PRODUCTION CONTROL

by

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Chapter I

Introduction to Production Control

Production control is that technique employed in manufacturing whereby the production facilities of a plant are coordinated through the advanced planning, routing, scheduling, dispatching, and follow-up of each individual product in the course of its manufacture from operation to operation, from production center to production center, and from department to department. Advanced planning, or predetermination, is the starting point of a complete production control program and involves deciding in advance of operations, what, when, and how work is to be done. By means of effective advanced planning difficulties may be foreseen and necessary steps taken to eliminate these difficulties before delays occur. The control of production involves the preparation and maintenance of records and progress reports for both past and current operations in order that through their comparisons coordination, follow-up, and corrective action may be accomplished.

The shipping dates on sales orders serve as the basis for production planning and control. In order to remain in business, a plant must be able to produce goods and supply

consumers with goods when the consumers' orders state that the goods are wanted. Orders may be divided on the following basis: "(1) customers' orders which require special attention to meet the promised delivery dates, (2) repair orders accompanied by an urgent request for delivery, (3) customers' orders that will ordinarily come through on time for the promised date of delivery, (4) routine repair orders, (5) orders for goods to be placed in stock."[1] Progress reports and follow-up reports are very essential to make a production program based on shipping dates and sales orders effective. Organization, reliable information concerning requirements and productive capacities, and standardization are the prerequisites of successful production control.[2]

The production control department is a staff department whose primary function is that of aiding the operating departments in a plant. The production control department strives at all times to obtain coordination of the following four elements: "(1) the manufacturing orders, (2) the material for these orders, (3) the productive equipment, including machinery, tools, and work places to be used, and (4) the workers, in so far as priority of work is concerned."[3] To obtain perfect coordination it is of the utmost importance that the production control department work in close cooperation with the purchasing

sales, stores, cost accounting, engineering, standards and methods, inspection, internal transportation, maintenance, shipping, tool, and plant layout departments. The philosophy behind the work of the production control department is one of preventive action through an anticipation of delays before they occur rather than a remedial type of corrective action.

In addition to the functions of advanced planning and follow-up there are three phases of production control which are performed before manufacturing operations begin; namely, routing, scheduling, and dispatching. Routing consists of determining the order in which work will be done, where work will be done, and by whom work will be done. The scope of the routing junction consists of: "(1) the analysis of the finished article from the manufacturing standpoint, including the determination of components if it is an assembly product; (2) the fixing of the sequence of completion in manufacture that are part, or piece of material, bears to another, in order that all may be brought together as needed in the process of manufacture; (3) the determination of the operations which must be performed at each stage of manufacture, and the place where these shall be performed; (4) the division of the total quantities required into proper manufacturing lots or

batches."[4] In order to perform the routing function a master list must be made consisting of the bill of materials, of the partial list, of the drawings, specifications, and blue-prints for each product, and of the operations sheets for machine selection, plant layout, and the operations to be performed on each product. From the master list and from previous production records the master route sheet is made. The master route sheet contains the name of the product and its component parts or lot number identifications, a list of all operations performed on each part or assembly, numbered serially indicating the sequence of operations, the name of the department in which each processing operation is to be performed, and the symbol numbers of the materials to be used on each product. Route sheets are valuable production control aids because they not only show the sequence of operations but may be used as progress reports also.

Scheduling consists of determining when each operation will be performed and the amount of work to be done during each operation taken, machine capacity, and information about previously scheduled work including machine and department time schedules and available. In an industry employing a continuous type of manufacture a master schedule is made which is based upon the production program, which in turn is based upon esti-

mated future sales. In an industry using an intermittent type of manufacturing a master schedule is made based upon the delivery dates of sales orders. The establishment of the order of work is a scheduling function. The order of work tells when to start performing each operation and is operated by the foremen or scheduling and dispatching clerks in a plant. Changes may be made frequently in the order of work but seldom in the master schedule. In order to obtain maximum scheduling efficiency close cooperation must be maintained between the scheduling section and the sales department.

Dispatching is a clerical function involving the execution of the plans and schedules made by the routing and scheduling sections; it is the operation of the order of work by fully utilizing workers, materials, and machinery according to the pre-determined schedule. While performing the dispatching function, the dispatching section issues job orders, makes certain that materials requisitions have arrived at the storeroom and sends stores-identification tags, sees that inspection tickets reach the inspection department, sends more tickets to the internal transportation department, and issues time tickets and tools requisitions. The dispatching function is performed by the foremen and the dispatching clerks. In order

to have effective performance by the dispatching section, it must cooperate closely with the routing and scheduling sections.

