Line till Engine coupling with Gear Box.	16.5.88- 30.6.88	Considered for implementation.

M.S. Nagel

(M.S. NAGENDRA)
MGR- ENGG.

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ABOUT "PUNJAB TRACTORS LIMITED"

After the independence in 1947, the entire industrial growth of India relied upon foreign technology. For setting up of new industries India had to look out for technical know-how from various advanced Countries. Then, only in 1965, the Central Mechanical Engineering Research Institute, a national laboratory of the Government of India took, a bold step of under taking the design and development of totally Indian know how for 26 H.P. agriculture tractors. After 5 years of development efforts by our eminent engineers, this know-how was ready for commercialisation in 1970. This was the tractor that had the credit of being the only indeginised tractor in India.

In 1970, the Punjab Government took up the bold challenge of setting up of Punjab Tractors Ltd.(PTL), for the manufacture of the "SWARAJ TRACTORS", based on totally Indian know-how. PTL started with an investment of Rs. 30 million with an annual capacity of 5000 tractors. It went into commercial production at Mohali (Punjab) in 1974 with a single 26 H.P. Model, The "SWARAJ - 724".

During the 14 years of it's existence, Punjab Tractors Ltd. has not only successfully produced thousands of "SWARAJ TRACTORS" but has also expanded it's tractor manufucturing capacity to 12000 per annum. Today it is a Multi Division

concern manufacturing a diverse variety of products such as Harvestor combines, Light commercial vets vehicles, agricultural implements, Fork lifts etc.

Following are the various divisions of"Punjab Tractors Limited"

1) SWARAJ TRACTORS DIVISION:

It is situated at Sahibzada Ajit Singh Nagar (Near Chandigarh) in Punjab. It covers an area of about 20 acres which has various manufacturing facilities, heat treatment shop, Paint Shop, Research and Development Centre etc.

It manufactures 4 models of tractors and various agriculatural implements.

2) SWARAJ COMBINE DIVISION

It is situatated on the kharar Landran Road (District Ropar). It manufactures India's First self propelled Harvester combine and Swaraj Fork lifts.

3) SWARAJ FOUNDARY DIVISION:

It is situated at Village Majri on Kurali-Siswan road in Ropar district. It produces sophistated automative Graded Grey Iron castings both for Swaraj Tractors division and Swaraj combine division. The Swaraj foundary division has two cupala's several Jolt-severeeze moúldong machines, Sand recycliong plant, core making shop, a laboratry for testing of

sand and iron and a pattern making and maintainence shop.

SWARAJ ENGINE DIVISIONS:

It is being erected on Sahabzada Ajit Singh Nagar in Phase XI. This plant is being set up with the collaboration of Kirloskar Engines. The Foundation stone of this plant was laid by Governar of Punjab Mr. S.S. Ray in December 1987. This plant will produce Engines required for the swaraj tractors which at present are being bought from Kirloskar.

During the last 5 years PTL has also set up SWARAJ MAZDA LTD, a Rs. 400 million project in collaboration with world famous MAZDA MOTOR CORPORATION OF JAPAN for the manufacture of Light commercial vehicles (3.5 tonnes pay-load capacity). This Project has come up in a record time and went into production in April, 1984. PTL's equity in SWARAJ MAZDA LTD is 29% MAZDA and their associates SUMITOMO CORPORATION hold 26% of the equity. The remainder is being subscribed by the Indian public. SWARAJ MAZDA has done very well despite very tough compitition between nine LCV firms in India at present. Even the rise in the value of yen from 28 yens per one rupee to 12 yens per rupee could not stop Swaraj Mazda Ltd from prospering and conquering the market.

PTL has also recently entered into technical collaboration arrangements with KOMATSV FORKLIFTS CORPORATION of Japan, for enlarging it's range of forkligts both diesel and electric.

The total turn over of Punjab Tractors Ltd. in the current year is projected at Rs. 750 million.

PTL's BRAND NAME "SWARAJ"

The word %"SWARAJ" in Indian language means 'freedom from bondage'. Since PTL was the first large-scale project in Indian based totally on Indian technical know-how "Swaraj" was appropriately chosen as its brand name and all swaraj products are sold under this brand name.

With 80,000 tractors and 500 Harvestors combines operating in Indian farms SWARAJ is now a well established brand name in the country besides its 1500 tractors operating in various. African Countries also Swaraj is also now an Internationally recognised name in the developing world.

EXPORTS:

After proving it self in the intensely competitive Indian market, the Swaraj team was encouraged to step into a new visitas international market, in 1977. Detailed surveys of Countries like GHANA, TANZINIA, ZAMBIA, KENYA, SUDAN, UGANDA, INDONESIA, MALASIA ETC. were conducted during 1977-1980 and appropriate co-operate statergy formulated to enter the international market. As local testing is a prerequisite to import any new brand of tractors in these Countries, tractors were sent for testing and evaluation to all these Countries. Since testing and approval was a long and tedious process the commercial debut could start

effectively only in 1981. It is very surprising that this year our Finance Minister Mr. N.D. TIWARI gave away prize for best exports to marketing department PTL. So in simple words it can be said that SWARAJ connotes 'SUCCESS'.

ORGANISATION:

The man power of the company is 2750, the break up of which is as follows:

Senior Management	= 33
Middle level management	= 209
Supervisors	= 61
Workers and Staff	= 2347
	= 2750

The day to-day management is looked after by two whole time directors. The marketing, Personal, Finance and materials management is looked after by the managing director. All the manufacturing, research and development is looked after by vice Chairman and managing director. Research and Development, Quality control, Product servicing are looked after by one senior executive to ensure quick and effective reaction to marked sensitivity of the product.

The entire staff is qualified and well experienced in their respective fields.

BOARD OF DIRECTORS:

Following are the board of directors of PTL :

1) A.S. Chatha (Chairman)
2) S.P. Virmani
3) B.K. Kapur.
4) H.C. Gandhi
5) G. Balakrishnan.
6) K.L. Kapur
7) S.R. Guruswamy
8) T.S. Sahney
9) J.N.L. Srivastata.
10) Chandra Mohan (Vice Chairman and Managing Director)
11) Yash Mahajan (Managing Director)

The management of PTL is vested in autonomous board of directors comprising of:

1) Punjab Govt. nominees including the chairman
2) Nominee of Govt. of India through HMT
3) Nominees of Public Finance institution
4) Eminent personalities representing agriculture and private sector industries.
5) Whole time professional directors including the managing directors.

The Secretary of industries Punjab Govt. is the Chairman of PTL. The day to day management is completely rested for two

whole time directors, Mr. Chander Mohan and Mr. Yash Mahajan. Mr. Chander Mohan is an eminent Mechanical engineer with over 30 years of experience in Production, research and design whereas Mr. Yash Mahajan who is a qualified charted Accountant from United Kingdom has more then 25 years of experience with reputed organisation in Country and abroad.

DEPARTMENTS (PRODUCTION)	Nos.
Tool Room	36
Heavy Machine Shop	73
Light machine shop-I	74
Light machine shop-II	75
Heat treatment	76
Paint shop	77
Assembly	78
Research and development	20
Industrial Engg. department	33
Product reliability cell	22
Tool design.	35
Electrical Maintainence	38
Mechanical Maintainence	39
Product servicing	47
Production Planning and implement	61
Stores.	64
Quality control	80
Production Planning and control	60

DEPARTMENT (ADMN.)	D.NO.
Directors department	00
Internal Audits	11
Cost accounts.	12
Financial accounts	13
Personnel department	14
Management system	15
Administration	16
Marketing	40
Overseas Marketing	45
Purchase.	50

MANUFACTURING FACILITIES HEAVY MACHINE SHOP (HMS):

All heavy casting of Tractors and Harvestor combine are machined in this shop through a variety of special purpose Multi spindle (SPM) Boring and Milling machines. These machines are tailor made by Hindustan Machine Tools (HMT) of India to suit the component requirements. In addition facilities of this shop include General purpose turning (GPM), Drilling and Milling machines 25 GPM and 35 GPM's are installed in a covered area of 47,000 Sq. ft. and at a cost of Rs. 20 million. 3600 tonnes of castings are machined annually are two shifts basis. HMS is equipped with a 500 Kg. caparity electric hoost over every machine where castings have to be lifted and placed on the machines.

LIGHT MACHINE SHOP (LMS):

Facilities of this shop include equipment for blank preparation boring and broaching, gear cutting, straight bend gear generating, tooth rounding, gear shaving and grinding. Except Bevel Gear Generater and Gear shaver which have been imported from WMW and churchill respectively, balance machinery is from HMT & kirloskar. The Rs 31 million plant and machinery of t is shopare installed in an area of 33,000 sqft, and castings, forgings and Bar stocks worth Rs 24 million are machined annually. In view of this complexity of operation high standards of facility, this shop is manned by 180 highly

experienced operators and Qualified inspectors. It is divided into two parts LMS I & LMS II

HEAT TREATMENT:

The heat treatment shop being one of the most important shop includes facilities of Pit type gas casburising furnaces which have been imported from Degursa of West Germany, Induction hardening generators from East Germany, tempering furnace and washing machines from Wester works of India. These facilities have been installed at a cost of Rs. 7 million. In addition the facilities for shot blasting, hardness testing, metalographic chemical analysis of metals and castings, abrassive cuttings, straightning presses etc. are also available. The shop is operating on 3 shifts basis and manned by 18 skilled technicians and qualified Engineers. 1200 tonne of steel are heat treated annually.

ASSEMBLY AND PAINT SHOP:

The layout and equipment of assembly are designed for line production with extreme flexibility of changing production as per marked requirements. The branch lines for sub. assemblies join main lines to complete chasses. Sub assemblies are also inspected and tested on test rigs by Quality control personnel before their fittment on chassis. Although all individual components are fully cleaned in high pressure washing machines before the sub.assemblies are made, complete is again cleaned by steam cleaning process prior to their

T. I. E. T.

primer/final painting. The chassis is painted in Downdraft type painting booth of Bullows and then baked in convention type baking oven for ensuring longer paint life.

Because of the requirement of high quality painting of sheet metal, seperate facilities for de-rusting, de-greasing Zinc phosphating for better bonding of paint, passivation, Primer and final painting, Wet. rubbing and baking were set up at a cost of Rs. 3 million. The material handling in this area is handled with an overhead continoous conveyer. Sheet metal, tyves/tubes, electricals and their accessories are also fitted on main line after the chases backing. There after the road performance test, Hydrolic lift test, Roller testing are carried on every tractor before their despatch to store.

TOOL ROOM:

Tool Room's function is to feed the required tools in time (i.e. jigs, fixtures, hand tools, assembly tools cutting tools, measuring tools etc.) and to fulfill the different department requirments such as R & D work, maintenance department, work that is machine break down parts, reworking and new manufacturing, Production and other department works and venders requirments.

To meet all these requirments according to urgency and priority, tool room is facilitated with a large number of tool re-grinding, General pupose. Turning/ millings Drilling machines, Jig boring which are of high degree of accuracy.

To achieve higher degree of accuracy and other special and continuous type of work, the following special purpose machines are in the tool room;

1) WMW Jig Boring Machine (veb micrometer Dresden coy. BKOZ 900 x 1400)

2) Engraving Machine (Pentagraph.)

3) Bevel Gear Blades Reshaping Machine.

4) Carbide Impregnating Mahine.

5) Broach Reshaping Machine

6) WMW Hob Reshaping Machine

Punjab Tractors Limited has it's own code for the raw materials used in shop. The code starts with letter 'R' which means Raw material. It is followed by different number whose significance is given below:-

R = Raw material

R_0 = Misc. Material

R_1 = Steel unalloyed

R_2 = Steel alloyed.

R_3 = Cast Iron

R_4 = Steel castings

R_5 = Fabrication

R_6 = Non Ferrous.

Each raw material is given a colour code for identification. Every length of raw material is marked with its colour before it reach shops floor. The tooling material used in tool room and their ISI equivatents are given below:

PTL CODE	ISI EQUIVALENT	COLOUR CODE
R_{11} Mild Steel	C_{20}, S_1, 42 W. 513(0)	Red
R_{12} 40 Carbon Steel	C-40	
R_{14} Spring Steel	C-75	Red and Green
R_{21}	20 Ni, 55 Cr 50 M_o 20	Blue
R_{24} Tool Steel	T 105 Cr 1 Mn 50	Green

The various standard documents and reports generated by this section are as follows:-

1) Record of tooling under manufacturing
2) Record of tools completion
3) Tools History card.
4) Monthly completion report
5) Record of daily production report
6) Machine utilisation reportion
7) Record of daily idle hours due to tooling
8) Tool room inventory of various tooling under reworking and resharpining.

