THE FLOW OF WORK

THE SIXTH WORK MANUAL
OF THE
MODERN FOREMANSHIP AND
PRODUCTION METHODS COURSE

LASALLE EXTENSION UNIVERSITY

IMPORTANT

THIS CONTAINS

1 Letter *from Director*

1 Foremanship Problem No. 6

1 Return Envelope

(They taught me all I knew)
Their names are What, and Why,
and When,
And How, and Where, and Who."

La Salle Extension University

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Chicago, Ill.

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DEPARTMENT OF
MODERN FOREMANSHIP

To the Students of
Modern Foremanship:

One way not to make mistakes is not to do anything; but that will not get the work out. Another way is to do something, but to know exactly what the results of your action will be before you do it.

Practical men usually prefer to increase the number of things which they do, and make a few mistakes if necessary, instead of waiting every time to know exactly what the results will be. This is learning from your own experience—taking a chance, hoping to be right more often than you are wrong —and no doubt it pays many times.

But is there any excuse for making the same mistake twice, or for making a mistake which someone else has already made? Probably not a good one, anyhow.

And that is what planning is: organizing, preparing, getting ready to be as sure as possible; profiting by mistakes which thousands and generations of other producers have made before; attempting not to make the same mistake twice; cashing in on the experience of others.

This sixth manual is full of the experience others have had in planning, scheduling, routing, dispatching, and other methods of controlling the flow of work. It shows a way which can be followed to get results without having to make unnecessary mistakes. The problem inclosed in the pocket is a job of dispatching for you to do.

Our consulting service should be of especial value in this part of the course. Write us about your production difficulties, and take advantage of our willingness to be of every possible assistance.

Going thru this manual is a production job in itself. It is up to someone to do the dispatching, and it looks as tho you were the man best fitted to do the work. The results are sure to be worth while.

Sincerely,

Hugo Diemer
Director

HD*VW

LaSalle Extension University

DEPARTMENT OF MODERN FOREMANSHIP
HUGO DIEMER, *Director*
CHICAGO

Matriculation No._____ Date_____192___

Name_____

Address (complete) _____

MODERN FOREMANSHIP PROBLEM NO. 6

Seeing that the work gets out—that is the first and foremost job of foremen to-day, as you well know. And to get work out, someone must do the dispatching; someone must say who does what, and where it is to be done and when. That is what we shall do in this problem—dispatch work.

When an automobile is all assembled, full of gasoline, and ready to go, someone must start it even if it has a self-starter; and dispatching is starting the machinery of production—but it is more than starting—the dispatcher takes the wheel and guides the work until it has reached its destination.

Some of the details of dispatching may be worked out by the planning department; yet dispatching is more than planning, it is actually seeing that the plans are carried thru. It may at times be accomplished by either verbal or written orders; but here in this problem about dispatching we shall make a written record of the preparation steps, and we shall limit ourselves to getting one job started.

Choose one specific job in your shop in which you are interested and with which you are personally well acquainted. Take this one job and consider it—not the numerous jobs performed in the whole shop—in forming the solution of the three problems on the following pages.

Here we will consider <u>one job as the work done by one man on one specific part or piece of material</u>. This job may consist of one or more operations performed simultaneously or in rotation on the one part or piece of material such as: drilling and reaming part No. A-148; planing a certain wooden part; sewing buttons on a vest; cutting soles for shoes; loom tending; wheeling ashes; that part of an assembly done by one man; or tracing a drawing.

Tools and materials for this job must be prepared and assembled for work before this specific job or order chosen can be posted on a dispatch board and assigned to a given man.

Effective dispatching requires preparation. Hence indicate here:

First—Preparation as to the tools required for the performance of this one specific job you have chosen. Write an order showing:

What tools are required on this job
To whom the order is sent
Where the tools are sent
When the tools are sent
Why they are sent (the job number or name)
Who issues this order, and when

Indicate here:

Second—Preparation as to material for this same job. Write out a material order showing:

To whom the order goes
What material is required
How much material is required
When it is required
Where it is required
Why it is required (the job number and name)
Who makes out the order, and when it is issued

Third—To dispatch the worker to this same job. Write out an order for the worker showing:

Who is to do the work
Where he is to work
What he is to do (first operations)
When he is to do it (time of each operation)
Why it is to be done (job number or name)
How it is to be done (it is not necessary to give detailed instructions here)
Who makes out the order, and when it is issued

THE FLOW OF WORK

THE SIXTH WORK MANUAL

MODERN FOREMANSHIP
AND
PRODUCTION METHODS

Being the Expression of Practical Foremen

Assembled, Organized, and Edited by
HUGO DIEMER, MEYER BLOOMFIELD, DANIEL BLOOMFIELD,
AND E. F. DAHM

In Coöperation with Others

LA SALLE EXTENSION UNIVERSITY
CHICAGO

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The average worker gets along without knowing where his work comes from or where it goes to, but the workers above the average—the foremen of to-day —know they must know these things.

Both men and management depend upon them to have a bigger, broader view of the flow of work.

Process mapping, scheduling, planning, dispatching, and other methods of controlling the flow of work, are taken up in this sixth work manual. It presents a broad view of the process of which any single job is a part.

There are rough spots in the flow of work—breakdowns, jams, and difficulties to overcome, but these are opportunities, chances to prove the value of your training and experience. It pays to be prepared for them.

The foreman worth while is the one who delivers when everything goes dead wrong.

THE MODERN FOREMANSHIP COUNCIL

There are production managers, practicing foremen, executive officers, labor managers, and educators on this Foremanship Council.

Tho from different walks of life, they have one strong tie binding them together—that is, their experience with and interest in the work of Modern Foremen.

The Council reviews the course and lessons and serves in an advisory capacity. It brings to bear on the planning, organization, presentation, and service of the Modern Foremanship and Production Methods Course the judgment of experts from all important points of view. In many minds there is increased wisdom and safety of judgment.

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Hugo Diemer, Director, Modern Foremanship and Production Methods Course

THE FIFTEEN WORK MANUALS

of the Course in

MODERN FOREMANSHIP

and

PRODUCTION METHODS

I. The Foreman and His Job

II. The Working Force

III. Leadership

IV. The Foreman and Training

V. The Foreman and Job Analysis

VI. The Flow of Work

VII. A Good Place to Work

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THE FLOW OF WORK

THE FLOW OF WORK

Suppose you were a foreman in the plant of the Amalgamated Steel and Ordnance Company, which, after the armistice was signed, switched its entire manufacturing program from making steel shells for the army and navy, to making washing machines for household purposes.

How would you go about it to turn out the washing machines? Or rather, how do you imagine the management of this company went about it? They did exactly what the management of your factory had to do when it started in business, or what it would have to do over again if it made as radical a change in its product as the Amalgamated Steel and Ordnance Company did in theirs.

You will find as you continue thru this manual, that before the Amalgamated Steel and Ordnance Company could start the production of washing machines and be assured that the work would flow thru the factory with any degree of regularity, it was necessary to take seven important steps, every one of which affected their foremen in one way or another. Of course some of these steps were

taken without the active assistance of any of the foremen, but they nevertheless were counted on right from the start to perform certain duties.

In order to know what these duties are and what type of work they include, it will be helpful to know in detail why they were assigned to foremen and why and how the conclusions were arrived at under each step.

The Seven Steps in the Flow of Work

The steps bear such an important relation to the flow of work, for which every foreman must shoulder his share of the responsibility, that the entire discussion in this manual will be centered around them in the following order:

1. Deciding on a general plan of work.
2. Fitting the general plan to the factory and product.
3. Planning the departments and the force to handle the work.
4. Establishing a detailed manufacturing program.
5. Scheduling the work.
6. Dispatching the work.
7. Safeguarding against interruptions.