The type of production control methods used in a plant are determined by the type of manufacturing done in the plant. A centralized, or order, control system is found mostly where intermittent manufacturing is done and in small plants. Under centralized control the production control department determines what workers will work on various operations and what machines will perform the operations in each department. "Order control methods are based on the control of the progress of the order, or lot of work, through the successive operations and departments in its processing."[5] Centralized production control is intra-departmental; that is, production is controlled within eacy operating department by the production control department.

A decentralized, or flow, control system of production control is used mostly in large plants doing continuous, or assembly, manufacturing." Flow control methods are based on the maintenance of a pre-determined rate of flow of work from each machine or work center."[6] The writing of work is carried only to where the work is to be performed. The production control department prepares a time schedule telling when work will enter and leave a department, or work center. The fore-

man is allowed to decide how much work will be done and what machines and workers will do the work within his department, or work center. Decentralized production control is inter-departmental; that is, production is controlled by the production control department only to the level of each operating department where it is then controlled by the foreman in charge of the department.

There is a trend, especially in plants performed an intermittent type of manufacturing, to use a system of production control called block control. "With this form of control, orders or batches of product are assigned to blocks of work, usually in accordance with their due dates. In order for it to work effectively, these blocks must represent equal amounts of work in each department, and therefore equal blocks of time. All the blocks must go through the same fundamental phases of the basic process, and the production division must be departmentalized on the basis of these phases. Manufacturing capacity must be balanced between departments, for otherwise these blocks will move through different departments at different rates. As blocks of work are released, they are numbered serially, and as a rule they must be processed in this order."[7] The reason for the trend to block control by intermittent manufacturing industries is because by using block control instead of order control they are able to approach more slowly a continuous manufacturing industry and a flow type of production

control.

The use of a production control system by a plant offers many advantages. Among the outstanding advantages are an increased rate and amount of production, a more efficient use of men, materials, and machines, lower inventory costs, more economical handling of raw materials, stores, and finished products, and more reliable service to customers by meeting delivery dates. A positive answer to the following two questions will help to decide whether or not a production control system has reached its highest stage of development and whether or not a plant is operating at maximum efficiency. Are delivery dates met according to schedule? Are as many mechanical, visual devices as possible used to control operations?

Footnotes

1. W. R. Spriegel, Industrial Management, p. 465.

2. Ibid, p. 468.

3. Ibid., p. 466.

4. Ibid., p. 475.

5. R. C. Davis, Industrial Organization and Management, p. 248.

6. Ibid., p. 249.

7. Ibid., p. 250.

Chapter II

Production Control for Intermittent Manufacturing Industries

"Intermittent[1] manufacturing is that type of manufacturing in which labor and equipment is applied continuously to materials for a relatively limited period." In order for a plant to perform intermittent manufacturing, plans must be made, tools and materials must be procured, and machinery must be set up for each order. Since a plant performing intermittent manufacturing is producing goods according to customers' specific orders and requirements, the product differences create control problems in the manufacture of each product..

With an intermittent type of manufacturing the production control department must place emphasis on meeting delivery dates and must know the current conditions regarding the plant's capacity at all times; that is, how much machinery, labor, and manufacturing space is available and for how long.[2] By placing emphasis on delivery dates and by utilizing plant capacity efficiently, a higher volume of production may be obtained. The quality of goods produced must be maintained carefully by means of follow-up and inspection methods and with corrective action when necessary.

Centralized production control, based on sales orders and their delivery dates, is generally used in industries performing intermittent manufacturing. With centralized order control the progress of each order through its manufacturing processes is followed closely and determined by the production control department. The production control department is practically given line authority over the operating department in a plant. Whenever possible, factories performing intermittent manufacturing try to use the methods of block control to control production because higher output may be obtained under certain conditions described in Chapter I.