Graded Grey Iron Foundary

The graded grey iron foundary which was set up in 1980 has already attained a production level of 5000 tonnes per year. The plant and machinery installed at a cost of 14.5 million rupees in a covered area of 64.242 Sq. ft. include hot blast cupolas, complete sand recycling plant, High pressure sand moulding machines with pallet convayen system. Pattern repair shop chemical laboratories sand laboratories, knuck outs and fetteling shops are also important facilities in the foundary. Automatic quality castings in grades 15,20,25 and 30 with dimensional tolerances varying from ± 1.5 mm onwards and weights ranging from 10 to 300 Kg are presently handled because of high pressure sand moulding machines. Use of metal patterns is done to get better result, Core shop is is also one of the most advanced shop with all facilities that are required to get best quality cores for the casting.

RESEARCH AND DEVELOPMENT

Swaraj Tractors have a history of 14 years of Research and Development. With this history R and D occupies a very key position in PTL. Ever since the begining of commercial production of Swaraj 724, 26.5 H.P. Diesel Tractor, In April 1974, R and D has developed and commercially launched three more models, Swaraj 735, 39 H.P. low capital intensive but still having all the essential features of most modern tractors in the world, Swaraj 720, 19 H.P. Simple low cost tractor for the Small farmer and Swaraj 855, 55 H.P. tractor for commercial farmers.

The R and D Group then successfully developed the first design of a self propelled Harvester combine-again first time in India. More than 400 combines are already in the field.

INDUSTRIAL ENGG. DEPARTMENT

This section is mainly responsible for the method improvement of products and preparing one standards. It receives component drawings from R and D. It then prepares the process sheets of the components and also make the necessary improvements in the following:-

1) I.E. Department makes operation lines and prepares a list of machines required.
2) It takes care of all the material handling problems in the factory.
3) I.E. Department is helpfull in working out the solutions to the problems concerning machining processes, rejections and method simplification.
4) I.E. Department carries out time study to get standard hr times for various operations and setting times of the jobs and fixtures.
5) I.E, Department makes all the improvement, in the layouts and is responsible for the implantation of any new machine.
6) Calculation of incentives of the workes. their efficiency also comes under I.E. Department. Machine efficiency are also calculated here.

PROJECT:

To improve the layout of battery charging area and estimate the time required for charging of a battery.

INCHARGE OF THE PROJECT

1. Mr. Darbara Singh
2. Mr. Balbir Singh.

PROJECT:

To improve the layout of the battery charging area and estimate the time required for charging of a battery.

INTRODUCTION:

Battery is the most important component in a tractor. It powers self-start motor of the tractor, dashboard indicators, headlights, horn and parking lights.

Batteries for "SWARAJ TRACTORS" are obtained from the leading battery manufacturing company of India "CHLORIDE INDIA LTD". These batteries are sent empty (uncharged with no electrolyte in them) to PTL where they are first filled with electrolyte and then charged with the help of battery chargers for the required time. After which they are ready to be used in the tractor.

The three different type of batteries which are obtained from chloride India Ltd are:

1) 9 plates, 12 volts. battery for Swaraj 720
2) 11 Plates, 12 Volts, battery for Swaraj 724
3) 13 Plates, 12 Volts, battery for Swaraj 735 and Swaraj 855.

All the batteries give 12 Volts needed for various applications and are divided into six cells. Each of the cell gives 2 volts, thus making 12 volts when connected in series.

In the battery charging area the empty batteries are braught in from the storage area and then filled with the electrolyte - a mixture of sulphuric acid and distilled water. After filling the batteries are placed aside for about 8 to 12 hours so that a necessary reaction between electrolyte and plate material takes place satisfactoraly. The next operation is to connect the batteries, numbering about 10, in series with the battery charger. The battery charger is set to give a required current so that after 60 to 70 hours the batteries are fully charged. A lot of care is taken to ensure that the batteries are properly placed on a well insulated pallet and are not touching each other because some times batteries are wet and this causes shot circulating. The specific gravity of the electrolyte in the battery is also checked meticulousely after regular intervals with a special specific gravity checking apparatus. After the batteries complete about 60 - 70 hours of charging, they are disconnected from the charger and taken again to the filling station. At the filling station they are first washed with a stream of water and then dried. After this the batteries are ready to be taken to the assembly shop for fitting on the tractor. A petroleum substance is applied on the electrods of the batteries where connections are to be made. This helps in preventing leakage and making better connection.

NOTES ON BATTERY CARE

1. **STACKING:**

The batteries should always be stacked upright. In stacking at the most three to four batteries with a layer of hard card board between the two can be placed. This would prevent excessive load on the terminals of the batteries.

2. **STORAGE:**

The batteries should never be stored in open as whather changes can affect the battery life. More over the body of battery being black absorbs heat in Sun. This can increase the temperature of the battery and damage it. Maximum permissible temperature for a battery is 48°C.

So the storage of the batteries should be in such a place which is properely vantilated and prevents the direct heat of sun.

3. **INSPECTION:**

The batteries during transportation may get damaged. These damages can be inspected visually either wise the hairline, cracks can be inspected with the help of air pressure. This should be done prior to putting the electrolyte in the battery as the plates are to be saved from sulphation.

4. COMPOUND OF LID SEALING:

The compound with which the lid of the battery is sealed is a special kind of compound which gets softened when its temperature rises. So all the cracks and bubbles can be got rid of by oxy-acetelene flame. Its negative point is that while in sum when it soffens if may attract dirt which is undesirable.

5. ELECTROLYTE:

The electrolyte used in the batteries is a mixture of Sulphuric acid and distilled water in the ratio of 1:4. The acid used is of IS Specification 266. The water should conferm to IS 1069-1964 and it should be distilled or de-mineralised.

The electrolyte should be made by putting acid into water and not water into acid. The specific gravity of acid. for preparing initial electrolyte should be 1.190 at 27°C. The mixture can be stirred by wooden or plastic rod.

6. CHARGING RATE:

The charging of the 9, 11 and 13 plates batteries should be done for about 60-70 hours or per the requirement. The voltage during the charging of the batteries should be constant and the specific gravity of electrolyte checked at regular intervals before the charging is terminated.

7. BATTERY CHARGING AREA:

The layout of the battery charging area should be clean and properly ventilated so that the toxic gases like hydrogen which are produced during the charging of the batteries are got rid of easily. The access to batteries and charger should be easy.

As the electrolyte can prove to be addrasive to the floor so the floor should be covered with acid resistant tiles Since the tiles available are only acid resistant and not acid proof so the floor needs regular washing with water.

8. BATTERY FITTMENT:

The battery is fitted to the tractor on a special stand and is covered with a battery cover. The battery cover is attached to the stand with the help of long bolts and hexagonal nuts. When tightoned with spanner the nut can put excessive pressure on the body of battery. So it reccomended that wing nuts in place of hexagonal nuts should be used.

9. IDLE STORAGE:

It is the inherent property of lead acid batteries, they gets discharged itself if not put to use for some time. Although dynmo is provided in the tractor to recharge the battery when the tractor is working even then the battery should not be kept idle for more than three weeks.

So in the battery charging area a card system is suggested which keep track of date of receipt, issue from stores, initial silling charging and fittment on tractor.

NEED FOR THE PROJECT was felt as the battery charging area was to be brought under direct incentive scheme. At that time the workers working in the battery charging area were being paid indirect incentive i.e. they were not paid according to the work they were doing but according to the average efficiency of the other workers working in the assembly shop. These type of workers have to face a lot of difficulty concerning their work and the incentive they get, which are not at all related to each other. So to overcome this difficulty and to measure the work in the battery charging area this project was assigned to me. The Layout was to be changed as a part of method simplification exercise and then the estimation of standard time for the charging of a battery was to be done

Following were the points considered while changing the Layout of battery charging area:-

1) Reduced Risk to health and safety of employee.
2) Improved morale and worker satisfaction.
3) Increased output.
4) Power Production delays.
5) Saving in floor space.
6) Reduced inventory in process.
7) Greater utilisation of manpower and machines.
8) Reduced material handling.
9) Shorter manufacturing time.
10) Reduced indirect labour

11) Easier and better supervision.

12) Less congestion and confusion.

13) Reduced hazards to material and quality.

14) Easier adjustments to changing conditions.

The Layout was changed keeping in view of all the above points so that best results could be achieved. The results achieved are as follows:-

1) The distance moved by a pallet with batteries on it has been reduced by about 23%.

As we can see inproposed Layout the gate of store which was used for both bringing in and taking out the batteries is being used only for bringing in the batteries. The operation of taking out the batteries from the store for charging is being done through a new gate which will help in reducing the moved distance to a major extent. Another advantage of this change is that the main gate which is in such a direction that the sunrays directly fall on the batteries till mid noon, can be closed for all the time except for bringing the batteries inside

2) Saving in floor space and reduced congestion has has been achieved.

Since the storage for charged batteries have been brought near the exit so lot of saving in space can be observed by comparing the two layouts. Consequently a reduction in congestion has been achieved.

3) All the intersecting paths have been removed.

By companing the two layouts and observing the paths of flow of work it can be seen that the paths have been simplified and are not intersecting or confusing.

4) Material handling has been reduced to some extent.

We can see that earlier the electrolyte was brought near the exit by forklift. This electrolyte was then taken inside with the help of hydrolic trolley where it was poured into three small tubes and then into the empty batteries. But now the electrolyte is not brought at the main exit but at the side exit. Then it is not taken inside but instead it is poured in the tub placed at the door from whewe it is pumped to the SINTEX STORAGE TANK placed at some height. It then can be poured into batteries with the help of a pipe.

Calculations have been made for estimating the volume of tank required for storage.

Amount of electrolyte required for filling of the various batteries is as follows:

1) 12 v, 13 plates (Swaraj 735, 855)
   require 6.1 litres of electrolyte.
2) 12 V, 11 Plates (Swaraj 724)
   require 5.1 litres of electrolyte.
3) 12 V, 11 Plates (Swaraj 720)
   require 4.5 litres of electrolyte

The daily production of the tractors is about 40. If we take it to be 50 and considering all the wastage of electrolyte we get the required amount of electrolyte for daily use i.e. 50 x 6.1 = 305 litres of electrolyte.

Taking care of all the future expansion in production a 500 litre capacity can be recommended.

Where as in the present system the tanks of 100 litre capacity are used. We require 3 such tanks to fill the batteries up.

5) Risk to the health of workers have been reduced.

As we know that while pouring electrolyte ~~t/e~~ plate material comes in contact with the electrolyte and various reactions take place. As a result of these reactions a lot of toxic gases are produced which are harmful for the worker. So to avoid this harmful effect on the workers a exhaust fan near the filling station has been suggested. This will take care of all the gases produced during filling up of the batteries.

6) A pipe with many holes in it for spraying water on the floor of filling station has been suggested which can be fixed in the wall at a proper height so that all the electrolyte is washed away.

ESTIMATION OF THE TIME REQUIRIED FOR CHARGING OF A BATTERY:

LOAD FACTOR ℌ – the proportion of the over all cycle time required by the worker to carry out the necessary work at standard performance, during a machine controlled cycle.

In other words reciprocal of load factor indicates the number of machines a worker can theoretically attend to.

So load factor = $\frac{\text{Number of Men}}{\text{Number of Equipment}}$

No. of men = 1

No. of equipment = 14 (considering number of chargers equal to 12 for load factor calculations as two chargers were out of order)

So load factor = $\frac{1}{12}$ = .08

= .1 (Approx.)

Charging time for the batteries

= 72 hrs (3 days approx.)

Number of batteries charged per day

= 40 (As 120 batteries in 3 days so 40 batteries in 1 day).

Batteries have been arranged in such a way that per day production of the batteries is 40.

Charging time/Battery $= \frac{72 \times 60}{40}$

$= 108$ minutes.

Effective time = Charging Time x Load Factor

$= 108 \times .1 = 10.8$ minutes/batteries

Considering 20%. Allowances we get allowances

$= 1.73$ minutes.

So total time for charging of a signle battery

$= 10.8 + 1.73$

$= 12.53$ minutes.

