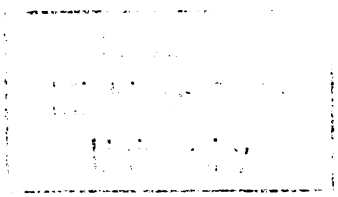


Scientific Management

for

M. A. C. Shops.

A Thesis Submitted to

The Faculty of

The Michigan Agricultural College

By

E. E. Beatty

Canditate for the Degree of

Bachelor of Science

June, 1916.

Scientific Management

for

M. A. C. Shops.

Owing to the great development that has taken place in the secondary schools of this country along manual training and shop practise it is necessary to change the shop routine at the Michigan Agricultural College and put it upon a higher plane in order to keep ahead of the secondary schools and teach the students work that is not given in the secondary schools.

The work of the engineer may be divided into three great groups or departments, the departments, the design of machinery, the methods of constructing and operating them, and the administrations of the plants in which they are constructed and operated. The first of these has had the attention of the best engineers for more than a century and altho the probable limit of excellence has not been reached there is a much greater chance for improvement in the other two departments.

At the present time industrial management or administration and methods of use of the machinery already possessed are the most important branches of engineering work. Of course it is not confined to the purely engineering projects but is an essential part of all commerce and manufacturing. It is easily seen since the greater part of our working population are engaged in some kind of industrial work, the proper supervision of their efforts is one of prime importance to the wellfare of the nation.

The science of management or direction of effort has lagged behind the development of apparatus and tools which the worker has to use and therefore, it is the duty of the engineering schools of to-day to train the student to be able to direct the efforts of others rather than train him to become a skilled worker himself. Viewed in this light it is the duty of the school which he attends to teach him the best principles of management that are in use at the present time.

This can be accomplished by teaching him the best principles of management, comparing the different kinds one with another, and then let him help carry out or become a part of a real industrial organization. There is no better way to these principles than to require that he help operate operate this organization and hold the various positions until he is perfectly familiar with them.

The performance of the so called "fundamental mechanical shop operations" unrelated to time and cost factors is not essential to the training of the prospective engineer but the principles of management are: Manual training or the teaching of the fundamental shop operations should be left to the secondary schools where there is no attempt to prepare the student for executive positions.

One might say that there are two systems which could be given attention in the choice of one to install in the shops. The first one is where the manager from the carefully kept records of the clerk and the bookkeeper adopts what he thinks is the best method leaving it largely to the worker and foreman to work out the details of the operations and how they

shall be carried out. The other has been developed by the engineer and as a result bears the marks of his training and methods. This method is frequently called scientific management. It breaks the problem up into its component parts and then brings to its aid in solution all of the resources of science. Every possible method of performing the problem is carefully analyzed and the best elements of all of the methods combined into a new method. This system of management having determined the best method of performing the work then proceeds to instruct the worker just how to perform his task.

It is the latter method which I think would be the most advisable to install in the shops at M. A. C. for it not only teaches him the best system of management that is available but it also teaches him the best methods of performing the work that he has to do in the shops.

The permanent members of the organization and the students should be divided into four groups as follows:

1. Manager and assistants.
2. Planning department.
3. Foreman.
4. Workers.

All positions except those falling under the first class are to be filled by the students in the shops. The time that they occupy the different positions is to be so arranged that they shall occupy all of the positions before they finish the course.

1. The Manager and his assistants will be the permanent members of the organization and will hold their positions throughout the year. The Manager will decide such matters as the out desires and other matters of a general supervising nature. There will be one assistant manager to act as the head of the respective shop departments as pattern making, foundary, etc. Their assistants will act much in the manner which they do at present. It will be the assistant managers or their assistants to which the members of the planning department or functional foreman can ask for assistance.when they have a problem which they cannot solve with the data at hand or when the planning department assigns an impossible task. It will be the duty of the assistants to inspect at the end of each class period all unfinished work and see that there are no mistakes so that the work can proceed at the next period, and grade their work on the amount done and the quality of it. He will decide the proportion of the whole that has been done and enter it upon the time slip of the worker. These men will inspect all parts of the machines in the shop and see that there are in the best of condition for it will be <u>inexcusable</u> to cut down a <u>machines rating</u> because it is not in the best of condition.

