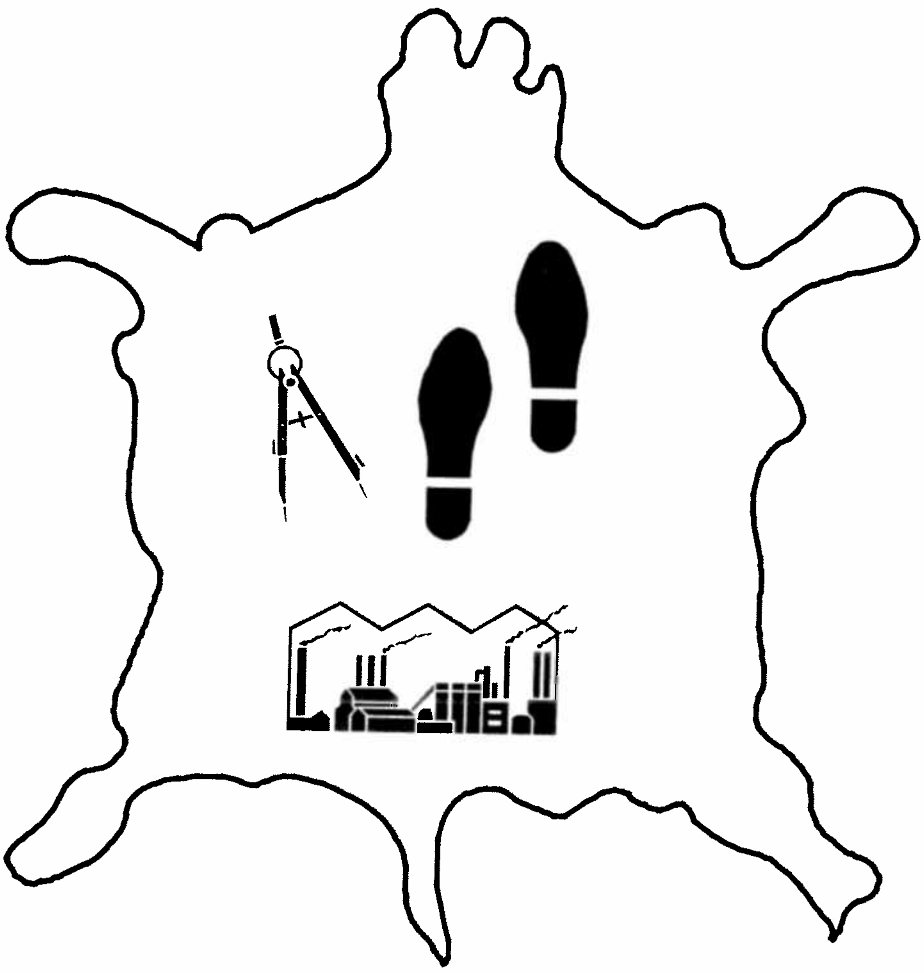
SHOE INDUSTRY CERTIFICATE COURSE

UNIDO

PRODUCTION MANAGEMENT*



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This learning element was developed by the UNIDO Leather Unit's staff, its experts and the consultants of the Clothing and Footwear Institute (UK) for the project US/PHI/85/109 and is a part of a complete Footwear Industry Certificate course. The material is made available to other UNIDO projects and may be used by UNIDO experts as training aid and given, fully or partly, as hand-out for students and trainees.

The complete Certificate Course includes the following learning elements:

Certificate course

-Feet and last
-Basic design
-Pattern cutting
-Upper clicking
-Closing
-Making
-Textiles and synthetic materials
-Elastomers and plastomers
-Purchasing and storing
-Quality determination and control
-Elements of physics
-General management
-Production management
-Industrial Law
-Industrial accountancy
-Electricity and applied mechanics
-Economics
-SI metric system of measurement
-Marketing
-Mathematics
-Elements of chemistry

PRODUCTION MANAGEMENT

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I. THE PRODUCTION FUNCTION

Production - is the process by which goods and services are created.

Production Management - deals with decision making related to production processes, so that the resulting good or service is produced according to specifications, in the amounts, and by the schedule demanded, and at the minimum cost.

Two Areas of Activity Associated to Production Management

a) the design
b) control of production system

Continuous Versus Intermittent Models

1) Continuous flow production situations are those where the facilities are standardized as to routings and flow, since inputs are standardized. Therefore, a standard set of processes and sequence of processes can be adopted.

   Ex production + assembly lines
   continuous flow chemical operations

2) Intermittent production situations are those where facilities must be flexible enough to handle a wide variety of products and sizes, of where the basic nature of activity imposes change of important characteristics of the input (change in product design).

No single sequence pattern of the operation is appropriate, so that the relative location of the operations must be a compromise that is best for all inputs considered together. Transportation facilities between operations must be flexible, too, in order to accommodate a wide variety of input characteristics as well as wide variety of routes that the inputs require. Considerable storage between operations can be carried on somewhat independently, resulting in ease of scheduling and in fuller utilization of men and machines.

Ex custom or job order - type machine shops

What is a System ?

A regularly interacting or interdependent group of items forming a unified whole - Webster

Production Management Problems

A) Long - Run Decision related to the design of the production system

1. Selection and design of products - strong interactions between product selections and design with productive capability and vise-versa.

2. Selection of equipment and processes - usually alternative equipment and processes are available for a given need. Production management must make decisions that commit capital of the enterprise and its basic approach to production.

3. Production design of items processed -

Production costs interacts strongly with the design of parts, products, paper work forms, etc. Design considerations often set the limiting characteristics of cost and processing for the system.

4. Job design -

Job design is an integral part of the total system design, involving the basic organization of work, as well as integration of human engineering data to produce optimally design jobs.

5. Location of the system

Location decisions in some cases be important where the balance of cost factors determined by nearness to markets and to supply are critical.

6. Facility lay-out

Decisions to design capacity, basic modes of production, shifts, use of overtime and subcontracting must be made. In addition, operations and equipment must be located in relation to each other in a pattern that minimizes overall material handling cost on meets the requirements of some more complex criterion.

B) <u>Decisions related to the design of operation and control systems</u>

1. Inventory Control - Decisions must be made concerning how to allocate productive capacity, consistent with demand and inventory policy. Feasible schedules must be unfeel out, and the load on men and machines and the flow of production must be controlled.

2. Maintenance and reliability of the system

Decisions must be made regarding maintenance effort, recognition of the random nature of equipment breakdown, and recognition that machine downtime may itself be associated with important costs or loss of sales.

3. Quality Control

Decisions must be made to set the permissible levels of risk that bad parts are produced and shipped, or that errors are made, as well as the risk that good parts are scrapped. Inspection costs must be balanced against probable losses due to passing defective material or services.

4. Labor Control

Labor is still a major cost element in most products and services. Production planning requires an appraisal of the labor component; thus much effort has gone into developing work measurement and wage payment systems.