Break up of Allowances:-

1) Personal need allowance = 5%

2) Power failure allowance = 5%

3) Interference allowance = 4%

4) Basic fatifue. = 6%

CALCULATION OF AVERAGE EFFICIENCY

Number of working days = 25

Total number of batteries charged/month

= 40 x 25

= 1000

Total load/month = 1000 x 12.53

= 12530 minutes

Total operator hours put in the job

= (12 x 7.5) x 60

= 11250 standard minutes.

Average efficiency = $\frac{1253 \times 100}{11250}$

= 111.3%

CONCLUSIONS AND RECOMMENDATION

The new layout which has been suggested has certain advantages over the present system. Points like saving in floor space, reduced congestion, better floor of work, workers safety have been achieved.

The efficiency and safety of the worker can be increased if the battery charging area could be made more airy because of the toxic gases present in the shop. The floor of the shop is also not even at some places which impedes the movement of pallets and thus result in low efficiency. It is recommended that the floor should be repaired as soon as possible. The workers should also be provided High Shoes so that the lower portion of the legs could be made invulnerable from the xp 3 plashes of electrolyte white filling up the batteries.

REFRENCES:

1) Practical Plant Layout

By Richard Muther

2) Work study

By Gupta and Patel.

3) Material Handling

By Immer.

4) Material Handling

By Apple

PROJECT:

To stream line feeding and handling of sheetmetal components in the paint shop.

Incharge of the Project

Mr. Ajay Gupta.

PROJECT:

To stream line feeding and handling of sheetmetal components in the paint shop.

INTRODUCTION:

Paint Shop is one of the most important shop in any automobile industry. It needs a lot of investment, accuracy and should maintain high quality standards.

Sheet metal components which are painted in the paint shop are not made in PTL itself but are obtained from its ancillary units. The sheet metal components are unloaded at the storage ment only for these components. These components are not clean so they have to be cleaned before they get painted. The cleaning process in which components submerged in various chemicals to get rid of dirt grease and other, undesirable elements is called "PRE-TREATMENT". This cleaning processes is a necessity because it not only provides a cleaned surface for painting but also a surface that enables the paint to stick on it permanently. The various tanks through which all the components have to be submerged, serve the following purposes in the same sequence as given below :

1) Degreasing
2) Rinsing
3) Pickling

4) Rinsing

5) Derusting

6) Rinsing

7) Phosphating

8) Rinsing

9) Passivation

All the tanks used for various purposes contain solutions/chemicals of required type but their composition and concentration is not disclosed due to industrial secracy reasons.

The components are fed from the storage to the pre treatment area through a continuous overhead conveyer known as Pre treatment conveyer (PTC). The small components are put into buckets and are attached to the hooks on the PTC, where as large components such as Fender, Tob bonnet etc are attached to the hooks as such. These components are then unloaded in the Pre treatment area. They are then put into a large bucket made of iron bars so that the components can be dipped in various chemicals for their Pre treatment.

After the pre-treatment of the sheet metal components is over, they are loaded on two other conveyers for painting. These two conveyers are ment for two Spray booths known as spray booth (I) and spray booth (II). Spray booth (I) conveyer is loaded with the components which are to be painted in spray booth (I) i.e. which are to be painted either Red,

black or blue. On the other hand spray booth (II) conveyer is loaded with the components which are to be painted in spary booth (II) i.e. which are to be painted either white or blue. Just after loading, the components are not simply painted but are first sprayed with primer. Primer provides a very good base for the paint and also with the use of primer the paint consumption is reduced. Primer also helps in getting good finish and lustur.

After giving a coat of primer and first coat of paint to the components, they are passed through Baking ovens which helps the paint to set dry fast and uniformly. The speeds of both the spray booth conveyers are fixed in such a way that the coated compoents get enough time to stay in the baking ovens and get properly and uniformly dried up. After coming out of ovens the components are ready for the second coat of paint. They are again made to pass through baking ovens for the last time. Then they are unloaded and sent to assembly shop. But unfortunately all the components do not go to the assembly shop because of being rejected by the quality control personnels. They have to go again to painting booths after being wet rubbed and putting applied on them. The rejection in the paint shop vary from 15% to 30% according to weather changes and quality of paint. Rejection in the paint shop are

also due to manual faults but there rejections can be reduced by educating the workers in this field. Another cause of rejections is the damaged sheet metal components.

Rims on the other hand do not require a coat of primer because they are already coated with red oxide. They simply have to be coated twice with white paint and then passed through oven. Rims need a lot of skill on thepart of workers of the spray booth. Because of the intricate shape at some portions on the rim, there is a maximum probability of flow of paint which can cause rejections of the rims.

NEED FOR THE PROJECT was felt when it was observed that the components after pre-treatment are not able to go over to the spray booth conveyers and were getting accumulated in the paint shop. This was causing a lot of inconvenience to the workers and supervisors of the paint shop. This accumulated material could not be loaded to the spray booth ~~mmmm~~ conveyers because the conveyers were already full and did not have any room for any more components. The reason for this was ill planning of the feeding sequence of the components to the pretreatment area from storage area. There was no synchronization between the PTL and two spray booth conveyers. This caused an increase in inventory level on the shop floor.

VARIOUS COMPONENTS IN THE PAINT SHOP AFTER PRE-TREATMENT

1) 15.2.1988 (9.00 AM)

1. Front False Plate = 102
2. Box Assembly = 122
3. Front Grille = 100

2) 15.2.1988 (2.15 PM)

1. Front False Plate = 77
2. Box Assembly = 39
3. Front Grille = 100

2) 16.2.1988 (9.00 AM)

1. Box assembly = 38
2. Front false plate = 12
3. Dash board = 14

16.2.1988 (2.00 PM)

1. Tob bonnet = 13
2. Front false plate = 12
3. Box. assy. = 28
4. Side Pannel = 15

3) 17.2.1988 (9.15 AM)

1. Fender = 20
2. Tool Box = 20
3. Upper and lower channel = 30

17.2.1988 (2.30 PM)

1. Tob bonnet = 35
2. Fuel tank = 24
3. Side Pannel = 24
4. Front shield = 42
5. Rear shield = 45
6. Dash board = 8
7. Seat frame = 8
8. Box assy. = 31

9. Perforated sheet = 50
10. Foot board = 25

17.2.1988 (4.15 PM)

1. Side Pannel = 24
2. Top bonnet = 25
3. Dash board = 13
4. Front shield = 46
5. Rear shield = 40
6. Fender = 15
7. Fuel tanks = 20
8. Seat frame = 8
9. Box assy. = 31
10. Perforated sheet = 50
11. Foot board = 25

4) 18.2.1988 (9.00 AM)

1. Fender = 13
2. Battery stand = 20
3. Seat frame = 40
4. Battery cover = 20

18.2.1988 (12.15 PM)

1. Fender = 24
2. Tool box = 30
3. Dash board = 23

4. Seat frame = 40
5. Front shield = 24
6. Fuel tank = 8

5) 19.2.1988 (9.00 AM)

1. Fender = 12
2. Seat frame = 40
3. Perforrated sheet = 40

19.2.1988 (2.00 PM)

1. Side Pannel = 38
2. Front shield = 24
3. Tool box = 12
4. Front grille = 12
5. Rear shield = 15
6. Battery stand = 12
7. Fender = 6

6) 20.2.1988 (8.45 AM)

1. Tool box = 31
2. Fender = 14
3. Dash board = 12
4. Fly wheel = 5
5. Top bonnet = 5

20.2.1988 (11.00 AM)

1. Tool box = 30
2. Tob bonnet = 12
3. Front shield = 30
4. Rear shield = 25
5. Seat frame = 12
6. Flywhee = 5

7) 22.2.1988 (9.00 AM)

1. Fender = 12
2. Fuel tank = 8
3. Fly wheel = 5
4. Perforated sheet = 20

22.21988 (2.45 PM)

1. Fly wheel = 5
2. Fuel tank = 3
3. Tool box = 25

8) 23.2.1988 (9.10 AM)

1. Flywheel = 5
2. Side pannel = 35
3. Top bonnet = 8

23.2.1988 (2.00 PM)

1. Box assy. = 30
2. Rear shield = 40

3. Front shield = 40
4. Upper and lower channel = 80
5. Perforated sheet = 50

9) 24.2.1988 (9.00 AM)

1. Tool box = 16
2. Box assy. = 20
3. Foot board = 20
4. Battery cover = 20

10) 25.2.1988 (9.00 AM)

1. Dash board = 10
2. Rear shield = 40
3. Upper and lower channel = 80

25.2.1988 (2.15 PM)

1. Fender = 3
2. Front shield = 15
3. Dash board = 4
4. Upper and lower channel = 80
5. Battery cover = 20
6. Battery stand = 40
7. Foot rest = 40
8. Front pa rting plate = 20
9. Bonnet = 12

11) 26.2.1988 (9.15 AM)

1. Fender = 5
2. Flywheel = 5

26.2.1988 (2.30 PM)

1.	Flywheel	= 5
2.	Fender	= 25
3.	Bonnet	= 20
4.	Side pannel	= 18
5.	Tool box	= 20
6.	Front shield	= 25

CONVEYERS

PRE-TREATMENT CONVEYER (PTC):

It is an overhead type of continuous conveyer which brings the sheet metal components from storage area to the pre-treatment area. The components are loaded on this conveyer according to a sequence provided to the workers by production Planning and control department. All the small components are put into buckets and then attached to the hooks on PTC, where as all the Large components are put on the hooks as such. These components are then unloaded in paint shop.

SPECIFICATIONS:

1.	Length of the conveyer	= 167.64 m
2.	Speed of the conveyer	= .457 m/min
3.	Distance between two hooks	= 1.04 m.
4.	Number of hooks	= 161
5.	Time elapsed between two hooks	= 2.27 minutes.

LOADING OF VARIOUS COMPONENTS ON P.T.C.

1.	Fender	1 (on one hook)
2.	Top bonnet	1 (on one hook)
3.	Dash board	2 (on one hook)
4.	Front shield	8 (on one hook)
5.	Rear shield	15 (on one hook)
6.	Front grille	10 (on one hook)
7.	Tool box.	10 (on one hook)

8.	Box assy.	= 10 (on one hook)
9.	Seat Frame	= 3 (on one hook)
10.	Moving plate	= 20 (on one hook)
11.	Instrument pannel plate	= 20 (on one hook)
12.	Pefforated sheet	= 20 (on one hook)
13.	Upper and lower channel	= 20 (on one hook)
14.	Front false plate	= 8 (on one hook)
15.	Foot board	= 10 (on one hook)
16.	Battery cover	= 8 (on one hook)
17.	Battery stand	= 3 (on one hook)
18.	Front parting plate.	= 8 (on one hook)

SPRAY BOOTH (I) CONVEYER:

It is an overhead type of continuous conveyer which is ment for the components which are to be painted in spray booth (I). In this spray booth the components are either painted blue, red or black. The shape of this conveyer is such that it passes near to the area where components after pre-treatment are unloaded. This enables the workers to laod the components on this conveyer very easily.

SPECIFICATIONS:

1.	Length of the conveyer	= 65 m.
2.	Speed of the conveyer	= 0.533 m/min.
3.	Distance between two hooks	= 1.04 m.
4.	No. of hooks	= 62
5.	Time elapsed between two hooks	= 1.95 minutes.

LOADING OF VARIOUS COMPONENTS ON SPRAY BOOTH (I) CONVEYER:

1.	Top bonnet	1 (on one hook)
2.	Dash board	2 (on one hook)
3.	Front shield	4 (on one hook)
4.	Rear shield	12 (on one hook)
5.	Box assy.	5 (on one hook)
6.	Perforated sheet	4 (on one hook)
7.	Fenedor	1 (on one hook)
8.	Upper and lower channel	20 (on one hook)

The components like Front shield, Rear shield, box assy etc. are attached on to a frame which in turn is hooked to the conveyer, paint is then sprayed on the whole attachement

SPRAY BOOTH (II) CONVEYER:

This overhead conveyer is ment for the components which are to be painted in spray booth (II) i.e. the components which are to be painted either blue or white.

This conveyer also passes near to the area where components after pre-treatment are unloaded. This components on the conveyer easily.

SPECIFICATIONS:

Length of the conveyer	= 91 m.
Speed of the conveyer	= 0.76 m/min.
Distance between two hooks	= 1.04 m.
Number of hooks	= 87
Time elapsed between two hooks	= 1.36 min.