Step One

The General Plan of Work

The foreman who first sizes up the flow of work in its relation to the entire plant or factory, and then endeavors to meet the problems in his own department accordingly, soon discovers that there has been a general plan of work mapped out which neither he nor the higher executives with whom he has been working, have created as a whole, and which underwent few, if any, changes before it was decided upon.

For practically everything that is made, somebody has worked out a plan for manufacturing it. A housewife does not bother about working out a general plan for baking bread; nor does a farmer's wife work one out for churning butter. If they did not inherit such general plans from their mothers, a receipt book or a few suggestions from a neighbor, would supply them. The same principle is true of any concern which starts the manufacture of steel according to the Bessemer process. Bessemer laid out the original general plan of work, and other companies perfected it. All a concern needs to do is to adopt this plan at the point where the others left off.

Where the General Plan Originates

So in any plant or factory which has been in operation for any length of time, there is first of all a general plan as to how the work shall be done. The plan may have been inherited from the past, or it may have been devised by an inventor or an engineer, or by the planning department. In the case of a new factory or plant, it is adopted wholly or in part out of the experience of one or several concerns in the same line of business.

Finding out what is the general plan of work in your factory—ascertaining what are the methods recognized as best for accomplishing what your organization has set out to accomplish, and studying the history of the industry in which you belong—that is the first step toward a well-grounded understanding of the main program of your factory.

You will of course realize that this first step is being emphasized in order to enable you to get your work out efficiently in connection with the plant as a whole. The better you can understand the general plan of work in your factory, the better you will be able to accomplish this. The planning department—

and where there is no planning department, the superintendent's office—is a mine of information for you. By coöperating with them whenever it is possible, you will soon train yourself to think in terms of the main factory program and supervise your own department accordingly. Once the general plan of work is firmly set in your mind, many points which heretofore may have seemed questionable will become clear.

Step Two

Fitting the General Plan to Your Factory and Product

But this general plan of work, as it was inherited from the past or worked out by others, may be too general to fit the present needs of your factory and product. A radical change from one type of product to another may have taken place, or the factory space and equipment may have been increased or decreased since the general plan was adopted. While in a general way this plan answers the new purposes of these changes, it nevertheless does not meet the detailed requirements of the present equipment and product.

Work will never flow thru a factory as it should, on mere general plans. The details of fitting the general plan of work to meet the present requirements of both equipment and factory, must be painstakingly worked out. It is at this point that planning begins to take definite form. Future planning is dependent upon the thoroness with which details are worked out and applied. Unless care is exercised in working out these details, future plans will collapse.

So the first important move in starting a new factory or in adjusting an old one to an entirely different product, would be to find out the general way in which the product can best be made.

The Ideal Plant

It is not difficult to believe that the most efficient factory is the one where there are no delays, no interruptions, no excess of one part, and no deficiency of another. In such a plant, which we may call the ideal one,—

1. Every man is busy producing every minute of his time.

2. Every machine is busy producing every minute of its time.

3. There is always just the right amount of each part or of each kind of material, produced at all times to form just the right amount of the finished product.

Under ordinary conditions few factories, if any, can reach this ideal; but all can approach it more and more closely by carefully attending to the details of changing the gen-

eral plan to meet the needs of the factory and the product, so that the flow of work is as smooth and as continuous as conditions will permit. Each foreman who approaches the ideal condition in his department does so by paying careful attention to every detail which will make the flow of work thru his department more smooth and more continuous.

Process Mapping Is One of the First Moves

Planning just how the work shall flow thru the plant as well as thru the individual departments, is called "process mapping."

It is one of the first moves in fitting the general plan of work to the factory and product. Conditions are seldom the same in any two factories, but this explanation of how one concern mapped its processes so that its general plan of work would meet the requirements of its new factory, will illustrate one way of doing it.

How One Company Fitted Its General Plan to a New Factory

A certain company was greatly overtaxed for production during the War. To clothe the

armies of the Allies as well as our own army, required sewing machines in vast quantities. To meet this demand, this concern found it necessary to erect a new factory beside its former one.

The problem was to lay out the departments and machines in accordance with the general plan of work. The old and new buildings were to have connecting passageways on each floor. The first task was to determine what departments to take out of the old building and put into the new one, where to locate these departments in the new building, and how to relocate the departments of the old building to the best advantage.

On first thought that would seem to be a very simple matter. Just bring the raw materials in on the ground floor, ship them up to the top floor, and then arrange the departments in both buildings so that the material would flow down by gravity. That plan would have been all right had it not been that this company manufactured 1,800 different models, consisting of more than 30,000 different parts, and requiring 180,000 different operations.

If the plant were to be laid out to give straight-line routing for one group of parts, that would mean complicated routing for the other parts. At the best, it had to be a compromise, as the routing of any one part had to be sacrificed for the best good of the whole product.

It was impracticable to attempt to study the routing for all the different parts, so twenty-four important parts were selected. Then by the aid of the routing charts and an isometric layout it was possible to study the routing of these twenty-four parts under various locations of departments. A reproduction of such a chart is shown on the folded insert directly opposite.

First, by cut-and-try methods, the departments were so listed on a routing diagram as to require the least number of elevator trips for the major parts. It is obvious that any one part could have been manufactured entirely on one floor by merely grouping the departments or machines thru which that part passed. However, had this been done, it would have seriously affected the routing of the other parts, which were equally important.

Any arrangement of departments tentatively worked out from the routing diagrams, was transferred to the isometric drawings, in order to give a comprehensive bird's-eye view of the entire layout. Each department was located on this isometric chart, and then moved around until a permanent location was definitely determined upon which would not conflict with the location of other departments. So thoroly was the work of process mapping done that after production was started it was necessary to make only a few slight changes.

VISUALIZING YOUR PROCESS MAPPING PROBLEMS

Fig. 1.—The above blue print drawing is a reproduction, considerably reduced, of the isometric layout which the sewing machine manufacturer referred to in this manual, used to excellent advantage in process mapping his plant. The original drawing, which included six floors, made it possible for those responsible for the flow of work to visualize the routing of parts and shift the various departments from one location to another in order to determine which location would best answer their purposes. Such a chart has at least one big advantage over any plan which utilizes individual floor plans, namely, that each floor is shown in its exact relation to all the other floors. It would be practically impossible to show this relation by using separate floor plans. This isometric chart, which is of course drawn accurately and to scale, when made on a sufficiently large scale, makes it possible to trace the course of a product from the time the raw material is received at the receiving platform to the storeroom and then thru the various processes and departments back to the storeroom or shipping department. We are indebted to Mr. Hasbrouck Haynes, President of the Hasbrouck Haynes Corporation, and to "Factory," the magazine of management, for permission to reproduce this drawing.

A "Model" Way of Mapping Processes

Some companies, instead of using an isometric layout, prepare small wooden models of their buildings, and have removable floor board on which are mounted blue prints or photostats showing the equipment on each floor. Instead of colored crayon lines, they take colored threads to show the flow of work. Occasional arrowheads are used to indicate the direction of the flow. This procedure will soon show where there is a tendency towards congestion or where the flow tends to reverse. Such a model is reproduced in Fig. 2.

Like job analysis, process mapping must be thoro in order to accomplish all the possibilities it is capable of. When careful thought is put behind it, such as was exercised by the company just described, process mapping is capable of performing what, without it, might be termed production wonders. Mass production would be impossible if process mapping were unknown.