2. The planning department personnel shall be made up of the senior students who have held the various positions in the shop. The personnel of this department shall be divided as follows each head having as many assistants as needed to do the work at hand.

a. The chief production engineer shall receive all orders for work from the sales department or the manager and shall figure out at what time the respective parts shall be completed ready for assemblying and shall determine the relative amount of time that the different departments shall have to do their part. It is his duty to prepare production sheets or take care of the production board so that the statis of the departments can be determined at a glance. He is also responsible for keeping the production up to his origional planning in order to finish the order at the time desired. He shall issue orders to the instruction card clerk and materials clerk for the number that he desires to be manufactured or assembled from the stock on hand in the store room.

b. The Materials clerk shall make out the bills of material as specified on the drawings. He shall make out orders for the same and send them to the store keeper stating the number of pieces and the department to which they shall be delivered and the date of delivery. Upon orders from the chief production clerk he shall prepare an order to the store keeper for the proper number of pieces to be sent to the assembly department for assembly either for stock or for the sales department.

c. The route clerk shall determine the path of a piece of work through the shop or the successive machines to which it goes and the order of the operations which are to be performed on the different machines.

c. There shall be an instruction card clerk for each

department and it will be his duty to consult his records and find the order of operations which is the most efficient for the piece in hand and then make out an instruction card for the worker telling him the order of operations, just how to do each operation, how long it should take, and the fixtures and tools needed.

e. The feed and speed clerk will take the instruction card from the instruction card clerk and from his records, containing data on every machine in the shop will find the highest speed and the heaviest feed that the machine will stand or the limit of the tools that are to be used. He will take the lowest of these as a basis and then make out the rest of the instruction card telling just what cone step to put the belt on, how course a feed to take and how deep the cut must be. He will also find out what is the quickest time that the job can be done in and this will act as the standard time for the job and the student will receive a grade on how closely he approaches this time period.

g. The time or cost clerk will take the time slips of the workers and grade them in the following way. The grade and percent will be the standard time for each piece divided by (the total time worked divided by the number of good pieces). If desired each class of workers can be graded at so much per hour and then a piece rate made up from the standard time for each operation. The worker can then be graded from what he earns compared with what he should earn being paid by the piece. If there was a student who could work faster than the standard

time he would get a grade of over one hundred percent. If the standard time is so low that this is likely to happen, the standard time could be taken as, say equal to a grade of seventy five percent. The use of this method would also serve to get the cost of each piece and from the pieces the cost of the product. Although the latter method is more complicated I think it would be the best to use as it gives so much more in return for the effort expended. It also gives the student a line on his earning power in the shop.

The store keeper shall have charge of all of the stores and all raw and finished material shall be received, stored and devlivered by him. All materials purchased outside of the shop, all of the castings and forgings made in the shop, and all machine materials for stock shall be delivered to him as soon as they are passed by the inspectors. The store keeper shall be provided with adequate room to keep all stores. The smaller perishable stores shall be kept in double bins. Materials shall only be taken out at one at a time until that one is empty and then out of the other meanwhile filling up the first one. The larger castings and supplies shall be kept in piles or rows which are excessible from both sides or better yet in double piles using from one as the other refilled. All bar stock shall be kept in racks, sorted as to size and material, provided for the purpose. A hook is to be provided adjacent to the space occupies by the stock for a card upon which is to appear the following data regarding the stock number or amount on hand, lowest number of

amount on hand before reordering, amount or number to order and amount due from previous orders as yet on receipt.

The toolroom shall be equiped with all necessary small tools and space provided for the storage of the same. All jigs and fixtures shall be stored in the toolroom in a portion reserved for that purpose. The toolroom man will take the instruction card and from the stock in the toolroom supply all of the tools and fixtures needed for the operations listed and will give the same to the messenger in time that they may be delivered at the machine in time for the operator to begin operations as soon as he finishes the previous job. He will inspect all tools and fixtures when they are returned to the toolroom and any that need sharpening or repairing shall be put into first class condition before they are issued again.

In the shop there are three men who will aid the workers in carrying out the orders of the planning department in the shop.

a. The gang boss will assist the worker in setting the work up in the machine and getting everything ready for the actual machining.

b. The feed boss will see that the feeds and speeds called for on the instruction card are used and that the work is being properly machined. If at any time the worker is unable to maintain the speed and feed called for, the worker will at once appeal to the feed boss who will find the trouble and remedy it and under no circumstances will he reduce either of them without orders from the planning department.

c. The inspector will take the gauges and other methods of measuring the finished work and measure all of the work to see that it is of the proper size and that it is properly finished. All of the work that will pass is credited to the student on his time slip and all work that will not pass is laid to one side where the boss inspector can see it and decide whether it can be placed in the machine and salvaged.