LOADING OF COMPONENTS ON SPRAY BOOTH (II) CONVEYER

1. Fender	1 (on one hook)
2. Front grille	4 (on one hook)
3. Tool box	3 (on one hook)
4. Frame assy.	5 (on one hook)
5. Moving plate	15 (on one hook)
6. Instrument pannel Plate.	20 (on one hook)
7. Front false plate	8 (on one hook)
8. Side pannel	3 (on one hook)

THE SOLUTION TO THE PROBLEM of increased inventory level on the shop floor after pre-treatment has been given by synchronising the feeding of PTC with that of the loading of both the spray booth conveyors. We can see that by doing this we can very easily get rid of this problem. From the graph we observe that as soon as the sheet metal components arrive after being pre-treated, they are absorbed by the two spray booth. It shows that the feeding of PTC and spray booth conveyors have been synchronized in such a manner that every component which enters into the paint shop has a hook available for itself in a serial manner. For this a new feeding sequence has been given along with the timing of feeding for PTC.

On an average it takes about an hour for the charges to under go pre-treatment cycle. So the time elapsed between the coming out of two successive charges after pre-treatment is equal to the time required to fill up the later charge. The filling up of the later charge in turn depends upon the number of hooks of pre-treatment conveyer to fill that charge up.

Simillarly the time taken to load the charge which comes out after pre treatment on either of the spray booth conveyers is equal to the time elapsed between passing of the hooks of the conveyer that are required to load the given charge on the conveyer.

The filling timings of the charges and their loading timings have been so arranged such that any charge comes out only after the previous charges has been absorbed by spray booth conveyers. It has been taken care of, that both the spray booth conveyers area able to absorb the charges are readly i.e. the hooks required to load the various components are available on the conveyer.

Since all the charges have to be phosphated for about 10 minutes; So the minimum time that elapses between the coming out of two successive charges is 10 minutes. For example if it takes 4 hooks of the P.T.C. to fill up a charge then the time taken to fill up the charge is 4 x 2.27 = 9.08 minutes. But this time is less than 10 minutes, so we take 10 minutes as the difference in the coming out of the charges, in which later charge requires 4 or less hooks of P.T.C. to fill up.

From the graph it is seen that there are some vacant hooks on spray booth conveyers. There hooks have been left vacant so that rejections and reworks can hooked to them. Even if some hooks are left then they can be used for painting extra components and rims.

As we know that the length of the P.T.C. is 167.64 meters and its speed is 457 m/min.

time taken for 1 revolution = 366.67 minutes.

Time taken for half the revolution = $\frac{366.67}{2}$

= 183.33

= 3 hours (approx.)

This means that it takes about 3 hours for a hook to reach the paint shop from the store. Keeping this time in mind the feeding timings have been given in the graph.

PROPOSED FEEDING SEQUENCE

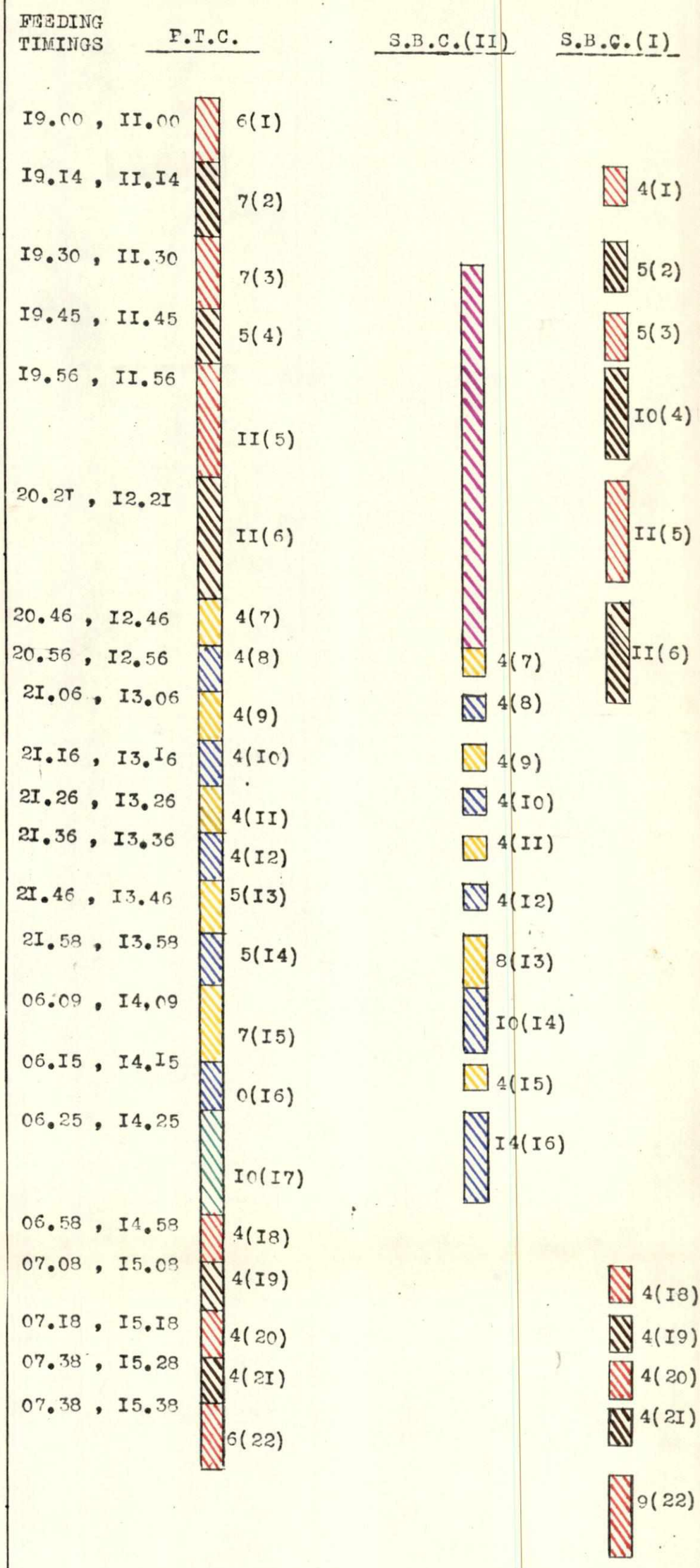
(PRODUCTION - 20 TRACTORS A SHIFT)

Charge No.	Components	Charge	Hooks PTC	Hooks SB(I)	Hooks SB(II)
1.	Rear Shield (L) 20 Rear Shield (R) 20 Battery cover 20	1	6	4	
2.	Dash board 10 Foot board 20	1	7	5	
3.	Dash board 10 Foot board 20	1	7	5	
4.	Front Shield (L) 20 Front Shield (R) 20	1	5	10	
5.	Top bannet 10 Lower channel 20	1	11	11	
6.	Top bonnet 10 Upper channel 20	1	11	11	
7.	Fender 4	1	4		4
8.	Fender 4	1	4		4
9.	Fender 4	1	4		4
10.	Fender 4	1	4		4
11.	Fender 4	1	4		4

PROPOSED FEEDING SEQUENCE

(PRODUCTION - 20 TRACTORS A SHIFT)

Charge No.	Components	Charge	Hooks		
			PTC	SB(I)	SB(II)
12.	Fender 4	1	4		4
13.	Moving plate 20 Front grille 20 Instrument pannel plate 20	1	5		8
14.	Tool box 20 Front false plate 20	1	5		10
15.	Seat frame 20	1	7		4
16.	Side pannel 40	1			14
17.	Front parting plate 20 Batt. stand 20	1	10		
18.	Fender 4	1	4	4	
19.	Fender 4	1	4	4	
20.	Fender 4	1	4	4	
21.	Fender 4	1	4	4	
22.	Box assy. 20 Peforated sheet 20	1	6	9	


FEEDING TIMINGS
P.T.C.
S.B.C.(II)
S.B.C.(I)
I9.00 , II.00
6(I)
I9.I4 , II.I4
7(2)
I9.30 , II.30
7(3)
I9.45 , II.45
5(4)
I9.56 , II.56
II(5)
20.2T , I2.2I
II(6)
20.46 , I2.46
4(7)
20.56 , I2.56
4(8)
2I.06 , I3.06
4(9)
2I.I6 , I3.I6
4(I0)
2I.26 , I3.26
4(II)
2I.36 , I3.36
4(I2)
2I.46 , I3.46
5(I3)
2I.58 , I3.58
5(I4)
06.09 , I4.09
7(I5)
06.I5 , I4.I5
0(I6)
06.25 , I4.25
I0(I7)
06.58 , I4.58
4(I8)
07.08 , I5.08
4(I9)
07.I8 , I5.I8
4(20)
07.38 , I5.28
4(2I)
07.38 , I5.38
6(22)
4(7)
4(8)
4(9)
4(I0)
4(II)
4(I2)
8(I3)
I0(I4)
4(I5)
I4(I6)
4(I)
5(2)
5(3)
I0(4)
II(5)
II(6)
4(I8)
4(I9)
4(20)
4(2I)
9(22)
A(B)
CHARGE NUMBER
NO. OF HOOKS

The timings in the graph are taken in the following way:

ON PTC:

If the hooks required to bring components for a charge are 5 that means it takes 5 x 2.27 minutes to fill that charge (2.27 being the elapsed between two hooks of PTC).

ON SPRAY BOOTH CONVEYERS I AND II:

If we require x hooks of conveyer I or conveyer II to load the components of a charge then it will take X x 1.95 and X x 1.36 minutes respectives on spray booth conveyer I and spray booth conveyer II.

CONCLUSION AND RECOMMENDATIONS:

In this project a new sequence of feeding list for the paint shop was conceived. The target of production was 40 tractors a day i.e. 20 tractors a shift at that time. This system will not only improve the blocked inventory problems but also help in dividing equal work among the workers of different shifts.

One recommendation which I would like to make is that a blower should be employed to blow components dry when they come out after pre-treatment. As these components have some chemicals remaining on their surface this can affect the hands of the workers. The workers should wear gloves as precautionary measure.

PROJECT:

Second shaft line (Load balancing and conversation.

INTRODUCTION:

In Light Machine shopd (LMS) all the light components such as gears, Shafts, Cage assembly etc. are machined. All these components require a large no. of operations to be performed on them so that they could be braught in the final form. Since all the operations can not be performed on a single machine so the components have to go to various different machines for different operations. The machines, being scattered all over the shop, cause a lot of material movement in the shop. The components are to be taken from machine to machine for next operations. This purpose is served by Forklight which are a versatile means of transportation on the shop floors. Although utmost care is taken while designing the layout of the shop floor to reduce the material movement to a minimum but it is not at all possible to eliminate it at all. The reason for this is that there are a large no. of components to be machined and all these components have different sequience of operations and standard setting times.

According to some experts "The least the material is handled the better it is handled". This shows that the material should not be touched very frequently while it is being

operated upon on different machines. In another words such a system is the best in which components are automatically moved to next machines without being delayed or stored. To get such a system we suggest a line system which encompasses two Principals:

1. Principale of Minimum distance moved
2. Principel of Flow.

Principle of minimum distance moved:

"Other things being equal, that system is best which permits the material to move the minimum distance between operations".

Every industrial process involves some movement of material. We can not eliminate it entirely. And we are usually willing to have it. When ever we divide up a process into several operations, we can put a specialist or specific machine on each operation. This specialisation of Labour and machinery is the heart of efficient production. But it means moving the material from operation to operation. This is why even though the handling does not alone add any value to the product itself we are willing to move material.

In moving the material, we save by reducing the distance of these moves, This means trying to place subsequent operations immediately adjacent to previous ones. We can thus eliminate transportation between operations, for one operation discharges the material where the next operation picks it up.

Principle of Flow:

"Other things being equal, that system is best which arranges the work area for each operation or process in the same order or sequence that forms, treats, or assembles the materials".

This is a complement to the principle of minimum distance moved. It means that the material will move progressively from one operation or process to the next towards its completion. There will be no backtracking or cross movement; congestion with other parts or with other process of the same part is at a minimum; material will glide through the plant without interruptrain.

Flow does not mean that material always has to move in a straight line. Neither does it limit the motion to but one direction. Money good Layouts call for zigzag or circular flow of material. The flow idea is one of constant progress forward completion with a minimum of interruption, interference and congestion - not necessarily on of direction.

