THESIS

A STUDY IN
WORKS-MANAGEMENT

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1913

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This thesis was contributed by

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A STUDY IN WORKS-MANAGEMENT

THESIS

Presented to the

DEPARTMENT OF MECHANICAL ENGINEERING

M.A.C.

In Partial Fulfillment For The

Degree Of

BACHELOR OF SCIENCE

By

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EAST LANSING, MICH.

JUNE 1913.

THESIS

12-4-51

EXPLANATORY NOTE.

The following thesis represents to a small degree the results of an investigation into the system of works-management as practiced in the plant of the Omega Separator Company of Lansing, Michigan. In this thesis, special attention has been given to the routing system employed in the machine shop.

The present plan is to limit discussion to the problem presented by the routing of the parts of Separator No. 14, since it is the most popular size made in the plant. The routing of the parts of the other sizes will be identical with that established for the parts of No. 14.

FORE - WORD.

In attempting a thesis of this sort, the writer has held two motives constantly in view. The first of these has been the desire to acquaint himself with average shop conditions and methods of manufacturing; and also to afford an opportunity for the exercising of his own ingenuity in detecting any faults, and offering suggestions for the corrections of such faults that are easily discernible. The second motive has been a desire to offer some practical suggestions to the management; whereby the output may be increased with no greater outlay of capital or overhead expense, or that the labor costs may be cut down for the same rate of production at which the plant is now operating. Either of these would be of tremendous value to the company in a financial way.

All suggestions contained herein are freely offered for the use of the company.

As preliminary reading, before doing any work in the shop, I referred to the following contemporary works: "Industrial Plants"- Day; "Scientific Management"- Evans; "Factory Organisation"-Diemer.

I wish to take this opportunity to thank Mr. Wilford and Mr. Billings of the company for the very willing assistance they rendered me.

:PROBLEM:

Can a practise of systematic routing eliminate confusion to the extent of increasing the daily production-rate from its present number (35) to a much greater number, possibly fifty?

METHOD OF ATTACKING THE PROBLEM.

Since the principal problem concerned the routing of parts through the machine shop, the first steps of the investigation were concerned with drawing a plan of the machine-shop as it now is, and mapping the machines and usual routes that the various separator parts now follow. (Blue-print 1.)

The machines were numbered and identified with their particular jobs in the following:

MACHINE SHOP INVENTORY.

Number of Machine	Kind of Machine	Job.
1	Milling-m	Tool-room
2	Eng. Lathe-	Tool-room
3	Eng. Lathe-	Tool-room
4	Small drill press	Tool-room
5	Small Emery	Tool-room
6	2-Spind. Drill-press	I.Op.3-Frame Jig-drill
7	Multi-spindle drill-press	———————
8	Drill-press	Jig-drill Cranks 7/8"-hole-564
9	Drill-press	House frames
10	Small drill press	II.Op.3-Frame-Jig-drill
11	Eng. Lathe	Small parts
12	Eng. Lathe	Small parts
13	Eng. Lathe	Small parts
14	Arbor press	Press crank bushings
15	Eng. Lathe	Bore and Face Frames
16	Eng. Lathe	Small parts
17	Eng. Lathe	Small parts
18	Eng. Lathe	" "
19	Eng. Lathe	" "
20	" "	" "
21	" "	" "
22	" "	" "

Number of Machine	Kind of Machine	Job
23	Eng. Lathe	Small parts
24	" "	" "
25	" "	" "
26	" "	" "
27	" "	" "
28	" "	" "
29	" "	Hob Bronze worm gears.
	Hobbing attachment	
30	Eng. Lathe	Small parts
31	Small Drill-press	Jig-drill tub.-shaft
32	Shaper	_____
33	4-Spindle drill press	_____
50	Hobbing Machine	Hob pinion-helical & worm-gears
51	Milling-m. 3-cutter	Op.2-Frame and mill cranks
52	Milling-m	Skim-milk and cream holes-564
53	Grinding Machine	Worm-spindle
54	Milling-m	Small parts
55	Hobbing Machine	Hob- worm-spindle.
56	Small mill	Notch tub shaft
57	Turret- lathe	Drill & ream tub shaft
58	Milling m	Op.D., tub shaft
59	Turret-lathe	Op.3 on bowl-shell.
60	Turret-lathe	Op. 4 on bowl-shell