The workers or operators will be the Sophomores and Juniors taking shop work.

The first thing that must be done before this system can be put into operation in the shop is to make a complete survey of all of the machines and either determine from their manufacturers or from actual experiment, the maximum pulling and feeding power of each and work this data up so that it will be available for the use of the men in the planning department. As a large amount of this data will have to be obtained by experiment and to gain a complete knowledge of the capabilities of each machine would require a long time. I would suggest the use of the following method until the time that such data is available. Make up the tools and fixtures for a piece of work and then have one of the permanent instructors perform the operation until he is perfectly familiar with it and then putting the machine on the highest speed and the coursest feed and the heaviest cut that in his judgment that the tools and machines will stand, do the operation several times having someone take the time with a stop-watch. The data thus taken will be used as a

standard time only until such time that it is possible to get more definite data on the machine. Data on hand operations will also be lacking and if it is not possible to obtain this data by time study or from the results of such men as F. W. Taylor, it will be necessary to adopt the above method until such time that more complete data is available.

It will be necessary to equip all of the machines in the shop with a copious supply cutting compound or other cooling liquid for it has been proved that the cutting speed may be increased as high as fifty percent where a copious supply of coolant is used and it is desired to work the machines to the limit.

Five or six periods of the time that the student is in the shop should be given to what might be called experimental work. The student doing some experimental work on the cutting or pulling power of the machine should be given enough to illustrate how to go about it and get the data required for the planting department.

Some work should be given that would illustrate the value of the planning department. The students should be given some work as rough turning and first be allowed to do this as they see fit, then they should be required to do the same operations under directions from the planning department. The work under the direction of the planning department should be done first using no coolant and then using a copious supply. This will serve to illustrate the value a coolant at the point of the tool.

The applied course in management should be supplimented by lectures on some of the various things that might come up in the actual management of a shop.

The product being manufactured should be analyzed and the reasons for the use of the various kinds of material in the different parts of the machine discussed. The materials that are used in the shop should also be analyzed and the reason for the use of each explained. These lectures should be accompanied by demonstrations or tests on many of the materials among which toolsteel and belting would take a prominent place.

The purchasing of materials and supplies for the shop should be taken up quite in detail for it is very important that a technical man should know something about purchasing and here would be a very good place to give the students an insight into some of the things that should be observed. Salesman or purchasing agents of some of the companies in Lansing or elsewhere could probably be obtained to give some very good pointers along this line.

Another important thing that could be considered here is the hiring of labor. This is a great problem and one could not hope to cover the subject in the time that could be given to it nor would it be possible to treat all of the things that arise in a course of lectures on the subject but I think enough good pointers could be given that would set the students to thinking and cause them to observe conditions that would otherwise pass unnoticed/

The above system would serve to bring out many of the points that would arise in the management of a plant and if conducted with the supplementary work as outlined would greatly broaden the training of the student. It will also teach him one thing that will be invaluable above all others namely, "To carry out orders" for that is the first essential of this system.

Following are a list of orders and instruction cards that would be necessary for the completion of a part of a machine. A gas engine connecting rod is taken as an example.

Order from Sales Department to Production Engineer for X machine.

Order from Production Engineer to Materials clerk for X machine.

Order from Materials clerk to Storekeeper for material for X machines telling the date and department to which they shall be delivered.

Order of work card.

Instruction card.

Inspection card.

Stock bin card.

Production sheet.

Following the production sheet is a stores classification and a tool classification.

SALES DEPARTMENT

TO Production Control

ORDER NO. 1476 DATE 5/10/16

FOR 25 MODEL Va SIZE 10

WANTED 6/6/16

DELIVER TO Stock

SIGNED A.B.C.

PRODUCTION DEPARTMENT

TO Materials Clerk

ORDER NO. 1476 DATE 5/10/16

FOR 25 Model Va Size 10

WANTED Mahogany finish 6/6/16

SIGNED A. L. Beck

6½" x 8"

MATERIALS DEPARTMENT

TO Storekeeper DATE 5/16/16

ORDER NO. K494 FOR 25 Model V2 Eng. 10

PRICE NAME	SYMBOL	QUANITY	MATERIAL	DELIVER TO DEPARTMENT	DATE OF DELIVERY
Bed	V2-10-1	25	C.I.	Planer 5/day Starting	5/20/16
Cyclinder	V2-10-2	50	C.I	Lathe 10/ " "	5/20/16
Connecting rod	V2-10-3	50	Aluminum	Mill 10/ " "	5/18/16
etc.					