5. Cost Control and Improvement

Production supervisors must make day-to-day decisions which involve the balance of labor, material, and of some overhead costs.

The relative importance of these problems varies considerably, depending on the nature of individual systems.

Ex - equipment policy may occupy a dominant position in production system where capital investment per worker is very large, as in petroleum industry. On the other hand, equipment policy may occupy a minor role in a production system that is represented by a large material component. Part of the art of production management involves the sensing of the relative importance of these various problems in a given situation.

II. OBJECTIVES OF PRODUCTION PLANNING AND CONTROL

1. To deliver the product to the customer when he wants it.

2. To maintain an adequate but not excessive supply of finished goods and work in process following through the plant so that products can be delivered to customers who want it in less than manufacturing time.

3. To promise delivery in the shortest time possible if product delivery cannot be made when the customer wants it.

4. To keep promised delivery dates.

5. To maintain flexibility in our manufacturing operations so that occasional rush orders can be accepted and delivered thus, gaining new customers or additional business from old customers.

6. To issue coordinated schedules and orders to the production departments with complete information to tell them what is expected to meet delivery requirements.

7. To follow-up production schedules to assure that delivery promises will be kept.

8. To maintain adequate but not excessive inventories of production materials to support the continuous flow of production.

9. To maintain inventory, production, and employment levels that are relatively stable and consistent with the general level of sales.

10. To plan plant capacities that will provide adequate facilities for future production and sales.

11. To produce the most effective results for the least total costs in services provided.

III. PRODUCTION PLANNING AND CONTROL

All of the four basic phases of control of manufacture are easily identified in production planning and control.

The plan for the processing of materials through the plant is established by the functions of routing, loading, and scheduling.

The functions of dispatching puts the plan into effect; that is, operations are started in accordance with the plan.

Actual performance is observed and recorded by the function of reporting or follow-up. Actual performance is then compared to the planned performance and, when required, corrective action is taken. In some instances, replanning is necessary to insure the effective utilization of the manufacturing facilities and personnel. Let us examine, more closely each of these functions.

1. Routing

The determination of where each operation on a component part, subassembly, or assembly is to be performed results in a route for the movement of a manufacturing lot through the factory. Prior determination of these routes is the job of the routing function.

Routing may be generalized or detailed. In a large manufacturing works area, a general route may be established by buildings. More commonly it is established by departments, such as machine shop, assembly, finishing, inspection or others.

Detailed routing would indicate the specific work station or machine to be used for each operation. Regardless of the detail in which the routing is initially planned, a precisely detailed route eventually has to be determined.

For example, if a lot of parts is routed to the machine shop for processing, and there are three separate operations to be performed in that department, the decision by the foreman or dispatcher as to the three machines to be used for the job determines the detailed route of this lot of goods through the machine shop. However, this is too often a last minute decision, depending only on the availability of the machines instead of being guided to an effective degree by planning. On the other hand, in continuous manufacturing when a processing line of machines is used, or an assembly line is installed, the route of the materials must conform to the line; the routing function was incorporated in and accomplished by the original layout of the plant.

The source of basic information for the routing function is the standard process sheet, which indicates the type of machine or work station required for each operation in the process.

2. <u>Loading</u>

Once the route has been established, the work required can be loaded against the selected machine or work station. The total time required to perform the operation is computed by multiplying the unit operation times given on the standard process sheet by the number of parts to be processed. This total time is then added to the work already planned for the work station. This is the function of loading and results in a tabulated list or chart showing the planned utilization of the machines or work stations in the plant.

One of the problems in loading is the amount of utilization that can be planned for a given workshift, such as an 8 hour day. For example, owing to factors such as maintenance, repair, setup. and others, 85 per cent utilization is considered a good average for machine tools. Under these conditions, only 6.8 hours of productive work should be loaded for an 8 hour shift. But if workers can be expected to earn an average of 20 per cent bonus -- and the 6.8 hours is based on standard times - - a total of 8.16 standard hours can be loaded against an 8 hour shift.

Thus far we have indicated that loading is by work station or machines. This is detailed loading. Loading may be generalized like routing, that is, groups of machines or departments may be loaded as a single unit. For example, all lathe work may be loaded against the lathe department, or all milling to be done simply charged to the group of milling machines in the plant.

The objective of the loading function is to maintain an up-to-date picture of the available capacity in the plant. If a general type of loading is adequate this should be used and no further breakdown of loads made. Often it is sufficient to keep load charts on only the critical productive units or departments and assume that all other departments have adequate capacity to keep abreast of the production rate.

Obviously load charts would be referred to when determining routes of orders through an intermittent manufacturing plant. In this case, the route is influenced by the availability of a department, machine group or work station capacity.

3. Scheduling

Scheduling is the last of the planning functions. This function determines when an operation is to be performed or when work is to be completed, the difference lies in the detail of the scheduling procedure. In an centralized control situation - - where all routing, loading, and scheduling for the plant is done in a central office - - the detail of the schedule may specify the starting and finishing time for an peration. On the other hand, the central schedule may simply give a completion time for the work in a given department (as in the machine-department situation mentioned above). Here the foreman would be held responsible for having all three operations completed by a given date. The detailed schedule for the completion of each of the three operations in the machine department would have to be determined by the foreman or the dispatcher. Again, this is more than likely to be an after-the-fact determination rather than sound planning. However, as with routing all general schedules eventually become detailed schedules .

Prior determination of when work is to be done is the function of scheduling.

4. Combining functions

While it is easy to define "where" as routing, "how" much work as loading and "when" as scheduling, in actual operations these three functions are often combined and performed concurrently. How far in advance routes, loads, and schedules should be established always present an interesting problem. Obviously, it is desirable that a minimum of changes be made after schedules are established. This objectives can be approached if the amount of work scheduled for the factory or department is equal to or slightly greater than the manufacturing cycle. For optimum control it should never be less than the manufacturing cycle.

If it normally takes three days for work to pass through a department, the work load should never be scheduled less than three days in advance. The total work load ahead of the department might be three or six months. Obviously, scheduling all of the work load in advance would not be necessary for the effective day-to-day operation and would present a problem if changes in schedule were necessary.

Scheduling too far in advance of operating requirements introduces a degree of inflexibility in the control of production. Load charts may be maintained in addition to the schedule charts showing the total load ahead. This is justified only if it is necessary to identify critical shortages of productive capacity in advance of the normal scheduling procedure. Work can be loaded against a work station or department without being scheduled but it cannot be scheduled without being loaded.

5. Dispatching

Authorizing the start of an operation on the shop floor is the function of dispatching. This function may be centralized or decentralized. Again using our machine shop example, the departmental dispatcher would authorize the start of each of the three machine operations - - three dispatch actions based upon the foreman's routing and scheduling of the work through his department. This is decentralized dispatching. Anothe case of decentralized dispatching would be where the departmental dispatcher dispatched work based upon plans of a central control office, advising them only when the work had been started. In a centralized dispatch situation, when a job had been completed on a machine or at a work station the departmental dispatcher would call a central dispatcher and ask what job should now be started; the actual assignment of work thus would remain at a central point.