There is inspiration in the ceaseless flow and avoidance of congestion. It isn't every industry, of course, that can employ the appeal of rapidly moving mass production, such as

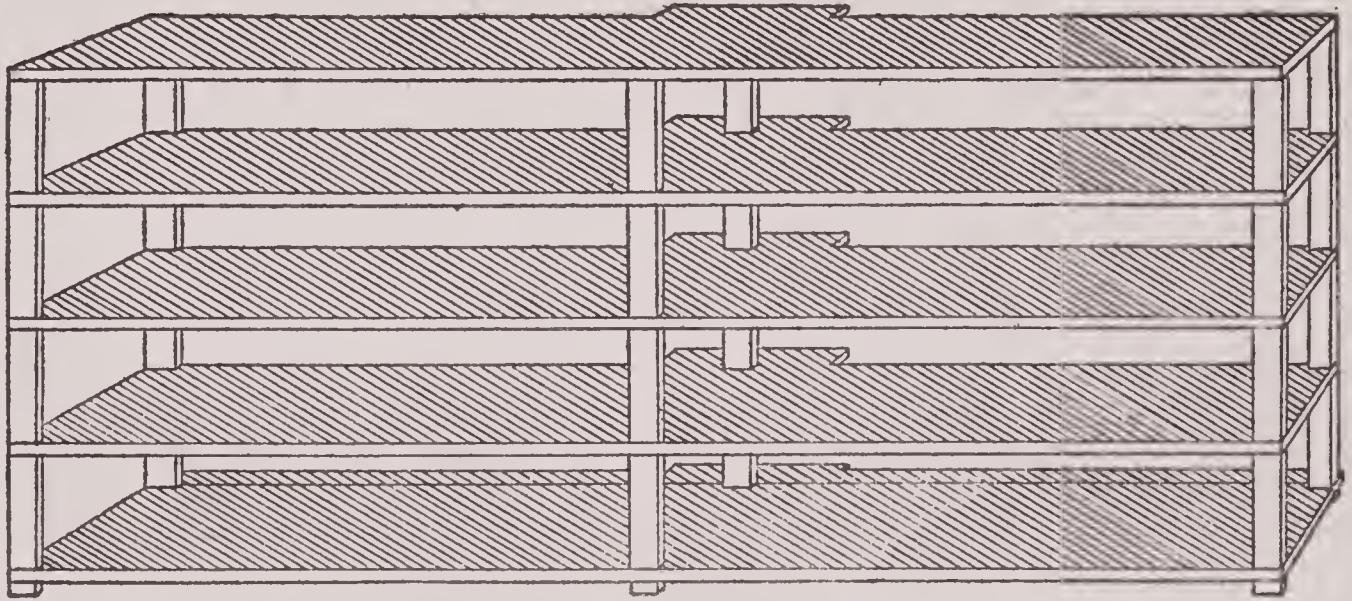

Fig 2.—Some concerns find a route model such as the one above which is of wood construction, a very effective assistant in process mapping their plants. Floor plans laid on the floors of this model show the posts and windows, and holes are cut for elevators and stairways. The course of products thru the plant can be graphically shown by means of different colored threads for each finished part or component.

is practiced in the Ford plant, for example; but there is a satisfaction and an enthusiasm inspired by a steady flow in the right direction.

Four Rules for Process Mapping

If the foreman understands the general flow of work thruout the factory, from receiving platform to shipping room, he will more easily understand the principles which experience has proved are helpful in process mapping. In fitting the general plan of work to the needs of the factory and product, probably the most important factor to consider is the movement of the materials as they go from one process to the next. Other factors must also be taken into consideration, but the question of getting the materials to move right is likely to be the most important of all. And here are four general rules for the movement of materials, which it will be well to bear in mind.

Rule 1.—Materials should generally move thru the plant in a certain path, which starts at the point where the raw materials are received and ends at the point where the finished product is shipped. It is not always possible to follow this rule exactly.

Rule 2.—The distance to be traveled by materials going along this path from process to process should be as short as possible.

Rule 3.—In making its trip along this path, material should move as quickly and as economically as possible.

Rule 4.—Choke points which tend to slow up or stop the work, should be eliminated.

These rules hold good in most cases; but where you have a special case, you may find it necessary to disregard some of them in order to get results and still meet the requirements of the special case.

For example, there are cases where a foreman, having finished a piece of work in his department, finds it advisable not to send it on at once to the next department but to keep it until he has accumulated a number of such finished pieces, at which time he sends the whole lot on. This not only may slow up the flow of work, but it often makes it necessary for the foreman to keep a store of goods in his department and to act as storekeeper. Since we go into this subject more thoroly in the ninth manual, "The Fore-

man as Stockkeeper," we shall do nothing more than mention it here.

Who Does Process Mapping for a Plant?

If a plant does not have within its own organization a person or group of persons able to do the process mapping and arrange its departments and equipment so that the flow of work thru the whole plant will be most efficient, an outside man is usually employed — either a professional industrial engineer or someone experienced in making plant layouts. But if the plant is organized to do this work itself, then either the engineering department or the planning department generally does the process mapping.

Process Mapping and the Foreman

The planning department was created to aid the foreman by coördinating the work of the various departments. Process mapping is one of the necessary and very important early steps in such coördination.

It follows that the work of process mapping does not stop at the door of each foreman's department, but goes right in and thru it. In

other words, to do its work right, the planning department lays out the path in which work shall flow inside each department from machine to machine, and from there into the next department. This department must rely on the foreman not only to see that its plans are carried out, but also to make suggestions whenever he feels that improvements can be made which will better stabilize the flow of work.

While the planning department lays out the general and often the detailed routing and processes by which work flows thru a department, the foreman is the person who keeps careful watch for new methods which will make the flow more rapid and more smooth. It requires his constant and intelligent supervision to insure the best results even from the best mapped processes, and there are always little places within the department where the foreman can suggest improvements or mark them out himself.

After process mapping has adjusted the general plan to meet the special requirements of the factory and product, it becomes necessary to figure out how this revised general plan shall be put into operation. Questions such as the following must be answered:

Is a special planning department necessary?

Shall there be an employment department, or shall the superintendent or foremen hire the help?

How many departments shall there be, and what type of foreman is best for each department?

It is right here that we start the third step in working out the main factory program.

Step Three

Organizing the Departments and Working Force to Handle the Work

The problems which are to be met while we are considering this step, generally fall under the headings of production planning and production control. They are present in every plant or factory. They must be worked out on practically the same lines whether the factory consists of two hundred employes or ten thousand.

In the shop of two hundred employes, it is likely that one man, generally the superintendent, with the assistance of his foremen, will have to give consideration to and pass decisions on a wide variety of problems. In the shop of ten thousand, the work will naturally have to be subdivided so that different individuals will make decisions on certain classes or groups.

The extent to which foremen are active participants in meeting production planning and producton control problems, depends somewhat upon the nature of the organization and the policy of its management. However, whether you do or do not take an active part in meeting these problems, you will find that

it pays to be conversant not only with the final decisions, but also with the methods by which they are arrived at.