Number of Machine	Kind of Machine	Job
61	Small turret lathe	Turn Spindles
62	Small turret	Small parts
63	Small drill-press	Small parts
64	Milling-m	Op.C. Tub.Shaft
65	Milling-m Straddle	Op.A Tub.Shaft
66	Drill-press	———
67	Heavy milling-m	Op.7-Frame Op.B-Tub.Shaft
68	Drill-press	Op.3-Frame
69	Drill-press	Tools
70	Drill-press	Op.3-Frame
71	Turret-lathe	Small-parts
72	Small turret-lathe	Bore, ream and turn worm gears
73	" " "	"
74	Heavy turret-lathe	Rough-turn tub.shaft
75	Turret lathe	Face and drill helical gears
76	Grinding machine	Pinion gear shafts
77	Turret-lathe	Small parts
78	Hack Saw	

Owing to the lack of time, attention will be paid only to the routing of the more important parts, as follows: frame, 816; tubular shaft, 588; spindle, 645; bowl-shell, 564; crank, 781; helical gear, 773; pinion gear, 789; and worm gear 809. Having drawn the present routing plan, the next step was to ascertain whether the machines now installed in the plant were used up to their full capacity in the manufacture of the various parts. To this end, the time slips made out for about a dozen different days were carefully studied and the important facts concerning the job, the time, the number of pieces made, and the machine used, were tabulated. By this means the detailed time and job schedules of the various machines were accurately determined. Having this information in hand, the time required for each machine to perform its operation upon fifty of the parts with which it is usually occupied, was computed. The following route-schecule of parts was then made up:

ROUTE SCHEDULE OF IMPORTANT PARTS

PART	OPERATIONS	NUM. of MACHINE	TIME TO MAKE 50
Spindle 645	Turn	61	?
	Hob.	55	?
	Grind.	53	4:30
	Mill	56	1:30

PART	OPERATIONS	NUM.OF MACHINE	TIME TO MAKE 50
BOWL-SHELL 564	1. Drill 7/8" hole	8	
	2. Face to Length	59	5:00
	3. Bore & Turn	59	7:15
	4. Finish out-side	60	5:00
	5. Inspect		
	6. Jig-Drill holes	10	2:45
	7. Mill 15/32" hole	52	3:15
	8. Mill 2/32" slot	52	3:00
	9. Ream Neck		
	10. Inspect		
	11. Fit up on Bench		
	12. Inspect		
	13. Polish		
	14.Tin		
	15 Inspect		
Helical Gear 773	1. Grind		6:00
	2. Rough Turn and Bore	75	5:30
	3. Hand Ream		1:30
	4. Finish Turn and	Lathe	
	5. Face	"	6:45
	6. Hob.	50	?
Pinion Gear 789	Cut-Off	Lathe	?
	Turn	Lathe	?
	Hob	50	?
	Mill Spots	Idle Mill	?

PART	OPERATIONS	NUM.OF MACHINE	TIME TO MAKE 50
WORM GEAR 809	Drill & Ream	72	3:45
	Straighten	72	3:00
	Turn Bevel	73	6:15
	Hob	29 or 50	9:30 ?
Tub Shaft 588	Rough-Turn outside	74	5:00
	Turning to Size	6 Eng.Lathes	
	#Mill Op.A.	65	10:00
	#Mill Op.B 2 Cutters	67	5:00
	#Mill Op.C	64	8:00
	#Mill Op.D	58	10:00
	Mill Notch	56	:45
	Drill & Ream	57	12:00
FRAME 816	1.Grind	———	7:30
	2.Mill-hubs	51	6:30
	3.Jig-drill bearing holes	68 & 70	11:00
	4.Ream	I.B.	4:00
	5.Bore & Face	15	7:00
	6.Mill Back	67	5:00
	7.Jig-drill small holes	6 & 10	10:00
	Rouse boss	9	3:30
	8.Mill Stop-screw boss	56	2:00
CRANK 781	Grind	———	2:00
	Mill Faces	51	1:45
	Jig-drill & Ream	8	6:00
	Press in Bush	14	

See Page

OPERATION AND MACHINE

MILLING OP. A.
MACHINE 65.

MILLING OP. B.
MACHINE 67.

MILLING OP. C.
MACHINE 64.

MILLING OP. D.
MACHINE 58.