6. Reporting or follow-up

The manufacturing activity of a plant is said to be "in control" when the actual performance is within the objectives of the planned performance. When jobs are started and completed on schedule there should be very little, if any concern about the meeting of commitments. Optimum operation of the plant, however, is attained only if the original plan has been carefully prepared to utilize the manufacturing facilities fully and effectively.

The effectiveness of any production control system is dependent upon timely and adequate information regarding actual performance. This basic information normally orginates with the dispatcher. Although the reporting of jobs completed is important, it is of even greater importance that delays in production be anticipated and work that is lagging behind the anticipated production rate be reported promptly to the production planning and control function.

A good production control procedures makes this reporting and a system of counter checks by follow-up automatic. The systems by its very procedures will call attention immediately to danger points in the manufacturing activity.

Effective corrective action is based upon these reports. Realistically, some jobs will always be running behind schedule others may be ahead of schedule. Careful analysis of the situation may indicate how a few changes can bring the late work back on schedule by using productive capacity made available by the jobs that are running ahead of schedule.

7. Corrective action

This is the keystone of any production planning and control activity. A plant in which all manufacturing activity runs on schedule in all probability is not being scheduled to its optimum productive capacity. With an optimum schedule, manufacturing delays are the rule, not the exception. However, if these delays are accepted without concern and schedules revised; then the actual output of the plant, not the management, is controlling the production. It is by corrective action that management maintains full control. Means are found to get the work back on the original schedule. Jobs are shifted to other machines or work stations, overtime is authorized, and extra help is put on the job. There are many ways in which production emergencies can be met.

8. Replanning

Replanning is not corrective action. Replanning revises routes, loads, and schedules; a new plan is developed. In manufacturing this is often required. Changes in market conditions, manufacturing methods, or many other factors affecting the plant will often indicate that a new manufacturing plan is needed.

In summation: Production planning and control plans, in advance, the route of work through the plant, determines the amount of productive capacity required to do the work, and -- based upon the availability of this capacity -- schedules all phases of the work so that the plant will be effectively utilized. Once these plans are established, production control provides the means to keep track of manufacturing activity and when necessary take corrective action or replan. It is simple: "Make your plan, then work your plan".

We have discussed each of the production planning and control functions, emphasizing that their application in manufacturing is not uniform. However, it should be remembered that at no time can any function be eliminated. Routing, loading, scheduling, dispatching, reporting, and corrective action are component parts of any effectively managed manufacturing operation. This is just as true of a street corner popcorn stand operated by one man as it is of a large concern employing many thousands and producing a wide line of products. Production planning and control of itself is a simple procedure; it becomes complex only in its application to a manufacturing situation. Decisions must be made as to the degree of control necessary, centralization or decentralization of the production control procedures, and when the various functions are to be performed.

IV. FACTORS AFFECTING PRODUCTION PLANNING AND CONTROL

The factors that affect the application of production planning and control to manufacturing are the same as the factors we have already discussed as affecting inventory management and control. Let us briefly review these in relation to production planning and control.

1. Type of product

Again, it is the complexity of the product that is important, not what the product is, except as this may in turn relate to the market being served. Production control procedures are much more complex and involve many more records when manufacturing large steam turbine generator sets or locomotives to customer orders than when producing large quantities of a standard product involving only a few components parts, such as electric blankets, steam irons, or similar small appliances. Of secondary importance is the type of market being served. A seasonal market may require careful planning of production for maximum output during a limited period of time (this is particularly true in the canning industry). On the other hand, a seasonal market in rubbers and overshoes may be offset by planning to manufacture to stock during the slack seasons. Manufacturing to stock, as opposed to producing only to the customer order, presents an entirely different situation.

2. Type of manufacturing

This is probably the most important influencing factor in the control situation. For a large continuous manufacturing plant producing a standard product we have already indicated that the routing was included in the planning of the plant layout. Also the detailed scheduling of work between operations was accomplished when the many production lines were balanced. As a result, about all that is left for the function of production planning and control in the operation of the plant is to set up key control points in the lines and, once manufacturing is started to make sure that all the many feeder lines are producing adequate stock so that no,shutdown occurs owing to lack of partially completed component parts of subassemblies.

As we have mentioned previously, this situation is for all practical purposes a control of materials at the start of the lines.

Intermittent manufacture of multi-product lines presents a quite different problem. Optimum operation of the factory is dependent upon the deffective use of all of the functions of production planning and control. All production planning and control functions occur after the manufacturing order is approved; this cannot be avoided. Depending upon the degree of control desired, the length of the manufacturing cycle, and the decentralization or centralization of control wanted, a production planning and control system must be developed that will result in the optimum operation of the intermittent plant.

Once more, the volume produced, or the size of the factory, is not a factor directly affecting the problem of the design of the control system.

V. OBJECTIVES OF PRODUCTION PLANNING AND CONTROL

The ultimate objective of production planning and control, like that of all other manufacturing controls, is to contribute to the profits of the enterprises. As with inventory management and control this is accomplished by keeping the customers satisfied through the meeting of delivery schedules. Specific objectives of production planning and control are to establish routes and schedules for work that will insure the optimum utilization of materials, men, and machines and to provide the means for insuring the operation of the plant in accordance with these plans.

VI. PRODUCTION PLANNING AND CONTROL PROCEDURES

It might be well, however, to point out again that any production planning and control procedure should meet the bench marks of good control practice. Though no production control function can be entirely eliminated, the least control that results in effective operation of the factory is the best control. It must be remembered that production planning and control systems should be tools of management. The objective is not an elaborate and detailed system of controls and records: the objective is the optimum operation of the plant for maximum profits.

1. Production Planning and Control Systems

Because production planning and control is the control of the work in-process, the system will in effect tie together all previous records and forms developed in all planning for the manufacture of the product. In like manner this activity brings together all the other functions of the enterprise --marketing, engineering, personnel administration, finance, and manufacturing. The production planning and control group is most generally a sub-group of the manufacturing function.

Basically, production planning and control system are industrial communications established to insure proper relationship between market forecasts,customers orders, manufacturing capacity and rates of production, and shipments.

Let us take a quick look at some of the records or forms that enter into the consideration of the production planning and control group in the performance of their duties. Those records and forms prepared by other functions are sold to be sources of basic data -- of information that is needed by production planning and control for the effective use of its own records and forms.

2. Market Forecast

The market forecast will be discussed in the chapter on marketing. Its value to production planning and control is that it will indicate future trend in manufacturing requirements. Workshift policies, plans for increase or or decrease of manufacturing activity, or possible plant expansions may often be based upon the market forecasts, and in turn affect the planning of the production planning and control agroup.