Under conditions of intermittent manufacturing each product has its own routing through the manufacturing operations necessary to complete it. The initial phases of the routing function are performed by the engineering and methods departments which determine what work is to be done from blue-prints, specifications, processes, and the bill of materials; then the production control department performs the further routing of a product.[3] However, before the production control department can perform the routing function, the master schedule must be established and the manufacturing orders must be made. When performing the routing function the production control department determines what quantity is to be produced, makes up a

route sheet for each product with its routing instructions, determines the sequence of processing operations and where the work is to be performed, and writes more tickets, materials requisitions, identification tags, inspection tickets, and tool requisitions.[4]

The scheduling function with intermittent manufacturing has two distinct parts: the establishment of a master schedule of all customers' orders and the establishment of an order of work for each part. In order to perform the scheduling function the following information must be available: route sheets, delivery dates, the time to perform each operation, data about previously scheduled work, and the quantity to be produced.[5] The objectives of the production control department when performing the scheduling function are to determine a satisfactory production rate and to coordinate the timing of production activities.[6]

The scope of the performance of the dispatching function consists of controlling the progress of work by controlling the authority to commence each operation in each department and of giving the necessary instructions and information concerning the work to the operating departments.[7] In its performance of the dispatching function, the production control department must see that materials requisitions arrive at the storerooms,

that inspection tickets reach the inspection department, that more tickets are sent to the internal transportation department, and that time tickets and tool requisitions are issued. The dispatching function in intermittent manufacturing is carried on at the operating departments by dispatch clerks and foremen.

The furniture industry is an example of an industry which performs its manufacturing on an intermittent basis. Pieces of furniture are manufactured according to customers' orders and specifications. Each product has its own individual routing through the various operations performed on it. An outstanding problem in the manufacture of furniture is scheduling to meet delivery dates. The Kittinger Company of Buffalo, New York, has overcome its scheduling difficulties by using a method of priority scheduling.[8] This system is based on a mill priority schedule prepared weekly by the production manager for the foremen in the producing departments. A constant visual check is maintained on orders to catch delays and bottlenecks. Production may be started and stopped on an order whenever necessary. Furniture plants now try to keep this assembly operations on a continuous manufacturing basis when possible. The cutting, machining, and finishing operations are performed by intermittent manufacturing methods.

Leather products are manufactured in batches. The manufacturing operations are slow and require much skill on the part of workmen. Each type of animal hide and skin mist be treated in a special manner. The principal production problems arise in determining the quantity to produce at one time and in scheduling operations. The quantities to produce are governed by the sales orders, the demand for the goods, and the capacity of the manufacturing equipment. Scheduling is complicated by the amount of time required to perform certain operations. For example, in the vegetable tanning process one step requires that skins be allowed to rest in a vat containing tanbark for sixty days.[9] Leather is produced by two processes, the vegetable tanning process and the chrome tanning process. The chrome tanning process is newer and faster than the vegetable tanning process and requires fewer operations. Other problems of production confronting leather manufacturers are the ability to obtain raw materials, the control of inventories, and competition from substitutes.

Foundries and equipment manufacturers provide the highest stages in the development of intermittent manufacturing operations. Manufacturing is done according to the specifications set forth by each customer's order. Products must be routed individually through their necessary manufacturing operations. Scheduling

is done according to delivery dates. Plant and machine capacities must be carefully considered when performing the routing and scheduling functions. It is necessary that rigid inspection procedures be maintained to insure precision and quality control. Today foundries and equipment manufacturers are attempting to use continuous, mass production methods whenever possible. Block control methods have helped to increase production and to place production on a more continuous manufacturing basis.

Footnotes

1. R. C. Davis, Industrial Organization and Management, p. 246.

2. Ibid., pp. 260-261.

3. W. R. Spriegel, Industrial Management, p. 477.

4. R. C. Davis, op. cit., pp. 271-272.

5. Ibid., p. 273.

6. Ibid., p. 273.

7. Ibid., p. 281.

8. J. Batsom, "Bottleneck Charts Get First Jobs Done First," Factory Management and Maintenance, Jan. 1947, p. 138.

9. R. N. Shreve, The Chemical Process Industries, p. 516.

Chapter III

Production Control for Continuous Manufacturing and Assembly Industries

"Continuous manufacturing may be defined as that type of manufacturing in which labor and equipment are applied continuously to materials for an extended period of time."[1] With continuous manufacturing advanced planning is essential, tools and materials must be procured, and machinery must be set up to produce large quantities of goods. Machinery must be standardized in order to achieve mass production. Materials must be prepared continuously and kept at a continuous rate of flow through the production processes. It is essential that the demand for products be forecast accurately because goods are produced both for stock and for demand. Continuous process and assembly industries are characterized by low inventories, high output, and a high turnover of working capital.

Decentralized production control is used by mass production industries. This control is on a flow control basis whereby materials are kept at their pre-determined rate of flow through the production processes. The production control department carries out the advanced planning of operations,

establishes the route which materials will take through the manufacturing operations, and into the starting and finishing dates of operations. The department foremen and clerks carry out the production control operations within their departments.