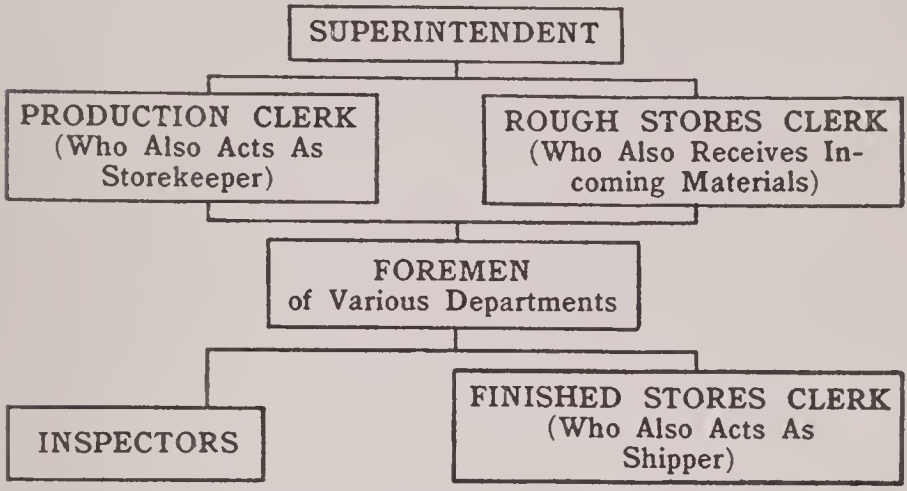

Fig. 3.—In a shop or factory employing about two hundred employes an organization chart such as the one above would most likely meet all the requirements. In such an organization, the foreman usually acts as first assistant to the superintendent in meeting problems which have to do with keeping up the flow of work.

A workable understanding of all the management helps and plans which deal with planning and controlling production and which you are called upon to apply in your department, is also very valuable. In a small shop these management helps and plans may be fewer and perhaps more simple, than in a large plant; but the general production and control problems will be identically the same.

One Type of Organization

Figure 3 shows a simple production chart as applied to a shop of about two hundred em-

ployes making taps and dies and similar articles. In this shop the production organization consists of:

1. The superintendent.
2. The production clerk, who is also chief clerk.
3. The rough stores clerk, who also acts as receiver of incoming materials.
4. The inspector.
5. The finished-stores clerk, who also acts as shipper.

In this organization, the man who acts as combined production clerk and storekeeper must do all the systematized work connected with what in the bigger organization is known as planning, preparation, scheduling, and production records. Many a man who is successfully carrying out production work in a company employing two thousand people, had his training in a smaller shop of this same type. It is easier to see the whole production problem as illustrated in this smaller shop and transfer the plan to the big establishment, than it is to apply the principles controlling the system of the shop of two thousand employes to the smaller shop. Hence it will be profitable for the foreman to

bear in mind that the smaller production organization here illustrated contains all the basic elements of the more detailed organization of the bigger shops.

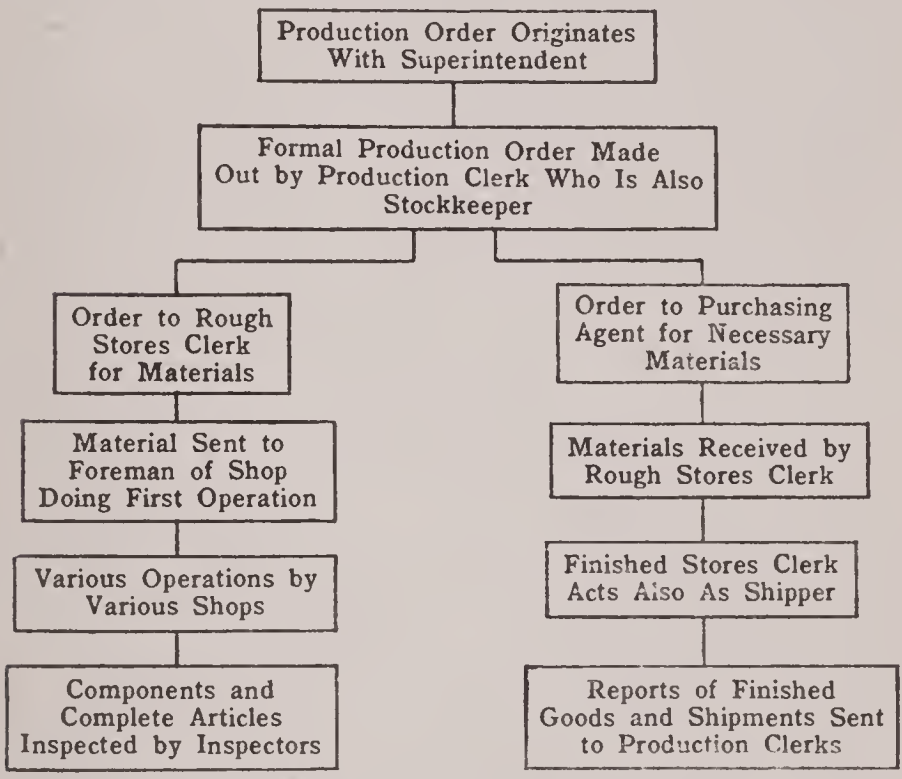

Fig. 4.—Here you have in graphic form the various steps and the line of progression by which a production order is put into operation and the flow of work kept up until the product is ready for the shipping room. Neither this chart nor the one in Fig. 3 is to be regarded as a model for your concern to follow.

Fig. 4 shows how the production system operates in this small organization.

The Larger Organization

The works manager in the larger organization generally has two chief assistants. One

controls all the planning and preparation activities, and is called the "planning superintendent." The other gets out the work in accordance with the plans, specifications, preparations, and schedules, and is known as the "manufacturing superintendent." The chart (Fig. 5) shows the flow of plans and preparations and schedules thru the offices of the different department heads who must look after these matters.

The citing of these examples does not mean that they are models which your firm should copy. They are simply types taken from actual practice. Your firm may call the departments by different names, and take care of its production planning and control in a different way.

In planning the departments and the working force to handle the flow of work, it is necessary to get more than a general idea of the various factors affecting production planning and control. They, too, must be refined and eventually made to fit into a manufacturing program under which production will begin.

In a highly productive age it is not enough to know how to plan or control production. The most efficient methods for doing this

must be worked out. Ways must be discovered to hold down the costs; to reduce or utilize the waste; to keep all the machines running the maximum time; to prevent breakdowns, and to insure against other interruptions in the flow of work.

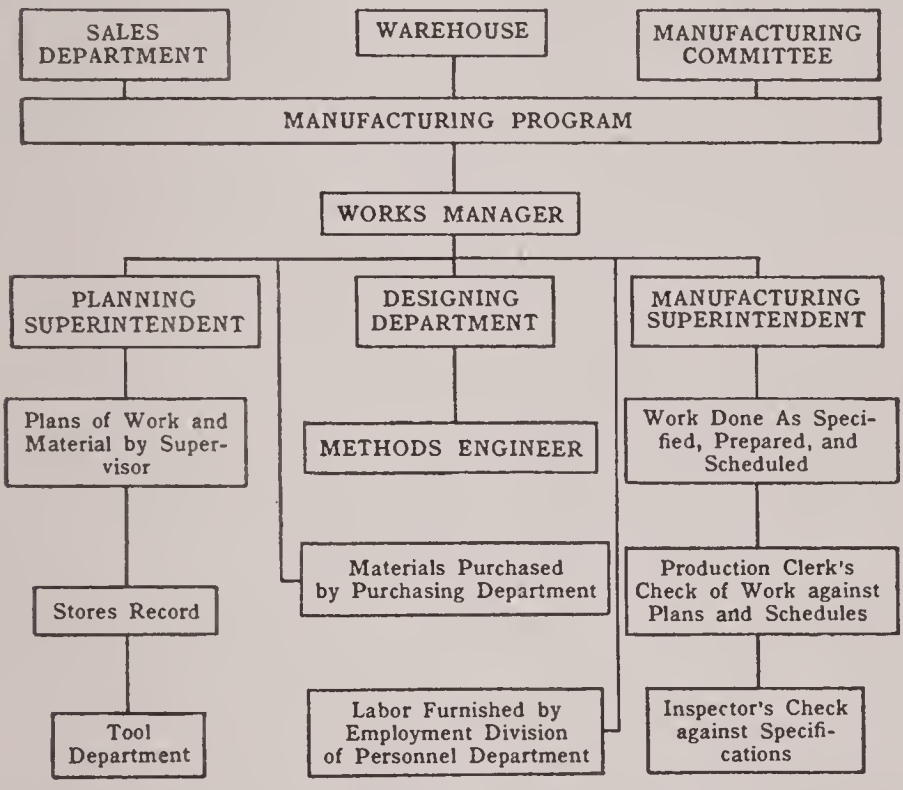

Fig. 5.—In the larger plant organization the line of production progression generally follows much the same lines as indicated in the above chart. Here we find that the works manager, whose duties correspond to those of the superintendent in the small organizations, delegates portions of his responsibilities to two assistants, the planning superintendent and the manufacturing superintendent.