3. Customer Order

These are received initially by the sales department. This is the first of five types of order involved in a manufacturing situation. Although there is no uniform terminology for all five of these classes of orders, each can be readily identified by what is ordered or authorized by the form. By a customer's order we mean an agreement to purchase the product; this becomes a legal contract once the order is accepted by the manufacturer. It is really the customer's purchase order. Such orders are usually forwarded to production planning for confirmation of the delivery date requested by the customer. This delivery date -- or shipping date -- must be carefully considered and agreed upon, often without an analysis of the order and its integration into load or schedule charts. If the request for delivery cannot be met, the matter should be promptly referred back to the sales group for further discussion with the customer before accepting the order.

4. Sales Order

This is the second of the five classes of orders. It is a rewrite of the customer's order specifying what he has purchased -- product and quantity -- and authorizing shipment of the goods to the customer. Multiple copies are prepared and all interested functions are furnished a copy. Sales orders may be written by marketing, inventory control, or production control. In any event they are processed through the finished goods inventory (if one is maintained).

In a custom manufacturing situation these orders are the base upon which all activity in preparation for manufacture is made. If items are to be shipped from stock, the shipping department will use this order as a requisition to draw the products from finished goods and to package and ship the order. In other cases these orders are accumulated until economical manufacturing lots are on order and a stock order placed with the plant to manufacture the goods, shipment then being made as the material is received in the shipment department. In all cases, however, the production planning and control group must use these orders as the basic data for the shipping promises to which they are committed.

5. Stock Order

The third class of order is not always used. In the preceding paragraph we indicated how it may be used after sales orders accumulate to an economical manufacturing lot. It is of courses, the principal order when manufacturing to stock. It will authorize production in anticipation of future sales. It may be issued by inventory control, or by marketing, but should always be confirmed by the marketing function to insure that surplus of products are not made that will result in loss owing to obsolescence. As with the sales order, the production planning and control group will determine a completion date for stock order and from this file will keep track of the dates for which they have commitment.

6. Shop Order

This fourth class or order deals with the manufacture of component parts. Customer orders, sales orders, and stock orders are for the finished product. In the preceding chapters, we discussed how by product explosion the requirements are established for component parts to build assembled product. Based upon the shortages that appear in the component parts inventory, shop orders are prepared by inventory control. This order, when passed on to the production planning and control group, becomes the basis for the majority of routing, loading and scheduling.

7. Standard Process Sheet

This form is prepared by process engineering. Also in discussing the function of routing we pointed out that this is the source of basic data as to the type of machine to be used, the time required for processing, and the sequence of operations in the manufacture of the product. Routing and scheduling of shop orders, as well as loading of work stations in advance of scheduling, depend upon up-to-date standard process sheets being available to the production planning and control group.

8. Engineering Specifications

Blueprints and bills of materials are used by production planning and control when they become a component part of the packaged instructions issued to the shop through the control office. One good planning procedure is to accumulate all necessary data for a shop order in a single package--- the standard process sheet, the blueprint, the bill of material (if an assembly operation is involved), the route sheet, and possibly the schedule for the production of the order. This complete package is then held pending the dispatching of the work to the shop.

9. Route Sheet

This is the form upon which the route of a shop order is indicated. In practice this form is generally combined with one of the other forms in the system. For example, the shop order, the standard process sheet, and the route sheet are often one piece of paper -- and usually called the shop order or the manufacturing order.

PRODUCTION AND MACHINE TOOL ROUTING

Part Name ______________________ Part No. ______________________

Material ______________ Rough Size ______________ Rough Weight ______________

Date Effective ______________________ Model ______________________

Quantity Per Assembly ______________ Sheet No. ______________ Of ______________

Op. No.	Dept. No.	Oper'n. Name	Mach. Name	Mach. Name	Tools & Gages	Tool No.	Grp. No.	Req. No.	Std. Mis.	Time Hrs.	Cap Each Mach./ H

Remarks:	Engr. Group Indes	Assembly No.	Totals Per Pc Per Job	

Figure 1. A Typical Standard Route Chart

10. Load Charts

These are prepared to show the productive capacity that has been "sold" -- and at the same time the available productive capacity. As we pointed out when discussing the function of loading these charts may be prepared for each work station or machine in the plant; or they may be for groups of machines or departments. One large manufacturer of heavy apparatus actually loads the entire plant, using this scale the kilowatt capacity of the equiment he is producing. Load charts, as such are not too common. This function is usually combined with scheduling and only one set of charts is maintained; the schedule charts.

Machines	Daily Machine Capacity (Hours)	Assigned Orders (Hours)

11. Schedule Charts

Schedule charts are prepared to show the planned utilization of departments, groups of machines, work stations, or machines in the plant. These charts not only shown what work is ahead of each productive unit, but not when it is planned that the work shall be done. They are usually a graphical representation -- such as the Gantt charts.

"Firm" schedules (schedules not subject to change) should never be less than the manufacturing cycle, and for flexibility should not be too much greater than this period of time. A usual solution is to prepare these schedule charts for a three-months period, the first month on the chart being a firm schedule, the last two months being tentative.

In a large shop it becomes quite a problem to transmit schedule information to the many departments involved. It might be included in the shop order package. This solution has the disadvantages that if changes in schedules have to be made there is a lot of paper floating around the shop that has to be located and changed. Another solution is to furnish each department with the portion of the schedule chart that applies to that manufacturing unit. Finally, the schedule clerk might draw off the chart a job priority list for each unit or work station and furnish only these lists to the shop; this has the disadvantage that the departmental dispatcher will not be as apt to anticipate work manning behind schedule.

Another problem in schedule charts is the matter of keeping them up to date. At least, it is often believed to be a problem. But if we accept the concept that schedules once firm should not be changed, then the incomplete work indicated on the chart will show us a true "late" condition of our manufacturing activity. By so doing this chart will be most valuable in the planning for corrective action. Once an order is late it should remain late until brought back to the original planned schedule.

12. Job tickets

This is the fifth and last type of order in a manufacturing situation. Job tickets authorize the performance of individual operations in the manufacturing process. Whether they should be pre-written by the production control group or made out by the departmental dispatcher when needed is not of a great importance. However, this is probably one of the most important forms in the production control system. Initially it simply authorizes that a particular operation is to be performed. However, when finally filled out upon the completion of the operation it becomes the"feedback" form that shows not only that the job is complete but also the number of parts processed and the actual time required. This is the principal form in the reporting and follow-up steps in the control of production.

Again, let us remember that there is no uniform terminology for the forms we have just discussed. However, if we get a clear understanding of what each form is being used for in the control situation, we can readily identify these forms in a manufacturing plant regardless of what title appears at the top of the sheet or card.

VII. PLANNING AND SCHEDULING

Planning and scheduling of production is the systematic preparation of sequence of operations and the allocation of time for the performance of these operations. In a small company manufacturing a limited number and variety of products, the problem of planning and scheduling production is relatively simple. Most workers in the plant are familiar with the products and the operations through which they must pass for production. In normal times intstructions for the various operations can be handed down by word of mouth. The volume of work in the plant is sufficiently small to be easily centralized under the personal supervision of a foremen. In such cases formal and detailed records and instructions are apt to become an unnecessary burden.