Keeping in view the above mentioned principles of minimum distance moved and principle of flow a line is suggested which has all the machines arranged in the same fashion as the operation of the components, and are situated very near to each other so that a roller conveyer can be used for movement of material. This line will not have any problems concerning material movement nor will it have the problems relating backtracking if it is provided with double track conveyer at

required position. The components for this line can not be selected at random but have to be sorted out. The criterion for sorting out components from a large list is that all those components which have identical operations and approximately same standard and setting times can be selected for the line. In case the sequence of operations for the chosen components are very different from each other, some machines may have to be skipped and this requires a larger storage and sometimes can cause even the blockage of the line. If the components will be selected according to the above criterion then we will be able to get a line in which components once fed to the line can be obtained in the finished form at the end of the line.

A shaft line 'I' was concieved by I.E. Department personnels, with all the above points in their mind. In this line the components i.e. shafts were chosen as all the shafts had almost identical sequence of operations and even the standard times for operations on various machines were almost same. Shaft line I had seven shafts and this line came out to be very efficient. The reason being that once the batches of of shafts were feed to the line they could be obtained in the finished form at the other end of the line not even requireing any movement at all.

NEED FOR THE PROJECT was felt when it was observed that the shaft line I was proving to be very effecient and the remaining shafts need a similar line, ~~tehreh~~ which will also result in reducing the material movement in the shop. The area alloted to the shoft line II was parallel to that of shaft line I.

In this shaft line, no standard criterion was used for the selection of components. On the contrary all the remaining shafts which were being machined in the LMS. except those of shaft line I were assigned for this shaft line. This resulted in a collection of components with a variation of standard times of the various operations. Following shafts were considered for shaft line II.

A. <u>SWARAJ 720</u>

1. Intermediate shaft (122003A)
2. P.T.O shaft (150002)

B. <u>SWARAJ 724 AND SWARAJ 735:</u>

3. Intermediate shaft (222022)
4. P.T.O. shaft (250020)
5. Output shaft (222033)
6. B.P.S. Left (250006B)
7. B.P.S. Right (250007B)
8. Input shaft (222013A)
9. Connecting shaft (281051)

C. SWARAJ 855

10. Intermediate shaft (722022)
11. Input shaft (722013)
12. Lay shaft
13. Lay - shaft (702001)
14. Drive shaft (722055)

The next step was to make a flow chart with the help of which we could know the loads on the various machines in a more explicit# manner. Firstly we had to divide the quantity of various shafts into appropriate batches. The quantity for the various batches was known from PPC department. The batches were divided in the following way:

1. Intermediate shaft (122003A)

Quantity = 50
Batches = One of 50

2. PTO Shaft (150002)

Quantity = 50
Batches = One of 50

3. Intermediate shaft (222022)

Quantity = 800
Batches = Three of 250,250,300

4. P.T.O. shaft (250020)

Quantity = 900

Batches = Three of 300,300,300

5. Output shaft (222038)

Quantity = 900

Batches = Three of 300,300,300

6. B.P.S. Left (250006B)

Quantity = 900

Batches = Three of 300,300,300

7. B.P.S. Right (250007B)

Quantity = 900

Batches = Three of 300,300,300

8. Input shaft (222013A)

Quantity = 800

Batches = Three of 250,250,300

9. Connecting shaft (281051)

Quantity = 400

Batches = Two of 200,200

10. Intermediate shaft (722022)

Quantity = 100

Batches = One of 100

11. Input shaft (722013)

Quantity = 100

Batches = One of 100

12. Lay shaft (722002)

Quantity = 100

Batches = One of 100

13. Lay shaft (702001)

Quantity = 100

Batches = One of 100

14. Drive shaft (722055)

Quantity = 100

Batches = One of 100

After the batch quantities of the various shafts were decided the next step was to calculate the number of shifts a batch would require for machining on various machines. The machines on which operations of various shafts were to be done were obtained from the summary operation sheets of the shafts. Since all the operations to be done on the shaft line were before the heat treatment of the shafts so only the operations before the heat treatment were considered for all the shafts.

Number of shifts required were then calculated by using the following formula:

Number of shifts:-

$$\frac{\text{Quantity} \times \text{Stardard time} \times (\% \text{ Set up} + \text{Rel. SPD } 6\%)}{450 \times \eta}$$

SURCES OF INFORMATION FOR ABOVE FORMULAE

1) Quantity:

PPC department according to theproduction

2) Standard times:

Load charts up to date load charts available with I.E. Department

3) Percentage Setup time:

Set up time records.

4) Rejections. Spare Part division requirement:

6% according to the previous records.

5) (efficiency of Machines):

From previous records available

Following are the various machines along with their efficiencies and percentage set up times:-

	Percentage efficiency	percentage set up
Facing and centring M/C	92	17
S. Pilote I & II (168)	77	14
Drum-Turt RTV-60 (175)	86	11
Herbert No. 4 (145)	86	55
Cylindrical Grinding	113	25
Herbert No. 7B (146)	82	4.5
Gear hobber R 1-8 (622.01)	94	12
Gear hobber L-400 (624.03)	94	12
Gear hobber P-251 (623.01/.02)	94	12
Shaper 2A-Maxicut	102	32
Gear hobber L-400 (624.06)	94	12
GTR Okamoto (668.01)	89	18
GTR WMW (668.01)	89	18
Gear shaving G-16 (674.02)	94	20
Lath LB-20 (114)	72	12
Bench drill (402)	72	18
Milling FN-2V (224.01)	93	15
Milling MZH (214.01)	93	15

Following are the Summary operation sheets for the components of the second shaft line.

SWARAJ 720

1) INTERMEDIATE SHAFT

(122003A)

OPERATION NUMBER	OPERATION	WORK STATION
10	Material cutting	203 Cobra Hacksaw
20	D/E Facing and centering	295 D/E, F & C M/C
27	Copy Turning	168 S. Pilote
40	Capstan Turning	145 Herbert No. 4
50	Inspection	008 Bench
60	Hobbing:-	624
	Hob splines	L-400
70	Hobbing:	688
	Hob Gear	P-251/C
80	Gear Tooth	C53
	Rounding	GTR M/C
90	Deburring	Bench
100	Gear shaving	Gear shaver
110	Drilling	402 Bench Drill.

2) P.T.O. SHAFT

(150002)

OPERATION NUMBER	OPERATION	WORK STATION
10	Material Cutting	20B Cobra Hacksaw
15	Straightning	Straightning Press.
20	D/E Facing and centering	295 D/E, F/C machine
30	Copy turning Skim	168 S. Pilote
37	Copy turning: R and F copy turn	168 S. Pilote
47	Copy turning: R & F copy turn, cut grooFe	168 S. Pilote
65	Centre turning: cut groove	114 LB 20/1000
70	Centre Turning: Cut grooves	114 LB 20/1000
80	Inspection	008 Bench
90	Hobbing:-Hob Splines	623.02, P-251
100	Hobbing: Hob Splines	623.02, P-251
110	Deburring	008 Bench
120	Bench drilling	402, Bench drill
130	Inspection	008 Bench.

3) PART NAME : Intermediate shaft (735-724)

Part No. : 222022

Material : R-21

010	Material Cutting	203, Cobra hacksaw
20	D/E Facing and centering	295
	Face and centre both end	D/E, P/C, M/C
27	Copy turning	168
	F. Copy turn	S. Piloto
40	Capstan turning	
	Drill, C'SK Boro, Cut Groon	145
	F.Purn, C' for O.D & Rean	Herb. No. 4
050	Inspection	008 Bench
060	Hobbing	G. hobber L-400/
070	Hobbing	623, G.Hobber P-251
80	G.Tooth roundering	668.04
90	Deburring	4060 Bench
100	SHAVING	674
	Shave gear	Gear Shaver
110	Drilling	401
	Drill oil hole	Bench drill
115	Deburring	Bench - 008
120	Vert. Milling	224
	Mill notch	FN2 V
130	Inspection	008 Bench.

SWARAJ - 735

4/ Part name : PTO shaft

Part no : 250020

Material : R-23

010	Material Cutting	203
		Cobra Hacksaw
015	Straightning	St. Press
020	D/E cent.and Facing	295
	Face and centre both ends	D/E cent.& face
030	Centre turning	168
		S. Pilote
037	Copy turning	168
	R and F copy turn	S. Pilote
038	Straightening	713
	Straighten turned portion	St. Press.
047	Copy turning	168
	R and F copy turn	S. Pilote
055	Centre turning	114
	Form Groove	IB 20/100
057	Centre turning	114
	Cut grooves	LB 20/1000
060	Inspection	008 Bench
070	Hobbing: Hob Splines	P-251/623.02
080	Hobbing: Hob Splines	P-251/623.02
090	Deburring	060 Bench.
095	Inspection: Inspect Splines	008 Bench.

5) Part name : Output shaft

Part no. : 222038

Material : R-21

010	Material Cutting	203
		Cobra Hacksaw
020	D/E Cent. and Facing	295
	Face and center Both end	D/E. C/F, M/C
027	Copy turning	168
	R and F copy turn, cut groove	S. Pilote
037	Copy turning	168
	R and F copy turn	S. Pilote
050	Inspection	008 Bench.
055	Hobbing	
	Hob splines	622 - RHS
058	Hobbing	622
	F. Hob Gear	HR 8
080	Deburring	060 Bench
090	Inspection	008 Bench.

6) PART NAME : BULL PINION SHAFT (L)

PART NO. : 250006 'B'

MATERIAL : R-21

010	Inspection	008 Bench
020	D/E Cent. Facing	295
	Face and Cent. Both ends	D/E, C/F, M/C
027	Copy Turning	168
		S. Pilote
037	Copy turning	168, S. Pilote
045	Drill, Core drill, F.Bore Cut	RTV-50
	internal grooves 'C' for Bore	175
075	Hobbing: hob slines	623.02, P-251
080	Hobbing: hob sline	Gear hobber RH-8
085	Hobbing	624.04
	R Hob Gear	G. hobber L-400
090	Hobbing	Gear hobber
	F. hob gear	624.06
110	Deburring	060 Bench
120	Shaving	674
	Shave Gear	G. Shaver G-516
130	Drilling	402
	Drill oil hole	Bench grill
140	Inspection	008 Bench

7) PART NAME : B.P.S. (RT)

NO. : 250007'B'

010	Inspection	008 Bench
020	D/E Cent. and Facing	295, D/E, C/F, M/C
027	Copy turning	168, S.Pilote
037	Copy turning	168, S. Pilote
050	Inspection	008, Bench
060	Hobbing	623.02
	Hob Splines	P-251
065	Hobbing	624.04
	R. Hob gear	Gear hobber L-400
070	Hobbing	624.06
	F. Hob gear	Gear hobber
080	Hobbing	622
	Hob splines	RH-8
090	Deburring	060, Bench
100	Gear Shaving	674, G.S. 16
110	Inspection	008, Bench

8) PART NAME : INPUT SHAFT

NO. : 222013'A'

010	Inspection	008 Bench
020	D/E Facing and centering	D/F, F/C, M/L 295
040	Copy turning	168
	R and F face and turn	S. Pilote
047	Copy turning	168
	R & F copy turn & cut groove	S. Pilote.
060	Capstan turning	
	Drill, 'C' for, Ream and cut grooves	Her. 4-145
070	CKL. Grinding	K-130/500-535
072	Straightening	HYL.S$. Press-713
080	Inspection	008, Bench
090	Hobbing: hob splines	H-400-624
100	Shaping: Shape sptines	Max.cut, 2A-614
110	Hobbing: hob gears	L-400-624.06
120	Tooth rounding: Round spline tooth	350F GTR-668.04
125	Tooth Rounding: Round of gear tooth.	WMW-GTR-668
130	Deburring	060-Bench
140	Gear Shaving	Churchill-GS,165-674
150	Bench Drilling	Bench drill, 402
160	Inspection	008 Bench

9) CONNECTING SHAFT : (735 + 724)

NO. : 281051

20	F and C	259.01, D/E, C & F M/C
30	R and F cop. turn	S. Pilote, 168
40	R and F opy. turn cut groove	S. Pilote, 168
50	Drill, Ream, 'C'SK cur groove.	Herb 7B/146
60	Inspection	008 Bench
70	Hob Spline	P-251/623.02
80	Hob spline	H-400/624.04
90	Great tooth	668.04-GTR, Okam
90	Round off spline tooth	GTR-668.01
100	Deburring	060 Bench
110	Inspect	008 Bench

10) PART NAME : INTERMEDIATE SHAFT

NO. : 722022

010	Material Cutting	203, Cobra hacksaw
020	Facing and Centring	D/E, E & C, M/C, 295
030	Copy turning: R, S, F, F. copy turn and cut groove	168, S.Pilote
040	Capstan turning: Dril, Ream i.e. cut groove	Herb No.4/145
050	Turning	LB-114
060	Inspection	008, Bench
070	Hobbing: hob splines	H-400, 624.06
080	Hobbing: hob gear	P-251, 623
090	Gear tooth rounding	GTR-668.04
100	Deburring	006, Bench
110	Shaving	G.Shaves, 674.01
120	Bench drill	Bench Drill, 401
125	Deburr	008 Bench
130	Milling	MM 2V
	Mill Batch	224
140	Inspection	008 Bench.