Job Analysis a Big Factor in Making Refinements

Job analysis, the underlying principles of which were explained in the fifth manual, is

a great source of valuable information in refining the factors of production planning and control. In fact, without job analysis it would be impossible to outline any definite program and still have it produce effectively. Routing, scheduling, job classification, time and motion studies, safety regulation, and all the other by-products of job analysis, must be applied in planning the departments and in organizing the working force to handle the flow of work.

Other Sources of Information

Engineers who specialize in working out the ways and means of producing or fabricating the work according to a given design are known as "methods engineers." The foreman can be of great assistance to them by giving them problems to work out which he sees in the rough but does not have time to work out himself.

Other sources of information need to be studied also. A job analysis of the product itself should be made, both in its finished form and by component parts: What processes are necessary for making each part? What is the logical order in which to do the various operations? What tools are necessary? And

what is the best way to have each operation handled in order to have it done in the shortest time and with the least effort, while still maintaining the necessary quality?

When the study of the product has included all these factors, then it becomes necessary to coördinate this information and present it in such form that it may be permanently recorded and readily put into practical use. The foreman will recognize the need for four distinct classifications of this information.

First Classification—Parts List

First, there will be the "parts list"—simply a written list of every part that goes into a given product. It is easy to make, but care should be taken to omit nothing.

Second Classification—Routing

Second, there is the question of what order is best in planning the processes. This involves the arrangement of the shop, the location of machines, and the time order in which various parts are needed in their relation to each other. This planning of the actual path which each part or group of parts will travel in going from one machine or operation to the next, is called "routing." Routing is

really a detailed continuation of process mapping. An example of effective planning and routing is given in the experience of the concern manufacturing sewing machines, which is related earlier in this manual.

Routing is an important step, because in the detailed routing of a factory's product from one process to another, just as in process mapping, there are usually dozens of places where inefficiencies that seem very small in themselves, amount up to big figures in both time and money when repeated on hundreds or thousands of pieces each day. Carefully planned routing means, too, that the flow of work will be steady and uninterrupted. Where the routing has been carefully worked out for each part in writing, the result is the routing instruction for that part.

Routing of Individual Parts.—The routing of an individual piece or component is not usually so easily presented in graphic form as is the case with general process mapping. Where we have the same process applying to practically all products, as in machine forging for example, we can indicate the path of travel of a forging from machine to machine quite clearly; but where we have a great

variety of metal parts undergoing varying operations, the parts and operations changing not only from day to day but frequently from hour to hour, we can only represent the routing of the individual piece by means of a written route sheet or route card.

Sometimes the routing is indicated on the detail blue print. Usually there is not room enough on a blue print to go into details further than to indicate the different departments which must work on the piece. The finer breakdown is usually taken care of on what is designated as an "instruction card" or "plan of work." The recording of the routing of each piece or component is of necessity a record which must be established before we can begin anything precise in the way of scheduling or time studies or piece rates.

The Time Element in Route Charts.—It is not enough to know, in the detailed plan of work, merely the route that a piece of material must travel from process to process. It is also highly important to know how much time each process will require.

For if a piece of material must go thru six processes before it becomes the finished pro-

duction on a certain date, then you will want to know how long beforehand you must start your first process in order to get the work thru in time.

Figure 6 is a route chart used in connection with a gun forging. Notice the vertical line labeled "assembly" on the right side of the diagram. This represents the date when this gun forging must be ready for the assembly department. Each vertical row of squares in the figure represents one day, so that thirty-two days are represented in the figure. Notice that six processes are necessary in order to get this gun forging ready for assembling, and that some of these processes take three days each, some take four days, and one takes five days. A day or two is allowed between the processes in each case, so that the product will have time to get from one department to another and so as to allow for possible delays.

Third Classification—Tool List

In order to have no interruption in the flow of work, there must always be the necessary tools on hand, each in good condition, so that no delay will occur when they are actually needed. To make this possible a tool list is

prepared, showing what tools are to be used on each operation of each process. Such a tool list helps in making out an instruction card.

Fourth Classification—Instruction Cards

Skilled workmen used to take the job a foreman gave them and, with a few suggestions from him, do the job as their own knowledge

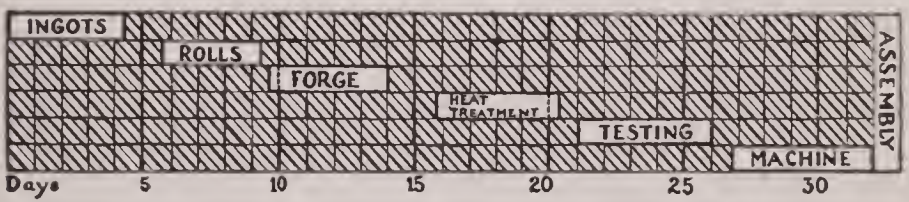

Fig. 6.—The time element in route charts is an important factor, as you will see from this graphic presentation of six different steps which a piece of gun forging must go thru before it is ready to be assembled. Charting each step in this manner aids materially in keeping control of the work in process.

and skill dictated. With most jobs there are several possible ways of accomplishing the final result, and even the same workman at different times would do the same job in different ways. For nearly every job there is one method which is best for obtaining a certain result; requiring either a shorter time, less fatigue to the workman, or less waste of material; or, it may be, a combination of these. From the information gained from job analysis, time study, and other sources, the planning department of many modern

factories works out the best method of doing each individual job, and the result is the instruction card for each part, which is sent with that part to the operator who is to work on it. The foreman must know that the instruction card really indicates the best way of performing a particular operation. It is his job to help and instruct the workman in that method.

With the general plan of work refined so that it will meet the special needs of the factory and the product, and with the departments and working force necessary to handle the work well fixed in your mind, the next step is to decide on a detailed manufacturing program under which production will stand.

Step Four
Establishing a Detailed Manufacturing Program

By the time any manufacturing concern has advanced to this point in laying out its main factory program, its management has a fairly well conceived program in mind. In a more or less general way it has already decided on many, if not all, of the various phases of this problem. However, before a definite manufacturing schedule can be established, it will be necessary to work these out in detail so that they will dovetail into the various factors under each of the important steps which are necessary before the main program can be decided on.

The important considerations are how much will be manufactured during the year, and whether this production will be spread out evenly over the entire year or whether there will be rush seasons and dull seasons. The amount of capital, the market for raw materials, labor conditions, sales conditions, the size of the market for the product, are all considerations which affect the manufacturing program. Sales quotas will be set, in order to fix the amounts to be manufactured; and there will be financial scheduling in order

to insure at all times a sufficient supply of money from products sold, to pay wages, to pay for raw materials purchased, and to meet any other current expenses.