In continuous manufacturing and assembly industries all the routing is usually the same, and the routing functions is practically eliminated. With these industries one route may be used many times. The routing function is further aided by the trend to construct factory buildings around the most efficient processing layout and to construct single-story buildings in which a maximum amount of material handling equipment is used.[2]

The scheduling junction under conditions of continuous and asembly manufacturing consists of determining the rate of flow of materials through the production processes.[3] A master schedule is established which is based on a production program which in turn is based on estimated future sales. The production program is simply a manufacturing order telling how many units of product are wanted in a given time. Schedules may be shortened and the rate of flow of goods through the production processes may be increased in continuous manufacturing and assembly industries when material handling equipment is used effectively.

Under conditions of continuous and assembly manufacturing the dispatching function is carried on by the department foremen, supervisors and dispatch clerks. The dispatching function consists of maintaining schedules and the rate of flow of materials through the production processes; it is the checking of production. The foremen, supervisors, and dispatch clerks in each department relay the orders to start and stop production.

Oil refining is an example of continuous process manufacturing in which crude oil is pumped through tubes inside a furnace and then allowing it to vaporize in a fractionating column which is tapped at several points to draw off products continuously at their boiling fractions. "The basic economic problem in petroleum refining, a multiple-product industry, is to maintain equilibrium between supply and demand."[4] Flexibility is necessary in refining because of the individual demands for each of the joint products. Oil refining is characterized by low labor cost, high investment, rapid obsolescence, and rapid changes in the demand for products. The routing function in an oil refinery is fixed. Production schedules are made according to quarterly budgets which are based upon contracts and the future sales estimates of demand. The maintenance of the quality of the refined products is the major production control problems. The Standard Oil Company has developed a

method of quality control wherein a visual control of refining operations is constantly maintained on a central control panel.[5] With this control panel the temperature, flow, pressure, and level of the crude oil in the cracking columns is automatically controlled; whenever a change occurs, the instruments respond instantly to correct the change and maintain the established standards. This provides a stability to the refining processes and reduces waste of materials to a minimum.

Paper manufacturing is another example of continuous process manufacturing. Two processes, heating and refining, are used either separately or together to prepare pulp stock for its formation into papers.[6] Two types of machines are used to make the actual paper sheets: the Fourdrinier machine and the cylinder machine. "The basic principles of operation are essentially the same for both machines. The sheet is formed on a travelling wire or cylinder, dewatered under rollers, dried by heated rolls, and finished by callender rolls."[7] Paper manufacturing is characterized by high investment, low labor cost, and seasonal irregularity. The routing of materials through the processing operations is fixed. Scheduling is done to meet future demand estimates and to fill sales orders. In the scheduling of production the seasonal irregularity of the paper business must be taken into consideration. The production control department in a paper mill must determine methods of

obtaining the highest volume of production possible and yet maintain pre-established standards of grade and quality.

The automotive industry has attained the highest degree of continuous, direct-line manufacturing known.[8] From the large automobile plants where cars are assmebled and finished down to the small plants which produce the thousands of parts for the automobiles, production is carried out on a mass production basis. Mass production is necessary to reduce unit costs and to meet consumer demand. From the viewpoint of the production control department, scheduling is the big problem because it must be set for high output.[9] Routing is negligible as plants are built for continuous assembly manufacturing. In order to obtain this high output, equipment, which is very expensive, is standardized. Material handling equipment is used as much as possible, to speed up production and cut delays. The production control department must be able to time and coordinate each operation in order that maximum output and minimum delays will be obtained. Flexibility is also necessary in order that production schedules may be changed with changes in consumer demand, style, and car models.

Footnotes

1. R. C. Davis, Industrial Organizations and Management, p. 246.

2. W. R. Spriegel, Industrial Management, p. 476.

3. R. C. Davis, op. cit., p. 310.

4. E. B. Alderfer and H. E. Michl, Economics of American Industry, p. 245.

5. "Visual Control by Instruments," The Lamp, Standard Oil Company, New York, January, 1949, pp. 23, 28.

6. R. N. Shreve, The Chemical Process Industries, p. 713.

7. Ibid., p. 716.

8. W. R. Spriegel, ~~p. 524.~~ op. cit., p. 524

9. Ibid., p. 529.

Chapter IV

The Importance of Coordination and Follow-up in a Production Control System

A production control system must be accompanied by the elements of coordination and follow-up to be of any value to a plant. The essential part of coordination consists of coordinating the departmental functions in order that the various departments in a plant may operate smoothly and efficiently.[1] The production control department is responsible for achieving the desired coordination of functions between departments.