11) PART NAME : INPUT SHAFT

NO. : 722013

010	Inspection	Bench, 008
020	Material Cutting	203, Power hakaw
030	D/E Facing and centring	295, D/E C & F, M/C
040	Copy turning	168, S.Pilote
050	Copy turning	168, S. Pilote
060	D/Turret Turning: Drilling, Reaming 'C' for a groove cutting	145, Herb, No.4
070	CYL. Grinding	535, K-130/500
080	Inspection	008, Bench
090	Hobbing: hob splines	624, G.hobber, L-400
095	Hobbing: hob splines	624, G.hobber, L-400
100	Shaping: Shape splines	614, Maxicut 3A
110	Hobbing: Hob gears	624.06, L-400
120	Tooth rounding: Round spline tooth	668.04, M/C
125	Tooth rounding: Round gear tooth.	668 WMW, GTR, M/C
127	Tooth rounding: Round gear tooth	668, WMW, GTR, M/C
130	Deburring	060, Bench
140	Gear Shaving	674, Churchill GS-165
150	Bench drilling	402, Bench drill
160	Inspection	008 Bench

12) COMPONENT NAME : LAY SHAFT (DUALEWTILE

NO. : 72202 'A'

10	Material Cutting	203, Power Hacksaw
20	Facing and centring	295 P & C, M/C
30	Capy turning: R & F copy turn groove	168 S.Pilote
40	Turret turning: Turn 'C' for, C, drill	146 Herb, No. 7B
50	Turret turning: Drill 'C' for C, drill	146, Herb, No. 7B
60	Inspection	008 Bench
70	Hobbing: Hob splines	624, [illegible]
80	Centre and turning cut threads	114, [illegible]
90	H.Milling: Mill slot	214, M 2H
100	Deburring	000 Bench
110	Inspection	008 Bench

13) NAME : LAY SHAFT

NO. : 702001

010	Material cutting	203, Cobra hacksaw
020	D/E Facing and centring	295.01 D/E, F/C, M/C
030	Copy turning: R and F copy turn and cut groove	168, S.Pilote
035	Copy turning: R.S.F.F copy copy turn and cut groove	168, S. Pilote
040	Capstan turning Dril, 'C'SK, Ream	Turret-7B(146)
045	Capstan turning : Drill, C'SK Tap	146-7B
050	Inspection	008 Bench
060	Hobbing : Hob splines	624, Grear Hobber H-400
070	Hobbing: Hob splines	624, Gear Hobber H-400
080	Centre turning: cut threads	114, LB-20
090	Horizontal milling: Mill slot	214.01, M 2H
095	Inspection	008 Bench.

14) NAME: : DRIVE SHAFT

NO. : 722055

10	Inspection	008 Bench
20	D/E facing and centering	D/E, F & E, M/C 295
30	Copy turning	S. Pilote, 168
40	Copy turning	S. Pilote, 168
50	D/Turret Turning	RTV-50, 175
60	Centre turning	LB-20, 114
070	Inspection	008 Bench
080	Hobbing	624.06, L-400
090	Hobbing: Hob spline	Great hobber, 624.
100	Deburring	060, Bench
110	Centre turning	LB-20, 114
120	Gear shaving	Churchill GS-165, 674
130	Inspection	008 Bench

With all the data collected shifts for all the shafts on various machines were calculated and written in a tabular form. The shafts were calculated using the formula.

$$\text{Shafts} = \frac{\text{Standard time} \times \text{Quantity} \times (\% \text{ Setup} + \text{SPD.Ref.6\%})}{\eta \times 450}$$

For example considering operation 020 of Intermediate shaft (Swaraj 720) on 295 Facing and centring machine:

Here:-

Operation no.	= 20
Standard time	= 2.8 min.
Efficiency of the machine	= 92%
Percentage setup time	= 17%
Quantity	= 50

$$\text{Shifts required} = \frac{2.8 \times 50 \times (1 + (.17 + .06)}{.92 \times 450}$$

$$= .415$$

Now the next step was to make a flow chart for all the quantity batches numbering 27. The shifts required on a machine were available in the table already made. While making the flow chart it was taken care that the sequence of the batches is such that we obtain a system with least material storage and with almost no idle time for the machines In another words that sequence was chosen by manipolation as a result of which the work flow is maximum with least idle time for machine and minimum storage of components.

		FACING & CENTRING M/C (295)	S-PILOTE I (168)	S-PILOTE II (168)	DRUM TURT RTV-50 (175)	HERB NO-4 (145)	CYL. GRINDING	HERB NO-7B (146)	GEAR HOBBER RH-8 (622.01)	GEAR HOBBER L-400 (624.03)	GEAR HOBBER D-450 (623.01/02)	SHAPER 2A-MAXI CUT	GEAR HOBBER L-400 (624.06)	GTR OKAMOTO (668.04)	GTR WMW (668.01)	DEBURR	GEAR SHAVING (674.02)	LATHE LB-20 (114)
		92,17	77,14	77,14	86,11	86,55	113,25	82,45	94,12	94,12	94,12	102,32	94,12	89,18	89,18	100,0	94,20	72,12
	SWARAJ 720																	
I	INTERMEDIATE SHAFT (QTY-50)	20 2.8 ·415	30 4.0 ·692			40 6.5 0·93				70 11.3 1·57	80 6.0 ·84			90 1.1 ·17		100,125 0·7,1·4 ·08,·16	110 2.8 ·42	50 2· ·36
9	P.T.O. SHAFT (QTY-50)	20 2.7 ·401	30 1.5 ·259	37,47 3·1,3·8 0·53,0·65							90,100 7·4,4·5 1·03,·63					110 0.6 ·07		57,65 1·9,2· ·34,·4
	SWARAJ 724,735																	
3	INTERMEDIATE SHAFT (QTY-800)	20 2.7 6·41	27 4.1 11·35			40 6·3 14·52				60 8·4 18·74	70 5·9 13·17			80 1.1 2·72		90 0·8 1·42	100 2·8 6·67	
4	P.T.O. SHAFT (QTY-900)	20 2.8 6·68	30 1.5 4·7	37,47 5·8,2·9 18·1,9·0							70,80 7·4,4·9 18·6,12·3					90 0·6 1·2		55,5 2·2,2· 7·2,7·9
5	OUTPUT SHAFT (QTY-900)	20 2.7 6·41	27 3·9 12·2	37 1·7 5·3					55,58 3·9,6·0 9·8,15·1							80 0·7 1·4		
6	B.P.S (L) (QTY-900)	20 2.9 6·69	27 3.0 9·3	37 3.0 9·3	45 23.1 62·85				80 5.3 13·3	85 5.0 12·6	75 6.1 14·8		90 8·1 20·32			110 0·7 1·4	120 4·6 12·35	
7	B.P.S (R) (QTY-900)	20 2.9 6·89	27 3·8 11·8	37 5·2 16·2					80 4·4 11·0	65 5·2 13·1	60 6·3 15·8		70 7·3 18·1			90 0·9 1·8	100 4·6 12·3	
8	INPUT SHAFT (QTY-800)	20 2·7 6·41	40 2·0 5·54	47 5·1 14·12		60 5·4 12·44	70 1·9 3·91			90 5·7 12·82		100 4·5 10·82	110 4·5 10·04	120 1·1 2·72	125,127 2·0,2·0 4·95,4·95	130 2·1 3·73	140 1·4 3·37	150 1·8 5·22
9	CONNECTING SHAFT (QTY-400)	20 2·7 6·41	30 2·0 2·8	40 2·3 3·2				50 4·4 5·3		80 3·4 3·8	70 2·9 3·2			90 0·9 1·1		100 0·6 ·5		
	SWARAJ 855																	
10	INTERMEDIATE SHAFT (QTY-100)	20 2·7 0·80	30 4·3 1·48			40 6·3 1·81					80 5·9 1·64		70 15·6 4·35	90 1·1 ·34		100,125 0·8,1·4 ·17,·31	110 2·8 ·84	50 2·0 ·73
11	INPUT SHAFT (QTY-100)	30 2·7 0·80	40 2·0 0·69	50 4·7 1·62		60 5·7 1·64	70 1·9 0·49			90 8·0 2·23		100 4·5 1·35	110 4·5 1·25	120 1·1 ·34		130 2·1 ·47	140 1·4 ·42	
12	LAY SHAFT (722002) (QTY-100)	20 3·1 0·92	30 3·8 1·31					40,50 17·3,13·1 5·18,3·92		70 18·4 5·13						100 0·8 0·17		80 4·5 1·64
13	LAY SHAFT (702001) (QTY-100)	20 3·1 0·92	30 3·8 1·31	35 2·9 1·004				40,45 3·3, 3·9 0·98,1·16		60,70 18·4,32 5·13,0·89								80 4·1 1·49
14	DRIVE SHAFT (QTY-100)	20 2·7 0·80	30 1·8 0·62	40 3·4 1·17	50 9·5 2·87					90 5·1 1·42			80 4·6 1·28			100 2·1 ·47	120 1·4 ·42	60,110 11·3,9·6 4·12,9·1

components. So these machines were included in the shaft line earlier. These machines were only having the load of shaft ~~&~~ line components but were situated far from each other. Now because of the flow chart an easily decision could be made to bring them closer in the shaft line.

2) Machines to be Surpassed.

Flow chart explicity explained the machines which were to be surpassed. For surpassing we require a double track conveyer so that the present components can lie on one track while the other components surpass the machine through second track. In our case the no. of shafts were large and almost every machine is skipped or surpassed by one or other component. So a over all double track conveyer is suggested except in front of three machines.

3) The maximum storage required for a machine:

Maximum storage for a machine is necessary as in some cases the standard time for operation is larger than the others. So the material has to be stored till all the previous material is machined.

4) The exact location and timing of the components:

Since the flow chart has been made for a month and date wise so we can easily know about the location and timing of the components any time we want to. In the flow chart it is seen that in some cases the load on the machine is more than the months load. In these cases extra time or shifts will be required to cope up with the situation.

Length of the aisle was also to be taken care of as in this case the pallets were to be taken off the coveyor tmack by the fork lift. This needs the fork lift to be first perpendicular and then lift up the pallet. This needed at least 4 meters of space were as in other cage 2.5 meters serve the purpose of feeding machine.

Compnaring the new shaft line II with the original method we can put forward some points:

1) First and the formost point is that with the making of the new shaft line II material movement in the shop will be reduced to a large extent. This will result in less traffic on the shop floor and less congestion.

2) Secondly the work flow through the shaft line would incease resulting in greater efficiency of man and machine where as on the contrary due to excessive material movement in the original method the efficiency is very low.

3) No extra space has been utilised for new system; Only the transfer of machines has been done. But this system will prove to be better than the original due to better planning.

4) Productiondelays in this proposed system would be very less as the material flow is very good. The operation times and loads have been balanced, which results in better work flow and lesser production delays.

5) By shortening distances and reducing idle material in delays and unnecessary storage, the time for material to move will be shortened thus getting more output in lesser time. This will also reduce indirect labour giving more efficient system.

6) All the machines being situated in confined area gives better chance for supervision and maintainance with work places ~~see all~~ in a row workers. In such a system. The supervision can also check the work comming through and going out.

7) This new system is also able to adjust to changing conditions.

REFERENCES:

1. Operations Research
By Hoera and Gupta.

2. Practical Plant Layout
By Richard Muther.

PROJECT:

To design a pneumatic lift for lifting of the trolley for Gear box assembly.