When the details of establishing the manufacturing program are completed, work on this program is started by scheduling the work thru the factory. This brings us to Step Five.

Step Five

Scheduling the Work

Scheduling the work is the act of indicating, among other things, exactly when work on a certain job starts, where it starts, thru what processes it passes, how much time it should take in each process, and when it ought to be finished.

Scheduling affects the foreman directly, because once he is prepared with floor space, machines, men, and tools, it is the first step where he is given the job of actually producing something. The whole aim of the factory is to produce goods which may be sold at a profit, and the foreman's responsibility is to see that his department furnishes its share of the total productive work at a sufficiently economical cost so that finally a profit may be made. Scheduling plans the work of the factory, particularly with the time element in mind, in order to produce goods at the least expense and at a time when they will be most quickly sold.

Scheduling During Dull Periods

Many manufacturers, during the business depression which followed the War, discovered

that they had large inventories of goods which it was impossible to sell profitably at the constantly falling prices.

The experience of a shoe factory in the East during this depression illustrates the need for scheduling goods that can be sold as soon as possible.

This factory's manager foresaw the approaching fall in prices months before it actually came. He immediately stopped manufacturing the shoes he had been making to sell at a high price; and by the time the drop actually came, these shoes had practically all been sold. Instead of sending thru the more expensive shoes, he had his scheduling department immediately start a flow of work on cheaper grades of shoes, plans for which he always kept on hand for such a time as this. By the time the fall in prices and wages actually came, he had a large quantity of these low-priced shoes ready to sell. At the same time, other shoe manufacturers were still maintaining a flow of work thru their factories, of expensive goods which they found it impossible to sell at a profit.

When Immediate Profit Is Not a Consideration

Of course there are some exceptions to the rules that the work should be profitable and should yield its profit as soon as possible.

For instance, it is often profitable to run off in a short time enough small drop forgings to last a company a year. It would be poor economy to run off only a month's supply. It is preferable to tie up the small amount of money required and have the year's job over, rather than to get the machine ready every month and run it for only half an hour.

Sometimes it is more expedient to keep the men and machines busy than to lay some of them off in order to conform to a sales schedule. In such a case it might be wise to modify the sales schedule rather than to disrupt the production organization. The best plan of all, however, is that which enables the foreman to keep his men and machines busy and still follow out the sales schedule.

How to Make the Most of Dull Periods

There are plenty of examples to be taken from the slack period which followed the War, that show how to make the best of dull periods. Often there is machine repair work, cleaning and painting, or odd jobs, to keep the force busy—or at least the most valuable workers on the force and the ones which the factory wishes to retain. Some companies

could keep only the foremen and the other executives. For example, this statement appeared in an industrial publication during the dull period referred to:

"The Edison Lamp Works of the General Electric Company is at the present time engaged in extensive machine alterations, much of this work being made possible because skilled foremen who are on salaries are now available for this kind of work."

Another program for the same period is the one used by a Wisconsin rubber company. This company's concisely stated program for capitalizing shorter working periods is an excellent example of how to proceed to make the best of dull intervals. This company took advantage of the lull:

1. By improving departmental methods.

2. By clearing and rearranging records and files.

3. By using off hours for plant activities.

4. By making a more careful study of departmental and plant expense.

5. By making job analysis.

6. By cultivating acquaintance and contact with the men on the job.

These examples show that during dull periods, just as in prosperous ones, correct scheduling will result in keeping the factory busy all the time at the work most profitable at that particular time.

The First Scheduling Move

The first move in scheduling is to take the general production schedule—for example, the program of producing two hundred fractional horsepower motors a month during January, February, and March; two hundred and fifty a month during April, May, and June; one hundred and seventy-five monthly during July and August; and two hundred and fifty a month for the rest of the year—and to translate it into a schedule of the various individual parts which it will be necessary to manufacture in order to live up to the general schedule.

With these parts listed, a production order must next be made out for each part and then

turned over to the scheduler, who will plan exactly how the part is to go thru the plant.

Preliminary Scheduling

It is usually advantageous to devise some kind of approximate schedule, even tho there are no precise data as to times or machine capacities.

Let us assume that we have several sets of parts which must be gotten together for assembly. We can get the estimates of the various departments involved, as to the time at which they will begin and complete their operations in order to tie up the capacity of their equipment. These estimates are then filed in a "tickler" memorandum (so called because it is intended to "tickle" the memory) back of dated guide cards a number of days ahead of the estimated times of beginning operations. On these dates the departments involved are checked up as to the validity of their previous estimates, and any changes necessary are made. This, of course, is the crudest kind of scheduling, but it is usually better than none. In a small shop the checking up is usually done at a conference of the various shop heads involved.

A well-organized planning department, generally speaking, should get from the general management a schedule of requirements for not less than three months' work, at least thirty days ahead of each three months' period. A preliminary program of this sort is usually made up irrespective of tool and machine capacity, and is based merely on a general knowledge of past performances and on the possible capacity with existing equipment and men. The tentative program is now to be broken down into route charts and orders for individual components, tools, and materials.

Detailed Scheduling

Before the exact schedule is decided upon, these three considerations must be weighed:

1. What is the condition of the stores of material? How many pieces of each part are already finished in the stock room? Of these finished parts, how many are already allotted to other products and therefore cannot be used in the products that we are now figuring on? What raw materials have we on hand? What purchase orders are out for more raw materials? What other manufac-

turing orders (besides those we are now working on) are in the plant? And how much material will they use up?

To get all this information on materials, the schedule clerk consults the "perpetual stores record"—an inventory which the storekeeper maintains in order to tell at all times how much material is on hand, and which will be explained in the ninth manual. When the schedule clerk gets these questions answered, he knows where the factory stands in regard to the material needed to work up the various production orders. If there is not enough material in sight, the purchasing department is informed.

2. The schedule clerk next asks, "What in detail is the capacity of this plant for doing each piece of work?" To get the answer to this question, he studies the layout of the plant, which was obtained by process mapping. Thus he gets a clear idea of all the shops involved in making each component of an order.

3. The scheduler next inquires, "What classes of men, machines, and supplementary tools are on hand, and in what numbers? And how

many will be needed from month to month in order to handle the production orders about to be scheduled?"

What Men and Tools Are Available?

It is very important that the planning department have early information as to what is available in men, tools, and material; because this department must order tools, equipment, material, and components, and must see to it that the workers are available, in order to meet its program.

With this information at hand the scheduler assigns each piece of work specifically to the shops and machines that can best handle it.

Step Six
Dispatching the Work

The work has now been brought to the point where the foreman is actually in contact with it. It is flowing thru his department, or at least into it; and he must see that there are no delays or interruptions in the way it flows thru and on to the next department.

Dispatching is *seeing that the work goes thru.* You could accomplish perfectly the first five moves; yet if you failed to dispatch the work, you would get nowhere.

Work does not put itself thru. It has to be put thru by persons of dispatching ability. Here the foreman is largely on his own responsibility and receives little help from outside his own department.

Some of the machinery of dispatching may be worked out by the planning department; yet the act of dispatching is not a planning act. It is a production act. The dispatcher of industry is the foreman—and beyond him the general foremen, the superintendent, and the works managers.

Between scheduling and dispatching there is the same fundamental difference that there is between planning a thing and doing it. Both are necessary, but they should not be confused with each other.

Dispatching is the first and foremost job of a foreman. He gets the work done. This job of getting the work done has become increasingly hard as modern industry has become more complex. Moreover, the foreman is the last-man executive, standing next to the working force, and on him industry has to depend for getting its work done. For this job of dispatching the work thru, no one can be substituted for the foreman.