This route-schedule suffices to show clearly that if the daily rate-production were increased to fifty, not more than one or two of all the machines would be seriously crowded by the press of work. To still all doubt regarding the ability of the few multi-purpose machines to take care of the various jobs thrust at them, a separate time schedule was made out for them. This schedule clearly indicates that only two of the multi-purpose machines need be operated at their ten-hour-day capacity. This schedule follows:

TIME SCHEDULE

OF

MULTI-PURPOSE MACHINES

Num. of Machine	Jobs	Time to Make 50	Idle time in 10hr.day
50	Hob Gears: Helical	?	
	Worm	?	
	Pinion	?	None
51	Op.2. Frame	6:30	
	Mill Cranks	1:45	1:30
56	Notch Tub-Shaft	:45	
	Op.6, Frame	2:00	
	Mill Spindle	1:30	5:00
67	Op.7, Frame	5:00	
	Op.8, Tub Shaft	5:00	None
8	Drill Cranks	6:00	
	Op.1, Bowl-Shell	2:00	2:00

Having thus clearly established that the present equipment ought to be capable of handling a daily production of fifty separaters, the next step was to arrange the machinery in its logical order. This new order is shown on Blue-Print 2. In laying out the plan of re-arrangement, a constant effort was directed toward a realization of the following shop conditions of industrial efficiency.

1. Accessability of machines, especially those at beginning and end of a route path.

2. Logical arrangement, consistent with capabilities of machines and the line of least resistance for the work.

3. Minimizing of trucking work.

4. Maximum day-illumination.

In the proposed plan, at least the first three of these have been realized. The route-lines show the uselessness of trucking; the work may be handed from one machine to the other. The work will need trucking only when it is brought into the shop and again when it leaves the shop. It is estimated that this routing plan would enable the company to dispense with four of the present trucking force consisting of five men. The saving that would result in this department alone would amount to approximately $2000 per year, at a conservative estimate.

A logical arrangement of machinery would eliminate practically all of the operating confusion now existing in the shop. The work would flow more smoothly and quickly from one machine to the next.

The capabilities of the machines being known and accounted for in the new arrangement, each machine would be taxed to its full capacity, decreasing overhead costs and thereby lessening the cost of production. Each machine will be given its specified work to do, and all congestion resulting from the present plan of sending work at a machine with no definite knowledge regarding the machine's capacity to handle the work, will be relieved. In the new plan, the work always flows in one direction and no job is allowed to interfere with another, all of which tend to minimize disorder within the shop.

Under the new plan, with the 40% increase in production, there will be a few machines that will be used at their full capacity, which is the ideal way of using machine-tools. The spindle hobbing machine will probably be used at its full capacity. The hobbing machine will undoubtedly be kept busy all day by the hobbing work upon the three gear-wheels. The drill presses 68 and 70 will be kept busy 11 hours each day and to take care of the overtime, drill press 69 (identical with 68 and 70) was placed adjacent to them in the new plan. Lathe 57, boring and reaming tubular shafts will be required to work 12 hours a day at its present rate of operation. Investigation shows however, that the drilling operations are not done at more than 75% of the speed of which the drill is capable. The $\frac{3}{4}$" hole, 4" deep, ought to be drilled at a feed of .01" per revolution and at 110 revolutions per minute. At this rate, the hole should be drilled in 4 minutes. The $\frac{1}{2}$" hole should be drilled in half of that time, since it is only half as deep. The combined

drilling operations on the tubular shaft should not total more than 7 minutes, and allowing for chucking time, this machine should work at the rate of one every 10 minutes or 50 in a 9 hour day.

In the new plan, the same number of machines will be available for other jobs, as the present plans provide. These are shown on both plans, and for the most part consist of engine lathes. In the re-arrangement, drill-press 66 and shaper 32 have been moved into the tool room, since they are used mainly for tool-room work.

CONCLUSION.

The plans clearly show the defects of the existing system and the advantages to be gained by a change of the interior shop arrangements. That the present equipment is capable of a 40% increase in the production-rate, has been conclusively demonstrated by a close study of the capabilities of the machines. With the elimination of the existing confusion, and the substitution of systematic routing of parts, for the plan now followed, there can be no reasonable doubt that the plant production will be greatly increased with no further investment in machinery.

GENERAL SUGGESTIONS.

In the consideration of the routing system, the writer has incidentally thought of other suggestions for changes, which are here set forth in brief form. It is thought that any of these suggestions might be investigated and found to yield very profitable possibilities.