In charge of the Project

Mr. S.L. Verma.

PROJECT:

To design a pneumatic lift for lifting of the trolley for Gear box assembly.

INTRODUCTION:

Assembly of Gear box is done on a trolley. Specially designed for the purpose. The trolly is so designed that it provides a strong base for the Gear box while it is being assembled. The trolley has four wheels and it moves on a specially designed rack. The assembly of the Gearbox starts from one end of the rack and is completed when the trolley reaches the other end. This end being close to main assembly line, the Gear box is lifted by a crane and assembled with Differential housing. After the assembled gear box is removed for its fitment with differential housing, the trolley on which gear box was assembled becomes unoccupied and has to be taken back to the for end of the rack of next gear box assembly. Instead of picking up the trolley and taking it back for new assemblies a pneumatic lift system is used. In this system a lift brings down the trolley to the base where it is pushed on a track parrallel to to the above one and the other lift at the for end takes it up to its original position.

The lift is operated with the help of pneumatic cylinders. A pneumatic cylinder consists of a simple cylinder with a piston and two openings, one each on either end. When

When the pneumatic valuve is operated, air starts going inside the cylinder from one side of the piston and it comes out from the other side. This giving an outward motion to piston. And when the valve is reversed the air starts going inside the cylinder from the other side and comes out from the first side thus moving the piston inawards.

In the present system pneumatic cylinders are used to lift and bring down the trolley. This system employs, the system of rope and pulley, the ropes being pulled by two pneumatic cylinders. The upward and downward motion of the lift is guided by two rollers between two channel sections. The ratio of the cylinder stroke to vertical lift can be almost 1:1.

NEED FOR THE PROJECT was felt when it was found that the present system though working well was not efficient. There were a lot many loop holes in the system. Then are as follows:

1. This system has been designed with a factor of safety as 9 which is too much for such requirement.

   Force to be lifted = 70 Kg.

   Force available = 313 Kg x 2 = 626 Kg

   (Due to two cylinders)

   Thus F.O.S. = $\frac{626}{70} \cong 9$

2. The stroke length of the cylinders is of 70 cm, where as the lift requires only 40 cm of stroke length. The excessive stroke length results in loosening of rope and its disengagement from the pulleys.

3. The lift acts as a cantilever.

4. Due to the misalignment of pulleys there is excessive friction.

5. The height of the trolley is 30 cm, whereas the distance between upper and lower track is 40 cm. That means the clearance provided for the rolley is 10 cm which can be reduced to 5 cm, which is quite appreciable. This would help us in reducing the lift required to 35 cm.

6. 54978 cc of compressed air is being consumed in every stroke compared to the actual requirement of 31415 cc with the same mechanism.

7. Due to the idle stroke, the operating time is more.

8. The ratio lift/stroke = 0.57 for the present system indicating that the system is not good technically.

The proposed system employes lever mechanism which works with the help of single cylinder and the chief advantage being the ratio of lift/stroke = 2. (the drawing attached.)

OBSERVATIONS AND CALCULATIONS:

CONVEYER RACK:

Total height of conveyer rack	= 76 cm
Height of upper track from ground	= 66 cm
Height of lower track from ground	= 26 cm
Distance through which the trolley is to be raised	= 66-26 = 40 cm

TROLLEY:

Weight of the trolley	= 40 Kg.
Height of the trolley	= 30 cm.

LIFT CHANNEL

Weight of the lift channel	= 15 Kg.
Weight of wheels attached to the lift channel for guiding	= 15 Kg.

PNEUMATIC CYLINDER IN PRESENT SYSTEM

Diameter of each cylinder	= 10 cm
Stroke of each cylinder	= 70 cm

CALCULATION OF FORCES IN PRESENT SYSTEM

Force required to lift the lift channel along with trolley

= 40 + 15 + 15

= 70 Kg.

To get the force available from each pneumatic cylinder we use

$$FA = P \times A - \frac{20}{100} \times P \times A$$

$$P = 5 \text{ Kg/cm}^2$$

$$A = \frac{\pi}{4} (10)^2$$

$$FA = 5 \times (25\pi) - \frac{1}{5} (5)(25\pi)$$

= 313 Kg.

DESIGN AND STRESS ANALYSIS OF PROPOSED SYSTEM

Weight to be lifted = 275 Kg.

Due to this load the links may buckle in two planes perpendicular to each other. For buckling in vertical planes the links are considered as hinged while in horizontal plane the links are assumed as fixed at both the ends.

From the drawing it is clear that main load acts on the links at the bottomposition i.e. = 25^0

Force (F) required to attain the lift

$$= \frac{W}{\tan 25^0} = 590 \text{ Kg.}$$

W_{cr} = 590 Kg.

Let t_1 = thickness of link

b_1 = width of links.

Crossectional area of link = $t_1 \times b_1$

Assuming the width to be three times that of thickness $\Rightarrow$ A

$$= 3t_1^2$$

M.I of crossection of link = $I = \frac{1}{12} t_1 b_1^3$

$$= 2.25 t_1^4$$

We know that $I = A K^2$ where

K = radius of Gyration

$K^2 = \frac{I}{A} = 0.75\, t_1^2$

Equivatent length for vertical plane = 60 cm.

Rankine constant 'a' $= \frac{1}{7500}$

Using Rankine farmula

$$590 = \frac{3200 \times 3t_1^2}{1 + \frac{1}{7500} \times \frac{3600}{0.75\, t_1^2}}$$

$$9600\, t_1^4 - 590\, t_1^4 - 3776 = 0$$

$$t^2 = \frac{590 \pm (590)^2 + 4(9600)(377.6)}{2 \times 9600}$$

t = 4.8 mm.

We take t = 6 mm.

$\Rightarrow$ b = 18 mm.

Now considering the buckling in horizontal plane,

Equivalent length $= \frac{1}{2}$ = 30 cm

Again using Rankine for-mula,

$$W_{cr} = \frac{3200 \times 3 \times 2.5}{1 + \frac{1}{7500} + \frac{900}{0.75 \times .25}}$$

W_{cr} = 1463

this is more than the calculated one. Hence the design is safe.

DESIGN OF PINS

Let d_1 = diameter of Pins

Since the pins are indouble shear

$$\therefore P = 2 \times \frac{\pi}{4} d_1^2 \times f_s$$

$$d_1 = \sqrt{\frac{4P}{2\pi f_s}}$$

$$d_1 = 5 \text{ mm}$$

So we take d_1 = 5 mm

FORCE ANALYSIS

Force required to attain lift = 590 Kg.

We will use two pneumatic cylinders of 10 cm diameter and 18 cm stroke.

Using:

$$F_a = P \times A = \frac{20}{100} \times P \times A$$

Where $P = 8 \text{ Kg/cm}^2$

$$A = \frac{\pi}{4} (10)^2$$

F_a = 313 Kg.

Since we are using two such cylinders

Force available F_A = 626 Kg

Since $F_A > F_a$

The design is safe.

COMPARISON BETWEEN PRESENT AND PROPOSED SYSTEM

PRESENT SYSTEM	PROPOSED SYSTEM
1) Two Pneumatic cylinders of 10 cm dia and 70 cm stroke are being used.	1) Two Pneumatic cylinderd of 10 cm dia and 18 cm Stroke is needed.
2) There is an idle stroke of 30 cm.	2) There is no idle stroke.
3) The lift acts as cantilever.	3) The lift acts as simply supported at ends.
4) 10995 cc of air is being used in every stroke.	4) 2828 cc of air is needed for each stroke.
5) There is excessive friction.	5) Relatively less friction.
6) Operating time is more.	6) Operating time is very less.
7) Ratio $\frac{\text{lift}}{\text{stroke}} = 0.57$	7) Ratio $\frac{\text{lift}}{\text{stroke}} = 2.$

CONCLUSION AND RECOMMENDATIONS

A pneumatic lift with the advantages like reduction in air consumption, Increase in lift/stroke ratio, reduction in operating time, reduction in cost of cylinder has been designed.

There are a few things I would like to recommended.- One is that the lift channel should be made of some lighter and stronger material so that the load to be lifted could be reduced. Secondly, the system should be properly lubricated and covered so that the dust does not at all come near the sliding mechanism. This would cause a lot of friction and power loss. Thirdy, the lower track should be given a proper slant so that the trolley could reach the far end by it self i.e. without any pushing.

REFERENCES

1. Machine design
By Mr. R.C. Bahl.

PROJECT:

To balance the assembly operations for conveyerisation of assembly line till Engine coupling with gearbox.

INCHARGE OF THE PROJECT

Mr. Ajay Gupta.

PROJECT:

To balance the assembly operations for conveyerisation of assembly line till engine coupling with gear box.

INTRODUCTION

In the assembly shop, the assembly of the tractor is done on the trolleyes which move on the prescribed track only. The wheels of the trolley and the track are signed in such a way that the trolley does not loose the track. First differential housing is placed on a trolley and all the assembly work is done on it. After that Gear box is coupled with the differential housing and all concerned parts are assembled till the Engine coupling stage is reached. At this stage Engine is coupled with Gear box and another kind of trolley is used for supporting Engine. Thus the tractor rests on two trolleyes after the Engine coupling stage. After this stage the assembled portion is sent for chesis painting in the painting booth specially designed for chesis painting. A baking over follows the painting booth in which for quicker and uniform drying of the paint. After the paint has dried the assembled portion is taken to the electrical and sheet metal fitting. In these areas various types of electrical, and sheet metal fitments are assembled on the tractor. The radiator, fuel tank, exhaust pipe, tyres etc. are also fitted to the tractor. After filling diesel in the tank and water in the radiater the tractor is ready for various tests to be performed on it.

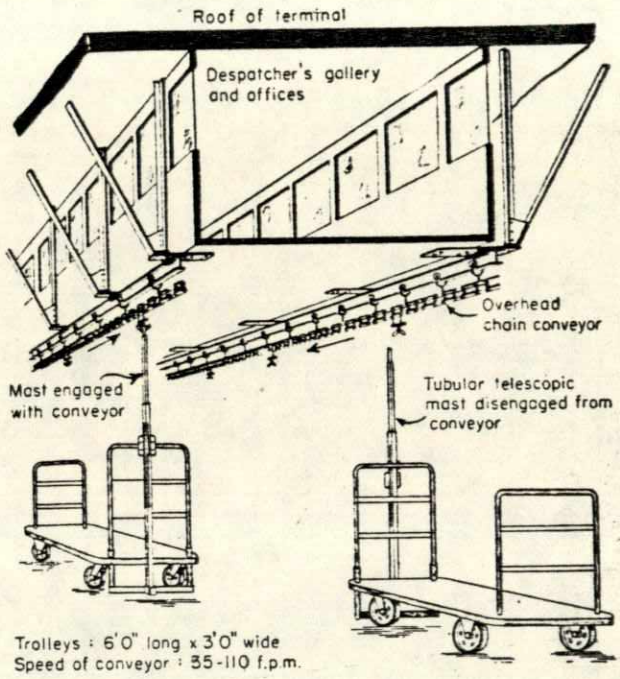
NEED FOR THE PROJECT was felt when it was observed that the trolleyer on which assembly of the tractor is done needed pushing while going from one stage to the next. The following are the disadvantages of pushing the trollyer from are stage to the next.

1. A lot of fatigue is caused to the worker as the weight of the trolley plus tractor is very large. Some times it is beyond the reach of a single person, so at least two persons are required to push the trolley.
2. An additional time of 2 minutes per stage has been given for the pushing purpose. This time per tractor amounts to be large when all the stages are considered.

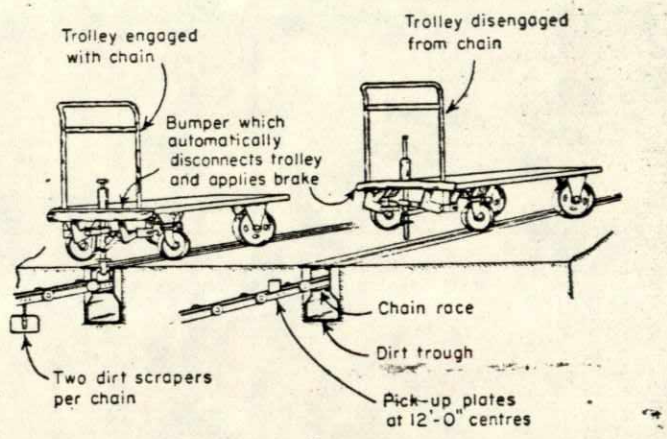
Thus on the average the system of pushing of trolleyer comes out to be very inefficient and time taking.