He is the key man in dispatching. For this reason modern industry is tending to relieve him of other labors that he used to do (such as planning), in order that he can better do the one great job which he alone can do—seeing to it that the work goes thru as planned.

The eighth manual will deal with a very important aspect of dispatching. It will have to do with those qualities of mind and heart which a foreman must have in order to produce. Therefore this manual will not discuss

these points, but rather will deal with some of the principles and methods of successful dispatching.

Control Boards As an Aid to Production

Planning boards, control boards, route boards, dispatch boards, assignment boards and the like, are designed to present in a convenient form readily accessible to the foreman, a picture of what work is being done at each machine and what is assigned to be done. These devices are appealing because they are concrete; but there must be good organization and management ability behind them. A good many companies think they have installed scheduling or dispatching when they have set up some of these boards with pockets to hold work tickets.

Essentials of Schedule Control

Schedule control does not exist unless the following seven points are covered:

1. Is the manufacturing program made out in advance, based on an analysis of the company's sales plan.

2. Has the program been checked against warehouse contents?

3. Is it known what parts are interchangeable?

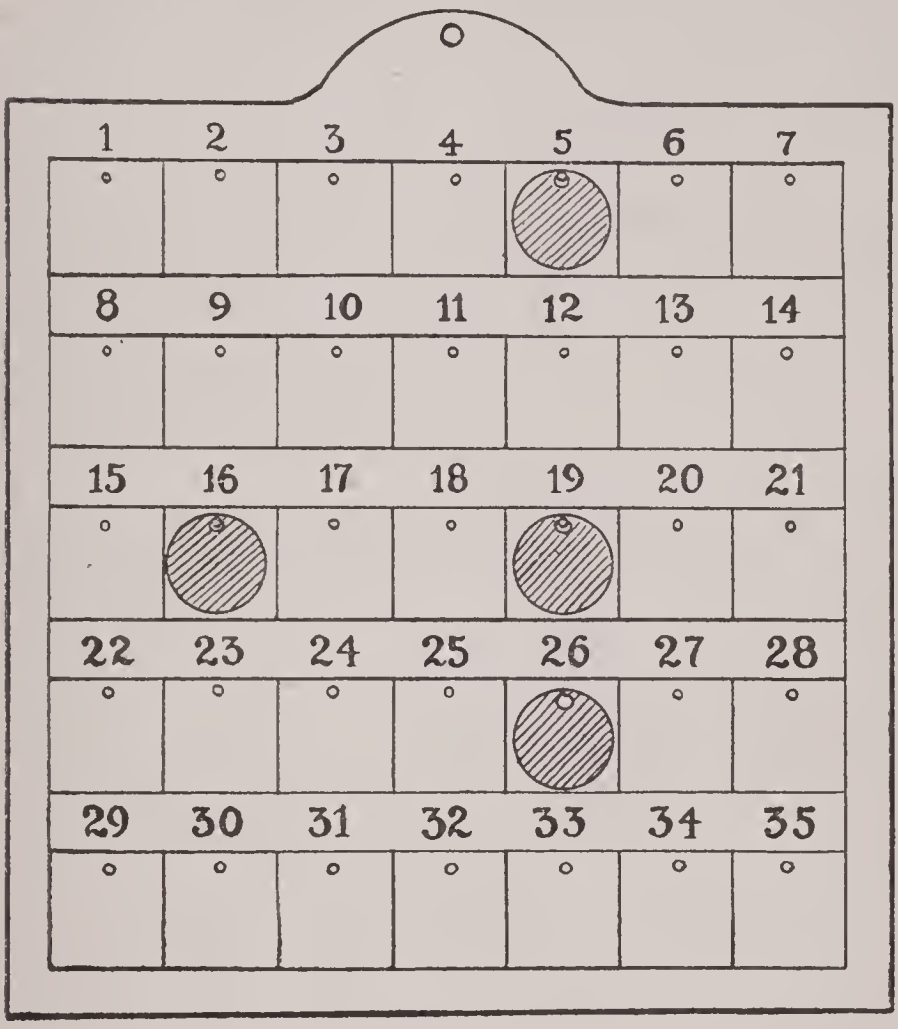

Fig. 7.—The above is a reproduction of a control board which one foreman devised to cut down the idle time of his men and machines. Instead of waiting to report in person to him, his men simply hang a metal check on the hook under the number corresponding to their machine an hour or so before they are out of work. Other types of control boards will be described in detail in Manual 8, "Getting the Work Out."

4. What raw materials, finished parts, and partially worked materials called for by the program, are in stock or in process?

5. What are the economical lots for each component part so that the program can be met, at the same time avoiding building up an unnecessarily large inventory of any components?

6. What are the limiting factors imposed by the capacity of the equipment which cannot be overcome, and to what components do these limiting factors particularly apply?

7. Are data available as to tool equipment for critical components; and have we available lists of all tool requirements, and tools necessary and available to meet the manufacturing schedule?

This tool schedule is always necessary before it is possible to schedule the product. This schedule is also necessary for gathering data as to the life of the tools.

Importance of Having All Material and Work Orders Written in Advance

In a well-organized planning department in which routing and standard times are on file, the plan of work and individual work tickets will be written out in advance of the issuance of the order. There will be a separate work

ticket covering the work of each separate machine on any lot of parts, so that each lot will have as many work tickets as there are different machines used.

WORK ASSIGNED TO MACHINE No.						
Work Assigned to Be Added			Balance Work Ahead in Hours	Work Completed to Be Deducted		
Order No.	Piece Symbol	Time Allowed		Order No.	Piece Symbol	Time Taken

Fig. 8.—Not only must each job or part of a job have a separate job ticket for each machine, but a record of the balance of work ahead for each machine must also be maintained. The above figure is a reproduction of such a record as used in one plant. Perhaps you can use it as it is or suggest several improvements.

Balance of Work Record

In order that the work represented by these tickets may be scheduled, a record of the balance of work must be maintained at each bench or machine. One way of doing this is to have a card on which are listed all orders to be done at a certain machine, these being placed on the left-hand side of the card. On the right-hand side will be listed all completed orders. A balance of work ahead will

be struck each day. Figure 8 is an example of this kind of card.

Now we must combine references to and use of these cards of balance of work ahead at each machine, with the sales or shipping schedule and the manufacturing program, which tell us when the respective orders are wanted. A knowledge of both the machine capacity and the program desired, is necessary in order to assign the work tickets to definite dates.

Ordinarily in scheduling work where no relative position of various orders is designated, the procedure would be to schedule work consecutively as received from the planning department. There is always likely to be more or less work which can be deferred or inserted at convenient places subsequent to or between orders which must be put thru on specific dates.

Usually the foreman is directly concerned with scheduling, tho he does not always do the actual work himself. The factory may have a centralized scheduling department; tho even if it does, it is likely to have a production clerk or schedule clerk in each de-

partment, if the factory and its departments are large. Where the scheduling is not centrally controlled, the foreman usually has a production clerk, who acts both as schedule clerk and dispatch clerk.

In order to dispatch each day's quota of jobs to specific men and machines, the foreman should prepare on Friday or Saturday of each week a list of the number of men on each kind of equipment and on each class of labor, who are expected to work the next week. A sheet ruled off with columns for each day of that week is then prepared for each machine or bench worker. As work tickets are assigned to certain dates, they are entered in the columns, a line being drawn down to cover as many hours on that day as the work will take. The space between the horizontal line may be used to represent one hour, or if fairly large sheets are used, four spaces to the hour can be used. Some foremen prefer to assign only about 80 per cent of the average time in order to make up for absences and breakdowns and to allow for the insertion of emergency work. This method will show at a glance how far ahead we have work scheduled for each machine and each class of labor.