Today most managements are forced to seek a substitute for the informal procedure of controlling production. The development of a more formal and systematic procedure seeks to accomplish these aims:

a) Maximum quality production at a minimum cost through even distribution or work to available equipment and personnel.

b) Added flexibility in equipment and personnel to meet unavoidable emergencies, and

c) Harmony and co-operation between departments.

It is a popular belief that written instructions and elaborate procedures of planning and follow-up make change difficult. If that is true, and it sometimes, is, management is guilty of attempting to make the job fit the system instead of fitting the system to the job. Every procedure and every instruction should be planned with the expectation that it must be changed. On the other hand, a foreman and the men under him must realize that they are but a part of inlarge organization and that a change in operations in one department may disrupt the work of numerous other departments.

1. Responsibility of the Foreman

The foreman stands as a connecting link between management and the worker. He has a direct responsibilities to both. He is responsible to management for getting the work out. He is responsible to the worker for the efficient scheduling of work and the movement of parts and materials in a way that will permit maximum earning to the worker as well as maximum profit to the organization as a whole.

The foreman can effectively promote these mutual interests of management and the worker through constructive planning and scheduling. If he has the work of his department well in hand, he should be in the best position to advise regarding the combination of orders for more economical runs. His suggestions can cover avoidance of extra setup time, alternative routing of jobs within the department for greater economy and efficiency and possibilities of freeing equipment that may be needed on an emergency order.

The foreman also has a co-operative responsibility with other foreman in the plant. A planning, or production-control, department of an organization should be looked upon as a service department, which helps in the work of the production departments. It carries responsibility and authority for planning, scheduling, and following up work in production. Yes, it can be effective only if it has the sincere cooperation of those departments which it serves.

If the purposes of planning and scheduling are to be achieved, the foreman must seek only an honest and fair allocation of time and equipment for the work of given order. It is a natural tendency for foreman to ask for extra allowances of time to avoid getting behind schedule. They know that a certain amount of breakdown or delay is unavoidable. Some extra time allowance should be recognized as advisable in efficient scheduling. Yet, the foreman who takes undue advantages of this opportunity is failing in his part of the cooperative effort and is disrupting the planning efficiency of the entire organization.

A foreman has the responsibility for keeping prompt complete, and accurate records of work scheduling and work in progress in his department or division. The extent to which he may receive assistance in the performance of these duties will vary in different companies., depending upon the organization, the size of departments and the degree of centralization of departments. But, since he is responsible for the work of his department, he must have at his finger tips concrete information regarding the work in progress and the work which is scheduled for this department.

2. Planning and Scheduling Function

The principal planning and scheduling activities can be divided into four functions:

a). Routing
b). Scheduling
c). Dispatching, and
d). Follow-up

2.1 Routing

Routing of operations for the manufacture of a product consists, first, of the determination of operations through which the product must pass and, second, the arrangement of those operations in the sequence that will require a minimum of handling, transportation, storage, and deterioration through exposure .

Designation of operations and their sequence, in general, is the function of the engineering, development, or methods departments, depending upon the organization structure of the company. However, the routing specified by any one of these departments must be subject to alteration as problems of scheduling and actual production are encountered.

It is usually customary in the development of a new product to make up a sample, or trail run. This trial run may be made in a special department or plant, known as a "pilot plant" or may be run through the regular departments; if it is run through the regular departments, all foremen should offer constructive criticisms for improvements of quality, economy, and operating efficiency.

In continuous -- manufacturing plants, where departments are devoted exclusively to the manufacture of standard parts or products, it is usually possible to establish "straight line" production over an established route of operations. However, in diversified or job-order manufacturing, the function of routing becomes much more difficult. An arrangement of equipment for the straight-line routing of one order may be entirely inappropriate for the next order. For this reason departments of such plants are usually arranged according to "process". By this arrangement, machines of a like kind or machines that are similar in the nature of work performed are arranged in one department, grinding in another, and painting in still another. This arrangement usually offers greater flexibility, since a breakdown of one machine may not immediately close down the work on operations to follow. Also, temporary overloading of orders on one adjustment the Planning Department should prepare alternative routings.

2.2 Scheduling

A production schedule is a budget of time that provides for the beginning and completion dates of manufacturing order. Preliminary information needed in the construction of a production schedule is obtained from the following sources:

a) The Forecasting and Planning Department, in cases where standard parts or products are being made to stock;

b) Date of delivery specified by the customer in the order;

c) Minimum time, in terms of past experience, required for production.

Other factors, however, must be taken into consideration:

a) Availability of equipment

b) Availability of specially skilled personnel

c) Availability of the necessary parts and materials

It is usually possible to anticipate the needs for equipment, personnel and material considerably in advance. Difficulty arises during abnormal rush periods or when unusual conditions have caused shortages. It is at such times that a manufacturer must put forth special effort in order to obtain the maximum work from men and machines.

2.2.1 Master Schedules

There are two principal types of production schedules: master schedules and manufacturing schedules. The master schedule list the production of a given product in one or more divisions of the company. In continuous manufacturing, this master schedule may cover a period of a year or more. However, it is usually reconstructed each month to include unanticipated variations in the demand and in the volume of productuon. For example, a master schedule prepared in January is revised in February to include the 12 months to follow. It would again be revised in March, etc.

In continuous manufacturing, informations for the master schedule is obtained from the department responsible for forecasting of sales and production. The information is based on the sales of previous years plus the data obtained from market analysis relative to the probable demand of the current year. Considerations must always be given to the probable reception of new products which are being introduced upon the market as well as to the effect of competing products.

In job-order manufacturing, forecasting future production for a year is next to impossible. Therefore, the master schedule can include only orders which have actually been received. Quite frequently, however, these orders may require several months completion. This is true particularly in the manufacture of heavy machines. Since departments of job orders plants are usually organized according to process, several departments will be involved in the manufacture of any one order. The master schedule represent the combined plans for all these departments.

2.2.2 Manufacturing Schedules

The manufacturing schedules is subsidiary to the master schedule in that it break an order down into various parts according to size, color, weight, material, etc. A separate manufacturing schedule is made up for each division of the order or perhaps for each process through which the product is to pass. A manufacturing schedule may, in fact, become a work schedule It also includes an assignment of time in assembling units and other special machinery.

Manufacturing schedules may be made by the Production Control Deaprtment or may be the responsibility of the foremen of the various departments. In either case, the preparation and revision of manufacturing schedules must be at least the cooperative responsibility of the foremen.

2.2.3 Scheduling as a Cooperative Function

Where a highly centralized system of control exists, two difficulties frequently occur:

1. Foremen may feel that since there is a department to plan and schedule production, they have no responsibility in this function;

2. Since the principal responsibility is removed from the foremen, they may not appreciate the problems involved and consequently may be non-cooperative in making and revising schedules.