6"x8"

ORDER OF WORK

MACHINE 12 DATE 5/16/16

PIECE Connecting Rod SYMBOL C2-10-2

QUANITY 50 ORDER NO. 7444

	OPERATIONS	MACHINE
1	Face side crank end	Miller # 5
2	" " pin "	" "
3	Face end	" "
4	Drill & tap crank end	Drill 14
5	Attach cap	Bench
6	Drill crank end	Drill 12-13
7	Ream " "	" "
8	Drill pin end	" "
9	Ream pin end	" "

PIECE—Ca

MATERI

	OPERATION
1	Clamp in ji
2	Throw in ji
3	Back out
4	Remove fro
5	Inspect
6	Clamp in j
7	Throw in ji
8	Back out
9	Remove fro
10	Inspect
11	Clamp in j
12	Throw in ji
13	Back up pow
14	Remove fro
15	Inspect
16	Clamp in jig
17	Drill
18	Tap
19	Remove fro
20	Attach Cap
21	Clamp in ji
22	Throw in jig
23	Rem & Chan
24	Throw in jig
25	Ream Cor
26	Remove jig
27	Throw in jig
28	Ream Tool & Ch
29	Throw in jig
30	Ream Cor
31	Remove fro
32	Inspect (Fin
33	

4"x8"

BIN 3-12

SYMBOL V-2-10-3

LOWEST AMT. 25 ORDER 100

DATE	IN	OUT	BALANCE
2-1-15	Inventory		34
2/10/15	100		134
2/11/15		25	109

COLUMNS ON BACK

2½"x4½"

DO NOT DETACH

LOT NO. 2-34

SYMBOL V2-10-3

QUANITY 50

OPERATION	INSPECTOR	DATE	BAD
Milling	Smith	3/29	—
Milling	Smith	3/31	—
Drill tap	Jones	3/31	1
Deburr	Jones	3/31	—
Returned in stock			49

TURN OVER Manufacturing

2½"x4½"

MOVE

FROM_____

TO_____

DATE_____

REC'D_____

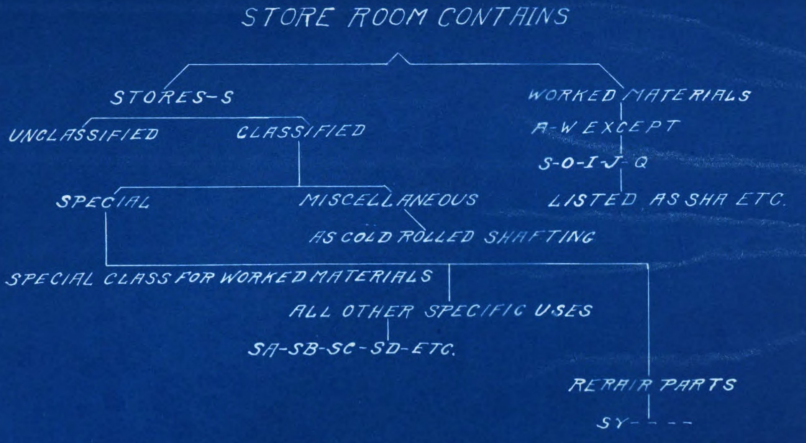
DATE_____

BY_____

…nk		Bearing cap					
Grind		Rid		Mill		Drill	
20		25		25		25	
DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL
15	15						
30	45						
5	50	25	25				
				25	25		
						25	25

DO NOT START LATER THAN UPPER HEAVY LINE

FINISH BEFORE LOWER HEAVY LINE


STORE ROOM CONTAINS
STORES-S
UNCLASSIFIED
CLASSIFIED
SPECIAL
MISCELLANEOUS
AS COLD ROLLED SHAFTING
SPECIAL CLASS FOR WORKED MATERIALS
ALL OTHER SPECIFIC USES
SA-SB-SC-SD-ETC.
WORKED MATERIALS
A-W EXCEPT
S-O-I-J-Q
LISTED AS SHA ETC.
REPAIR PARTS
SY- - - -