Step Seven

Preparing for Interruptions

Having disposed of the scheduling and dispatching of work thru the factory, it might appear that all the work of planning the main factory program had been completed; such, however, is not the case. No allowances have been made for unusual conditions; for breakdowns; for illness or quitting of employes; or, what is most important of all, for inspection.

In planning the drive thru the Argonne, the commanding general of the First American Army assigned certain objectives to be gained by the end of each day by the several divisions —that is, he scheduled their work. It was the task of the commanding general of each division, with the help of his staff, officers, and men, to attain those objectives. He was the man who had to dispatch the work scheduled by the commander of the army.

When one of the divisions failed to reach its objective at the appointed hour, the divisions at each side suffered greatly from the flank fire and the unusual harrassing of the enemy. New plans had to be made immediately. The most advanced divisions fell back temporarily, to allow the others to catch up. A new and fresh division was substituted for the weak one. Emergency plans succeeded, and the advance was successful, tho at a greater cost and

in a longer time than would have been true if the original plans had been successful.

It is just the same in the factory when a machine breaks down, or when workmen are sick. The well-planned schedule is interrupted because the work planned for that machine or that man is not done; and either serious delays result, or emergency plans are worked out and put in operation.

The Exception Principle

Emergencies of one sort or another may arise any time. Frederick W. Taylor, who first carefully studied and recorded the facts of so-called "scientific management," made use of what he designated as the "exception principle" in management methods, to take care of emergencies. In this principle he set up the rule that emergencies and unusual matters must not pass along with the regular routine, leaving it to major executives to scrutinize a mass of routine in order to dig out the emergencies,—but that systems and methods should be so arranged that any exception or emergency will stand out in bold relief in any records or papers pertaining to them, and that the force dealing with routine should be so instructed that only the emer-

gency matters come to the attention of these executives, whose judgment will then come into play in disposing of the emergency in a proper manner. The method of handling interferences in schedule, which will now be described, exemplifies this principle.

The Production Chaser or Interference Man

For the purpose of taking care of snags or other interferences, most shops having as many as four or five hundred employes delegate one or more persons to the duty of following up interferences. Sometimes this man is called a "production chaser," and he may have an assistant who is a material chaser or follow-up man. These follow-up men get their information from each shop from the classification of the order or work tickets which has already been referred to, namely, from the orders that are filed in a certain place as being behind schedule, and from those in regard to which interferences exist. The interferences will naturally need to be classified daily so that they can be disposed of by a single daily conference or by telephone conversation with the departments involved. For example, these interferences are classified in such a way that all the defective

products will be taken up daily with the proper department; so that all delayed purchase items will be grouped, with a daily follow-up; and so that all delays due to shortage of tools will be grouped in the same way.

It is important that the interference men get the new data covering the material, tool, or whatever it is that may have caused the interference. This is necessary so that the rescheduling can be properly done. When making out a new schedule, it is of course necessary to examine all existing charts and indexes.

In the case of an interference with assembly —that is, if the interference causes a change in the date of the assembly—the assembly order will also have to be rescheduled. It is customary for the follow-up man or interference man to have some system of periodically charging against the department responsible for delays, the accountability for these delays. This accountability memorandum may be in the form of a daily bulletin; or it may be in the form of separate cards covering defects or delays; or both may be used, the cards being sent to the departments involved, and the general bulletin being sent to such persons as are concerned.

Sometimes interferences use up orders schedules for certain dates. This means that work must be assigned to fill the vacancy. No matter how well the work is planned, it is also sometimes found in starting work that it is necessary to change operations or that a change must be made on the blue prints.

How Inspections Are Handled

While inspection is not an unforeseen nor an undesirable interruption in the flow of work, it can probably be best considered here. In attempting to go fast enough, production may fail now and then to do its work well enough; therefore inspection is introduced, in order to have the output high in quality as well as in quantity.

The quality of the work will, of course, be checked up by the inspection department. It is customary to have the inspection department quite distinct from and independent of the foreman. This is as it should be; because the foreman is primarily a production getter and cannot help having a tendency to be a little less strict in inspection matters than an inspector will be whose one and only aim is to observe the strict letter of his inspection, first, last, and all the time.

The inspection department, which may be under either the engineering department or the production department—or independent of both, depending on conditions—will also be in a position to draw conclusions as to the best way of doing things, on account of their constant contact with the work and with the imperfections and rejections that come up from day to day. It is the duty of the inspection department to maintain control over quality in accordance with determined standards. These standards should provide strength and accuracy at the essential points only. Any oversupply of caution, either in strength or accuracy, at points or parts where it is unnecessary, is useless waste.

Rejection by the inspection department must ordinarily be rigid, depending on the policy and the requirements of the product. It does not follow, however, that rejected materials or parts will not be used. They must be set aside for review by the properly authorized person or persons who will decide what disposition shall be made of them. The inspection system must be such that there is no delay, that decisions are prompt, and that the department is generally looked to as a means of expediting and benefiting production.

When "100%" Inspection Is Necessary

There are certain kinds of work and certain operations where 100 per cent detail inspection of each piece is necessary. This type of inspection may be again classified as either counting, weighing, gauging, or measuring, or as simple visual inspection. Where there is a constant flow of materials or parts, the trucks or conveyors will bring them into closed inspection cribs, or cages—material to be inspected entering at one end, and accepted goods passing out at the other end, with room for the temporary storage of rejections.

How Selective Inspection Is Applied

Where 100 per cent detailed inspection is not necessary, we may utilize selective inspection, the process inspectors making selections or "pick-ups" at critical points. Process inspection of this sort is usually preferable to a system of final inspection, which waits until many parts are finished before any inspection at all is made. Process inspection prevents errors and defects at the start, usually just when they are beginning to be made.

These process inspectors will make their selections at what are known as critical

points. The inspector at a given point is responsible for all operations which have been performed since the last previous inspection.

Applying the Principles to Your Shop or Department

Factories and plants differ as well as do their organizations and products. Each plant or factory is different in that the conditions are never quite alike and individual adaptations should be made from universal principles to meet the requirements of your particular plant, factory, or department. The universal principles of maintaining an even, steady, and smooth flow of work as laid down in the seven steps outlined in this manual, will give you a workable understanding of what is necessary to such an accomplishment. With this understanding it will no doubt surprise you to find how comparatively easy it will be to work out worth-while improvements and possibly to pattern a method of keeping up the flow of work which will be exactly what you want.

Determining just what system will work out best in your factory is a matter which may be up to you, your superintendent, or your planning department. In any event, you will be called upon to help.

Bear in mind that it is not the theory of such rules or principles, but the results they bring about after they have been applied to meet everyday factory or plant conditions, which you must be on the lookout for. Many of the suggestions in the seven steps outlined in this manual may be utilized in your shop or department immediately with good results. A good way to go about it would be first to select those which can be most easily applied, and try them out. If the first one does not succeed in bringing about an improvement, try another, always bearing in mind that no plan or suggestion, no matter how good it may be in itself, will work out successfully for you unless the details of it have been worked out to meet the requirements of your shop or department.

Work flows thru a factory or shop which workers consider a *good* place to work, much more smoothly than it does thru one which they regard as merely *a* place to work. There are a hundred and one reasons why this is so. The next manual, "A Good Place to Work," lists them in detail. The chances are that you will find many helpful suggestions in it.