Quite frequently a constant struggle exists between the foremen of various departments and the Production Office on the other hand. Foremen are apt to seek as much time as possible on the schedule. They would rather be ahead of schedule than behind. The Sales Department, on the other hand, is interested primarily in satisfying the customer through an early delivery date. The Production Control Office stands between these two points of view and attempts to mediate.

In many companies, foremen meetings are held at least weekly for the preparation and revision of schedules. Under this arrangement, scheduling is considered the joint responsibility of the Production Control Department and the foremen. Each foreman or his representative is called upon to accept or reject time allotments for his department. At these meetings, he is able to gain information regarding the problems of other departments and the effect of his own. He, therefore asks for a change in schedule or accepts a time allotment with full knowledge of the scope of his responsibility.

2.3 Dispatching

Dispatch provides official authorization and information for:

1. Movement of materials to different work places;
2. Movement of tools and fixtures necessary for each operations;
3. Beginning of work on each operation
4. Recording of beginning and completion time;
5. Movement of work in accordance with a routing schedule;
6. Control of progress of all operations and the making of necessary adjustments in the release of operations to conform to emergencies.

Dispatching requires coordination between all departments concerned. This is usually obtained through varied degrees of centralized control. Under centralized control, dispatch clerks, centrally located, release all orders and authorization for operations, including the movement of materials, tools, and fixtures necessary for the operations. Under decentralized control this responsibility is handled by each department.

2.4 Follow-up

Follow-up is perhaps the most important and most difficult of all the planning and scheduling functions. Planning and scheduling can be of little value unless there is adequate provision for obtaining the necessary information about emergencies which may require changes in schedule in order to maintain an even flow of work. The procedure used in the procurement of materials must include provisions for follow-up to ensure that material will be on hand for a specific job at the time it is needed. Work in process must be checked to determine whether it will be ready for the next operation. A pre-assembly check must be made to determine whether the necessary parts will be ready on the pre-arranged date.

Responsibility for follow-up is usually placed in the hands of special follow-up men. Thier function is one of obtaining information. They are essentially "go-betweens" who performs a service for the various departments involved. A follow-up man is usually given a specific responsibility in connection with one phase of the follow-up work.

2.4.1 Follow-up of Materials

Follow-up of materials may be classified into two depending upon the source of the materials. In the first case where materials are obtained from the outside, follow-up becomes a function of the Purchasing Department, in which case, the foreman has very little concern. In the second case, where materials are obtained from within the company, such as logs in a logging and plywood manufacturing concern, materials should be followed up by the foreman.

In the first case, although responsibility to follow-up is not within the duties of the Production Department, he may suffer the ill effects of a poor follow-up procedure.

2.4.2 Follow-up of Work in Process

Follow-up clerks may be assigned responsibility for checking the progress of work, either according to product or according to process. The former method is particularly adaptable to continuous, or line, production. Here the job becomes relatively simple, since the manufacture of a particular product progresses automatically from one operation to the next. One man follows a particular assignment of a product through the various departments until it reaches completion. He is responsible for reporting information about breakdowns and delays, shortages of material, etc.

Follow-up by process is frequently used in diversified manufacture. By this method, the follow-up men are assigned to departments for checking the progress of work passing through the processes of a particular department. When the work passes on to another department, it goes under the responsibility of other follow-up men, who are well acquainted with the supervisors of their particular department and with the equipment of the department. This method avoids the confusion which results when several follow-up men interested in different products are "nagging" at foremen for information regarding the progress of orders.

The foreman should assume the responsibility for the development of understanding and appreciation on the part of the supervisors within the department of the importance of follow-up work. He must also assume responsibility for the training of follow-up men, in order to develop cooperation within the department and to facilitate promptness and accuracy in checking the progress of the work.

A follow-up man has a very difficult role to play. He contacts the supervisor at a time when trouble has arisen and when the supervisor is most apt to be irritated and non-cooperative. If a machine has broken down, the supervisor is most interested in getting a repairman on the job and the machine back in operation as soon as possible. He may have a tendency to be impatient with the follow-up man who comes around asking questions.

The supervisor should be made to understand that the follow-up man is attempting to render a service to the department. He is merely truing to get information. This information, when relayed to the central control office, may prevent work piling up in the department and may, by rerouting of orders, prevent the stoppage of work in the processes which ordinarily follow the work of this particular machine or department.

Follow-up of work in process should operate on the "principle of exception". Only those orders which are listed as special rush orders or those orders on which difficulty and delay has arisen should be followed up. Automatic controls should suffice for the general run of production. In rush times, there is a tendency for production control departments to succumb to the pressure of customers and to place orders on a rush basis. Soon the manufacturer finds that 75 per cent of his orders are labeled "rush". The inevitable result is that foremen and supervisors learned to ignore the term and to consider all orders on an equal basis. A definite policy should be adopted on giving priority to any production order.

2.4.3. Follow-up of Assembly and Erection

A common problem in manufacturing, particularly in a job-order plant, is the coordination of the manufacture of parts so that they may arrive for assembly on schedule. Frequently, sub-assemblies are necessary before operations part may delay, not only the sub-assembly operation, but future processes and operations in several departments. If parts are let out to other companies or branches on a sub-contract basis, the complexity of the problem is increased.

Some companies place one follow-up man in charge of a job order, with responsibility for keeping a constant check on the progress of the various parts and controlling their arrival for assembly. He sees to it that the work progresses on schedule or that adjustments are made through the rerouting of other orders, so that men and machines will not be idle.

VIII; AIDS TO THE CONTROL OF PRODUCTION

A few suggestions of special aids to foremen will be given in this section. It is not expected that these aids will be wholly applicable to any one situation. However, it is hoped that these examples will suggest other possible techniques and devices that can be applied.

1. Load Charts

A foreman who is responsible for the even distribution of work on various machines in his department should have some means of visual control over the loading process. Figure 1 shows a sample load schedule showing the order number, the type of product, load in the number of pieces, and amount of time scheduled for each item.

Order No.	Type	No. of Pieces	Std./c	Cum. Std. Hours	Sizes	1	2	3	4	5
				Qty.						

Figure 3. Sample Load Schedule

A foreman would have to study the essential characteristics of materials or products passing through his department and construct a form providing him with the greatest information.

If records of standard time on the various products that pass through the plant are not available, the foreman can make approximations based on previous products which were similar in nature.

2. Planning Board

Planning boards provide a rapid and accurate check on work in progress and work that has been scheduled and is ready for operation.

There are various types of planning boards suited to the needs of different companies. One type may look like a bulletin board with three horizontal sets of hooks: one representing work in progress; the second, work dispatched; and third, work that has been scheduled but has not been dispatched to the workplace. Sometimes, clips may be employed instead of hooks.