INSPECTIONS. Whenever possible, it is advisable to perform inspections in the machine shop, since then there is no need for the maintenance of expensive trucking crews. To this end, inspection benches should be established at such points in the routes of the various parts where inspections have been found necessary. Instead of the expense, inconvenience and confusion of having the work brought to the inspector and later trucked back into the machine shop, the inspector can visit the various inspection benches established in the shop itself, and thus eliminate much of the confusion and all of the trucking expense incidental with the present system.

If, however, it is found inadvisable to alter the plan of inspection, the method of doing the necessary truck can be easily and profitably changed. The parts of the separators, as they come from the various machines should be deposited in suitable boxes or frames, which can in turn be easily loaded onto or taken off of the trucks. The present practice of picking the parts from the floor and transferring them one-by-one to the truck and unloading them at the next machine in the same manner, is all tremendously wasteful of time and money.

A very good system of trucking is exploited by the Cowan Truck Co., of Holyoke, Mass. Their advertisement appears on page 55 of the May 22nd number of "American Machinist."

The inspection system now in use, is very complete, - possibly too much so. In many instances, the work is inspected two or three times in the very early processes of its manufacture. The purpose of these early inspections is to prevent any operations being done on unfit material, and to secure the rejectment of such material as early as possible. Manifestly however, these early inspections should not be done, unless the cost of the subsequent operations on such material would have been greater than the cost of inspection. Where spoiled work occurs only rarely, it is not economical to maintain a system of early inspections to eliminate such work. It would be more profitable to let such work go through to the final inspection for rejectment. In any case, the cost of <u>early</u> inspection should be less than the cost of the damaged material rejected. In other words, early inspections should pay for themselves, or be discarded.

The mechanical work of inspection could be more efficiently done by means of an application of the principles of motion study#.

WAGE SYSTEM. In view of the thoroughness of the present system of inspections, it might be found advisable to change the hour-wage system to a piece-rate or bonus-rate system. With the

Gilbreth - "Motion Study."

hour wage, early and extensive inspections ought to be unnecessary. With a piece or bonus-rate, greater production would be secured, but the degree of inspection would need to be raised.

TIME SLIPS. The time slips ought clearly to give the following very valuable information: 1. Job and operation; 2.Pieces made; 3.Time consumed; 4.The workman's number; and 5.The machine used. These items will furnish means of comparison of abilities of men and of machines for doing a certain piece of work. It will then be possible to select the man and machine best fitted for a certain job. This specialization is advisable, because the time slips now show wide discrepancies in the abilities of two men to perform the same operation. Obviously, the best man should be chosen for any particular job, and his fitness for a job can be determined by his records of productivity of unspoiled work. In furtherance of this idea , a record should be kept of the amount of work each man spoils, and more than a reasonable amount of spoiled work should be assessed against him.

An hour-rate means leisurely work. There is no stimulus for getting the best results out of a man. The fact becomes especially apparent after a short study of the time-cards of the grinding room. Some jobs, notably rough grinding, drilling etc., could be placed upon a piece-work basis very easily and with better results than are now achieved under the hour-rate system.

SMALL PARTS. The small parts, such as screws and bolts etc., can be bought of companies who made a specialty of such work, more cheaply than they can be made. Some parts, notably the spindle

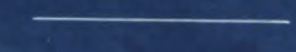
bearings could probably be die-cast of white metal more cheaply then they can be made.

FINAL SUMMARY.

The physical changes, such as the re-arrangement of machines and the systematizing of the trucking and inspecting plans, could be easily adopted with scarcely any friction being evolved with the workmen. Changes of wage and the like, would however require a great deal of diplomacy and must of necessity be therefore made very slowly and tactfully.

INDEX.

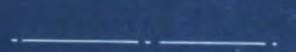
Conventions for Routes



Frame. Part 816.

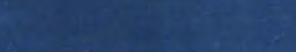
Tub. Shaft. Part 588.

Spindle. Part 645.

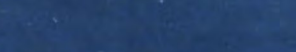


Crank. Part 781.

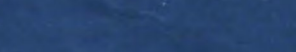
Bowl Shell. Part 564.



Hel. Gear. Part 773.



Pin. Gear. Part 789.



Worm Gear. Part 809.

S——F Denote Starting and Finishing Points, Respectively, of the Path of a Part.

——o—— Small Circle on Route of Part Indicates that Operation was Performed at that Point.

I.B. Indicates Inspection Bench.

Pocket has: 2 Plans