So, it was proposed that the assembly line should be conveyerised till the engine is coupled with the tractor. After that the tractor can be taken for painting on a different conveyer which will be of over head type of conveyer. The use of overhead conveyer is done so that the quality of of paint beneath the tractor could also be maintained as as being on whole of the body.

The solution to the problem can be given by balancing the various assembly operations. Standard times for all the operations are available and the space available for these operations is also know to us, thus an optimum speed of the conveyer can be found. The speed of the conveyer would be such that all the operations can be done in the space available to them and also the target of 22 tractors a shift can be reached.



a



b

FIG. 36. The tow-type conveyor has changed warehousing methods within recent years. The overhead type (*a*) is used where an existing structure or floor surface must be utilized. The floor-type conveyor (*b*), developed later, eliminated all overhead equipment. (*"Freight Handling," Anglo-American Council on Productivity. London.* 1951, *pp.* 18, 19.)

SUMMARY OF

STANDARD TIMES OF THE OPERATIONS OF ASSEMBLY LINE

1.	P.T.O	= 5.12 minutes
2.	B.P. Shaft (Land R)	= 6.56 minutes
3.	Cage assembly	= 29.05 minutes
4.	Tail Pinion carrier	= 9.3 minutes
5.	Back end assembly	= 72.65 minutes
6.	Rear axle and Trumpet housing	= 27.81 minutes
7.	Trumpet housing assembly	= 40.42 minutes
8.	Rig testing and P.T.O. assembly	= 13.83 minutes
9.	Gear box coupling	= 11.79 minutes
10.	Hydrolic pump coupling to Gear box	= 16.02 minutes
11.	Rear cover and clamps fittment	= 16.87 minutes
12.	Response control value assembly fittment to rear cover	= 2.15 minutes
13.	Steering assembly fittment	= 7.97 minutes
14.	P.T.O. shifter assembly	= 3.28 minutes
15.	P.T.O shifter assembly fitment	= 1.06 minutes
16.	Connections of hydrolic pump to response control value and torquing	= 7.16 minutes
17.	Breather Plug fitment	= 1.45 minutes
18.	Lower links and draw bar fitment etc.	= 6.20 minutes
19.	Angle bracket fitment	= 1.58 minutes

20. Rocker link fitment and tailor hook fitment = 2.43 minutes

21. Sensor tube sub assembly and to link fitment plus sensor tube fitment = 6.80 minutes

22. Brake sub assembly = 15.06 minutes

23. Brake fitment = 7.29 minutes

24. P.T.O shaft cover fitment and removed of rubber sleeve from its threaded part = 1.46 minutes

25. Fill oil in differential = 3.12 minutes

26. a) Couple chassis to testing
    b) Dip stick cover fitment with five bolts and inspect.
    c) Rivetting of stopper on control sector assembly = 29.51 minutes

27. Torquing of breathers plug = 0.29 minutes

28. Torquing of fastness and uncouple from testing rig. = 3.40 minutes

29. Brake pedal sub assembly and its fitmotment = 10.45 minutes

30. Assembly and fit clutch tie rod to tractor and linkage to brake pedal = 2.72 minutes

31. Drop arm fitment = 4.80 minutes

32. Parking brake sub assembly and fitment = 3.17 minutes
33. Fit battery mtg. frame = 1.63 minutes
34. Lock links to angle brackets by linch pins = 0.25 minutes
35. Foot board (L and R) foot accelerator fitment = 7.60 minutes
36. Engine coupling = 12.75 minutes
37. Front frame fitment = 2.38 minutes
38. Bonnet stand fitment = 1.78 minutes
39. Rear frame fitment and clamps = 2.05 minutes
40. Pick up and fit wiring clamp on differential and fit round pipe clamp on exhaust manfold by tighting screws with hand = 1.19 minutes
41. King pin stub Aexle fitment 8.70 minutes
42. Zero adjustment of stg Assbly = 4.47 munites
43. Tie rods fitment = 5.10 minutes
44. Throttle assembly fitment (Rane steering) = 1.83 munites
45. a) Cover plate plus tight ~~loosner~~ 4 screws of cover plate with nut runner = 2.51 munites
    b) Push rod assembly to rod only =
46. Fitment of fuel cut off rod = 4.32 munites
47. Torquing = 3.20 munites

SPEED OF THE CONVEYER

Total minutes in a shift = 480 min.

Working minutes = 480-30

= 450 min

Taking efficience to be 80%

we get the working minutues = 8 x 450

= 360 min.

Now:

Total distance of the assembly line to be conveyerised = 161 m

Production traget = 22 tractor/shift

Let the distance between two tractors on the coveyer = x m

Total distance required for 22 tractors

= 22 x. m

Speed of the conveyer = $\frac{\text{Distance}}{\text{Time}}$

= $\frac{22x}{360}$

$$3 = \frac{22x}{360}$$

or $x = 16.36$

Optimum value of x can be taken

= $\frac{161}{22}$

= 7.3 m.

Therefore

$$S = \frac{7.3}{16.36} = 447 \text{ m/min.}$$

From the above equation $x = 16.36\ S$ it is clear that as x increases, so would be the speed-increase. That means if the spacing between the trolleyes is increased the speed of the conveyer will also have to be increased.

From this equation one more thing is clear i.e. whatever may be the speed or distance chosen, the time elapsed between the tractors is 16.36 minutes. In another words a tractor reaches the same point only after 16.36 minutes of the passing of the earlier tractor. This infrence has been kept in mind while balancing the assembly operations i.e. it has been taken care of that no operation needs more than 16.36 minimum of the tractor. If it is so then there will be overlaping of the operations.

STAGE 1

The assembly of the tractor starts from the differential housing assembly. First the differential housing is placed on a trolley and then all other fitments made.

The standard time for all the operation before test rig in = 26.18

This job has to be done by two workers. So the time before test rig = $\frac{26.18}{2}$

= 13.09

According to this time the distance required to perform all operations is 13.09 x .447

= 5.85 m.

Since another trolley will come after 16.36 minutes and the worker is occupied for only 13.09 minutes so the remaining time of the worker can be used in other operation on in the sub-assemblies

STAGE 2

On the test rig the assembled portion has to undergo some tests. So they will have to be disconnected from the conveyer and taken out to the testing. The standard time for testing operations on the rig

= 31.04

But as the tractors would be coming after 16.36 minutes that means only alternate tractors can go to the test rig. Moreover the tractors can not be disconnected from the line to wait for its turn as this would block the line.

So to overcome this difficulty it is suggested that two test rigs should be made available. In this case all the tractors would be able to go to the test rig as alternate tractors come after 32.72 minutes where as time reavised on the test rig is only 31.04 minutes

STAGE 3

All the operations till trumpet housing assembly need only 15.50 minutes. If two workers are given these operations then the time for which conveyer would be required 7.75 minute.

The distance required for this work to be done in

7.75 minute = 3.46 minutes

STAGE 4

Now the next stage of the assembly is the trumpet housing assembly to the differential housing. This stage require about 40.42 minutes to accomplish. If two workers do this job then the work can be completed in 20.21 munites. And this work can be done in

20.21 x .447 = 9.03 m.

It is seen that in this stage the working time we are getting is more than 16.36 minutes. This is not desirable

but the only way to overcome this problem is to make three men work there. This is also not possible as it will cause a lot of congestion. In actual practice the time will come out to be less than 16.36 min.

STAGE 5

In this stage the differential housing is coupled to the overhead test rig and the standard time for this test is 13.83 minutes.

Since the test has to be performed by only one worker so the time taken will be 13.83 minutes. The distance for which this test will go on is 13.83 x .447 = 6.18 m.

STAGE 6

In the stage the differential housing is coupled to the overhead test rig and the standard time for this is

13.83 minutes.

Since the test has to be performed by only one worker so the time taken will be 13.83 minutes. The distance for which this test will go on is

13.83 x .447 = 6.18 minutes

STAGE 6

In this stage following functions have to be performed

1. Gear box coupling
2. Hydrolic pump coupling to gear box.

The time required for the above time operation are 11.79 minutes and 16.02 minutes respectively.

Total time required to perform these operations is 27.81 minutes. These operation hage to be done by 2 men so the time of the angagement with the conveyer is 27.81/2 = 13.90 min.

For this time the distance travelled by the conveyer is 6.21 minutes.

STAGE 7

This stage covers the fitment of rear cover to the differential housing.

Standard time required for the fitment = 16.03 min.
So the angagement of the workers
with the conveyer is for = 16.03 x .447
= 7.16 minutes

STAGE 8

This stage covers the following operation.

1. Response control value assembly fitment to rear cover
= 2.15 minutes
2. P.T.O shifter assembly
= 3.28 minutes

3. P.T.O. shifter assembly fitment

= 1.06 minutes

4. Connection of hydrolic pump to response control valve and tesquing

= 9.06 minutes

5. Breather plug fitment

= 1.45 minutes

The sum of all the operations is

= 13.82

So the distance through which the trolley will move while being worked upon is

= 13.82 x .447

= 6.17 m.

STAGE 2

Following operations come under this stage

1. Lower links and draw bar fitments

= 6.20 minutes

2. Angle bracket fitment

= 1.58 minutes

3. Rocker link fitment and tailor hook fitment

= 2.43 minutes

4. Brake sub assembly

= 15.06 minutes

5. Brake fitment

= 7.29 minutes

Sum of all the standard times being

32.57 min.

If two workers work on the above operations then the time required

= 16.28 min.

so the distance through which the conveyer will move

= 16.28 x .447 = 7.27 m.

STAGE 10

This stage include the following operation:

1) Sensor tube sub assembly and its fitment

= 6.80 minutes

2. P.T.O. shaft cover fitment and removed of rubber floor from its threaded part

= 1.46 m.

3. Fill oil in the differential

= 3.12 m.

The sum of all the times is 15.38 minutes and the distance required is 5.08 m.

STAGE 11

In this stage the trolley has to be taken to the test rig. The standard time required for undergoing the test is 29.51 minutes. But another trolley is available only after 16.36 minutes. So in order to keep the line moving we have to have two test rigs. Then only will all the tractors go on the test.

Along with the test the operation like torquing of breather plug can be done.

STAGE 12

Following opefations come under this stage:

1. Brake pedal sub assembly and its fitment
   = 10.45 minutes
2. Assembly of clutch the rod and linkage of brake pedal
   = 2.72 minutes
3. Parking brake sub assembly and fitment
   = 3.17

The sum comes and to be 16.34 and the distance required is:

16.34 x .447 = 7.3 minutes

STAGE 13

Following operation come under this stage:

1. Drop arm fitment = 4.80 minutes
2. Fitting of battery mtg. frame
   = 1.63 minutes
3. Locking of links to angle bracket by linch pins
   = 0.25 minutes
4. Foot board (L and R) plus , Foot accelerator fitment
   = 7.60 minutes

The sum of all the operations is 14.28 and if one worker does this work then the distance for which he is engaged with the trolley is 6.38 minutes.

STAGE 14

The stage include the following operations:

1. Engine coupling
= 12.75 minutes
2. Front frame fitment
= 2.38 minutes
3. Bonnet stand fitment
= 1.78 minutes
4. Rear frame fitment and clamps
= 2.05 minutes
5. Picking up and fitting of wiring clamp and differential
= 1.19 minutes
6. H.P.S.A. fitment
= 8.70 minutes

The sum of all the operations comes out to be 28.85. If two workers are put on this stage then the time required is 14.42 and hence the distance maximum required is 6.5 m.

STAGE 15

This stage covers the following operation:

1. Zero adjustment of stg. Assy
= 4.47 minutes

2. The rod fitment

= 5.10 minutes

3. Throttle assembly fitment (Rsme steering)

= 7.83 "

The sub of the standard times being 17.4 minutes and the distance required is 7.7 minutes.

STAGE 16

In this stage the following operations come:

1.a) Cover plate plus tight 4

Screws of cover plate with not runner

= 2.51 min.

b) Push rod assembly to

2. Fitment of fuel cut off rod

= 4.32 min.

3. Torquing = 3.25 min.

The sum of all the operation comes out to be 10.03 so the time of engagement of a workers will the conveyers is 4.48 minutes.