One principal criticism of planning boards is the amount of time spent to keep them posted. There are some types, however, which provide flexibility of equipment and personnel during heavy periods of production.

3. Progress Charts

Progress charts are useful in checking and reporting the process of work on a particular job or order. Usually, a record is kept of orders which are falling behind schedules or which are special, either as rush orders or as ones requiring special handling and operations.

The best type of progress charts is the Gantt chart. This has many variations which can be adapted to meet the needs of a foreman, supervisor or follow-up man. It may be used either as a paper form or as a progress-control board. The progress control board is specially valuable in planning meetings of foremen and schedule clerks.

Production Control simply means, as the name implies, the control of all elements which make up the operating functions of a manufacturing concern. It involves getting the proper materials,

- in the proper quantity
- at the proper place and time
- produced in proper quantity
- at the proper quality
- at the right cost

These functions involved all the major departments of a concern in the following sequence:

<u>Sales Department</u> : Receives orders and passes them on to the Production Control Depattment.

<u>Production Control Department</u> : Checks availability of material, initiates requisitions to purchasing, and sets master schedule.

<u>Purchasing Department</u> : Purchases and expedites incoming material.

<u>Engineering Department</u> : Designs and specifies material, if non-standard, also special tooling required.

<u>Manufacturing Department</u> : Produces basic parts and assembles materials using proper methods and labor.

<u>Quality Control Department</u> : Checks incoming material, in process material, and final quality before shipping.

IX. TIME & MOTION STUDY

SELECTED TIME : 0.80 min.

RATING FACTOR : 110%

PERSONAL ALLOWANCE : 5%

NORMAL TIME : 0.80 x 1.1 = 0.88 min.

STANDARD TIME : 0.88 = (0.88 x 0.5)

= 0.924 min.

STANDARD TIME : Normal time

\+ (normal time + allowances in %)

NORMAL TIME : selected time x $\frac{\text{rating in \%}}{100}$

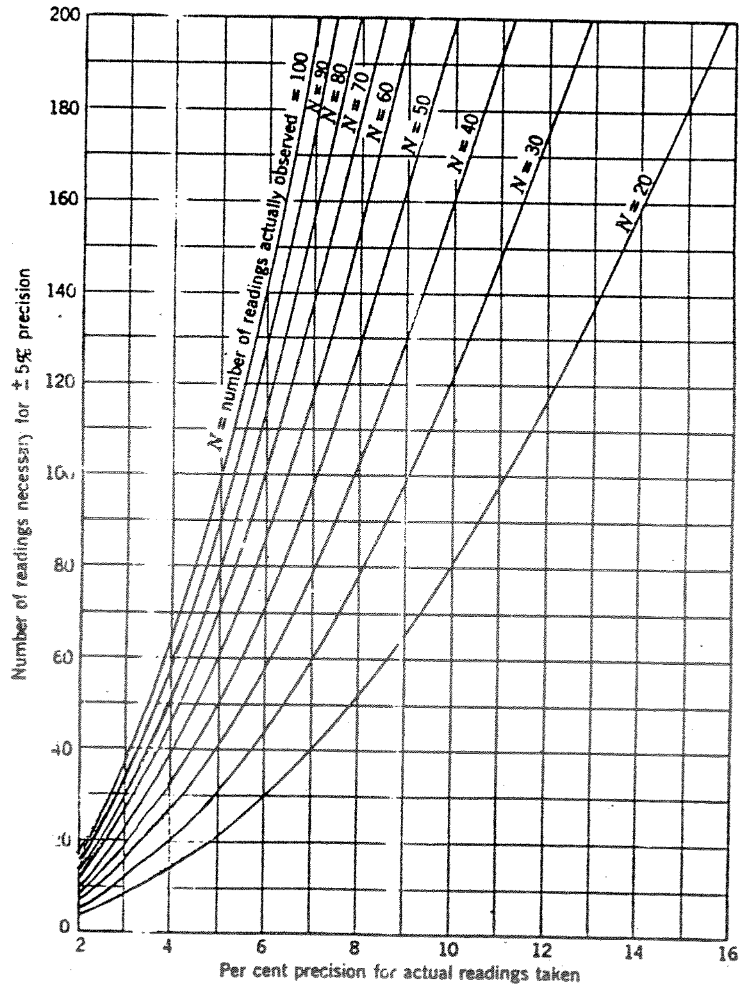


Fig. 233. Curves showing the relationship between number of readings necessary for ±5% precision, number of readings actually observed, and precision in per cent for readings actually taken.

TIME STUDY OF 10 CYCLES OF AN OPERATION

Element 1	.07	.09	.06	.07	.08	.08	.07	.08	.09	.07
Element 2										
Element 3										

Average = 0.076

Maytag Co. Method of Estimating No. of Observation to make

1. Take Readings : a) 10 good readings for cycles of 2 minutes or less

   b) 5 good readings for cycles of more than 2 minutes

2. Determine the Range R : H - high time study value

   L - low time study value

   H - L = R

   R = 0.09 - 0.06 = 0.03

3. Determine the Average, $\bar{X}$: $X = \frac{0.76}{10} = 0.076$ min.

4. Determine the value of $\frac{R}{\bar{X}}$: $\frac{R}{\bar{X}} = \frac{0.03}{0.076} = 0.395$

5. Determine the No. of readings necessary from Table 13.

   0.395 --------→ 27 samples

6. Continue the study until a total of 27 readings is obtained.

FINAL CHECK AS TO NO. OF OBSERVATIONS

Element I	.07 .09 .06 .07	.08 .08 .07 .08	.09 .07 .08.08	.07 .09 .08 .08
	.03	.01	.02	.02
Element I	.06 .07 .08 .08	.08 .09 .09 .06	.07 .08 .08 .09	.10 .10 .07 .08
	.02	.03	.02	.03

Average of 32 observations .0787 min.

$\bar{X}$ = .0787

1) Divide the readings for the element into sub-groups of 4
2) Determine the range R for each sub-group.
3) Determine the average range $\bar{R}$ of the sub-groups
4) Determine the average $\bar{X}$
5) Determine the no. of readings necessary from Fig. 232

Ex. Det. no. of readings necessary for a 95% confidence level and $\pm$ 5% of precesion

1) Sub-groups of 4
2) Range of each sub-groups : .03 + .01 + .02 + .02 + .03 + .02 + .03

= 0.18

3) Determine the average range $\bar{R}$ of the sub-groups

$$\bar{R} = \frac{0.18}{8} = 0.0225 \text{ min.}$$

4) Determine $\bar{X}$: $\bar{X}$ = 0.0787 min.

5) No. of readings necessary F g. 232

$\bar{R}$ 0.225 ←----- 30

↓

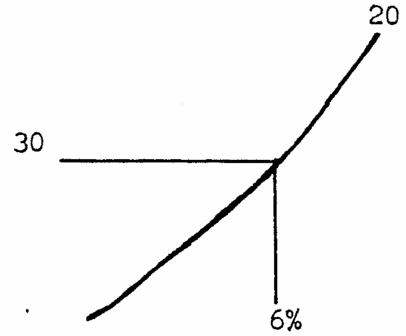
.0787

Determine actual precision observed for 20 ob ervations

N = 20

From Fig. 233

No. of readings for
± 5% precision



precision for actual readings

Table/Graphs : Table 13, Fig. 232. 233

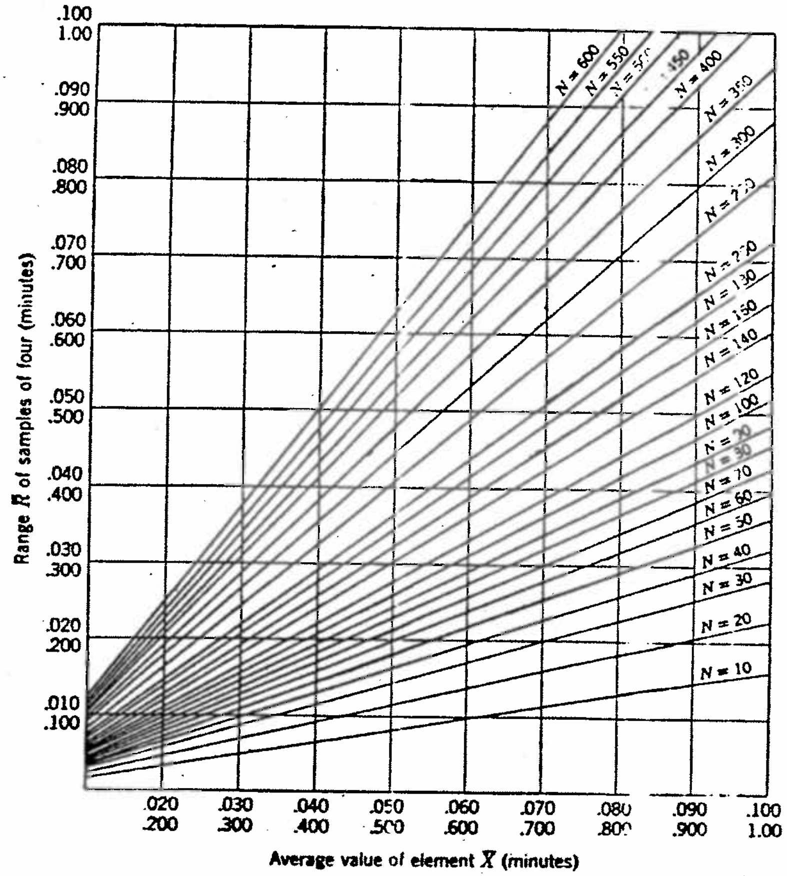


Fig. 232. Curves showing relationship between average range of samples of four observations and average value of the element being timed. All readings are in minutes.

X. SUMMARY

1. The basic principles of production control apply to all types of industry. They are mostly pure logic which involve the coordination of men, equipment, and materials within a specified time and at a specified cost.

   The "control" part of production control hinges upon decisions by somebody and instructions to somebody leading to some practical action. This action is controlled by schedules, shop orders, move orders, and assembly orders, and to assure that the customers order will be produced and delivered on time.

2. The system that is used will depend upon the type and size of a concern and its product. There are three major types of manufacturing concerns.

   a) Flow-continuous production of one major item, or chemical type.

   b) Intermittent -- mass production of products which are periodically changed. There would also be many common or standard parts between thoee products.

   c) Job Shop -- each product manufactured to order. It must first pass thoough Engineering for design and specifications.

3. There are four major functions of production control:

   - planning and scheduling
   - materials control
   - routing and dispatching
   - follow-up

3.1 Planning and Scheduling -- Determine what, how, where, when and how many. The method of scheduling must show the all important relationships to assure that all programs are in balance.

Planning could be either centralized or decentralized. In a centralized system, the planning, scheduling, follow-up, and expediting are done by the Production Control Department. In a decentralized system, the Production Control Department, sets a master schedule, but each of the manufacturing department sets a master schedule, but each of the manufacturing departments does its own planning to meet that schedule. In this case, there would be shop planners and expeditors to assist the department supervisor.

3.2 Materials Control -- is responsible for maintaining inventory, specifications, receiving, inspection (through Inspection Department) and storage.

The material problem is of grave importance, particularly in a smaller concern. Overstocking could be just as bad as shortages.

3.3 Routing and Dispatching -- consist of the actual process and transmitting of orders in correct sequence and accompanying the proper material.

3.4 Follow-up -- is the process of checking progress. It indicates what items need expediting and where readjusting of schedules would be necessary.

4. What a Production Control System Shows :

4.1 An overall picture of the present and future loads on each department section or machine in the plant.

4.2 A starting and clearing date for each order.

4.3 A basis for accurate delivery promises

4.4 Knowledge of the position and progress of each job in the shop.

4.5 A method to balance loads through all departments to prevent downtime due to lack of work.

4.6 A record of when material is available for a job.

4.7 A simple dispatching practice.

4.8 A simple, but effective, picture of work ahead or behind schedule.

4.9 A method of indicating relative priority of all ojobs.

4.10 A method to evaluate potential delay before they occur or before they become too serious.

4.11 Provisions for re-scheduling

4.12 Availability of special tools and equipment.

5. What a Plant Needs to Improve Effectiveness of Production Control

5.1 Bill of materials for all products - separating purchased and manufactured parts.

5.2 System of standardidentifications for all parts and operations

5.3 An effective inventory control system.

5.4 Operation sequence sheets and flow process charts for e each product.

5.5 Method and set-up description for every operation.

5.6 Standard rate of output for each operation.

5.7 Speeds and feeds.

5.8 Special tools, jigs, and fixtures for all non-standard operations

5.9 System for identification and storage of tools, jigs, and fixtures.

5.10 Knowledge of machine capabilities

5.11 Effectively designed product.

5.12 A preventive maintenance system

6. Responsibilities of a Supervisor with Respect to Production Control

6.1 Plan and coordinate men, materials and equipment in the department to meet production schedules.

6.2 Maintain product quality

6.3 Keep alert for possible delays, breakdowns, or bottlenecks.

6.4 Anticipate shortages before they actually occur.

6.5 Produce product within standard cost.

6.6 Keep adequate stock of all direct and indirect materials and tools.

6.7 Report lack of materials

6.8 Report receipt of faulty materials.

6.9 Know your help capability and such help whenever necessary

6.10 Properly maintain equipment.

7. Benefits to Expect from an Effective Production Control System

7.1 Accurate delivery

7.2 Improved efficiency

7.3 Greater output

7.4 Reduced costs

7.5 Improved quality

7.6 Elimination of delays

7.7 Reduction of lost labor

7.8 Improvement of overall conditions and personal relations in the plant

7.9 Credit to those involved in administering the program.

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FLIC/DIS Unit
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