The two principal departments whose functions must be closely coordinated are the sales department and the production control department. This coordination of sales and production control activities is necessary in order to eliminate seasonal loads, to provide more stable employment to workers, and to balance systematically production and inventories.[2] Another very important reason for coordination between the sales and production control departments is to maintain production schedules according to delivery dates. The production control department should inform the sales department of available production capacity and when delivery dates to customers may be promised. Otherwise inefficient production programs will result from the constant changing of schedules.

With intermittent manufacturing coordination between the sales and production control departments is obtained by having the sales department check with the production control department before promising delivery dates and by having the sales department check with the engineering department regarding designs and specifications.[3] Under conditions of continuous manufacturing coordination between the sales and production control departments consists of having a planned production program, a planned distribution program, planned personnel policies, and of forecastin sales.[4] The sales forecast establishes production rates and inventory stock control; however, these rates and controls should have a degree of flexibility to them in the event that changes are necessary.

The production control department is responsible for coordination between the work of the engineering department and the requirements of the manufacturing departments.[5] The engineering department supplies the manufacturing department with information concerning the design, specifications, and style of the product and concerning the methods of manufacture.

Coordination between the purchasing department and the manufacturing department is necessary because the required kind and amounts of materials must be on hand when operations are scheduled to begin. The manufacturing department should

notify the purchasing department well in advance of operations what its needs will be.[6] The purchasing department should maintain records telling where materials may be obtained cheaply and quickly and in the right amounts. When materials arrive, the purchasing department should notify the manufacturing department immediately; and if delays occur, the manufacturing department should be notified along with the production control department. The production control department should do everything possible to maintain coordination between the purchasing and manufacturing departments.

Another point at which the production control department should insure close coordination is between the stores department and the purchasing department. This may be easily accomplished by having the stores department keep stores ledgers and records of materials received, on hand, and issued. Whenever the quantity of materials on hand approaches a previously established minimum quantity, the stores department should notify the purchasing department.[7] When new materials are received at the receiving department, the purchasing, stores, and production control departments should be notified of their receipt.

Other departments between which the production control department must achieve coordination are between the inspection department and the purchasing and receiving departments and between the inspection department and the manufacturing department.

All newly purchased materials should be inspected and approved by the inspection department before acceptance. In order to insure the quality of products, the inspection department should test and inspect each finished product thoroughly and notify the manufacturing department of any defects.

"Follow-up is an important element in the control of production in any industrial plant, whether that plant be engaged in the quantity production of a single product or in the diversified manufacture of many different products."[8] The production control department and its follow-up men should constantly check operations to be certain that materials and equipment are ready when needed, that schedules are maintained, and that delivery dates are met.

Requisitions for and purchase of materials should be closely followed up.[9] Invoices should be checked against actual shipments to insure the receipt of the right quantities and specifications of materials and to insure the receipt of materials on the promised delivery dates. Materials requisitions should be made out in as many copies as are necessary; usually they are in triplicate with one sent to the vendor, one sent to the production department, and one is kept by the purchasing department. Adequate records of purchases and requisitions should be maintained and checked frequently in order that materials will be available when needed. Home manufacturers use

a system of priority ratings wherein the production control department notifies the purchasing agent of what materials are needed and in what order they are needed according to the urgency of the need for them.

Work in process is followed up under conditions of continuous manufacturing by means of efficient scheduling and dispatching, by checking the required materials, and by maintaining schedules.[10] In intermittent manufacturing work in process is followed up by two methods: by products and by departments.[11] When the follow-up is by products, the follow-up check follows each product through the manufacturing operations to completion. If the follow-up is by departments, one clerk follows the materials for all products through the particular department in which he works; this is regarded as the best follow-up method for intermittent manufacturing.

In the follow-up of sales the primary objective is to be certain that customers receive their orders on the promised delivery dates. Along with the follow-up of sales it is important to provide the customer with such information as operating instructions for the product and to help install the product for the customer. During the follow-up procedure valuable information regarding the product may often be obtained from customers criticisms and suggestions which will help to improve the product.

The Glenn L. Martin Company of Baltimore, Maryland, aircraft manufacturers, has devised an effective method used by the production control department to achieve coordination and follow-up.[12] With this system all production charts are kept in one room and are constantly maintained to show what the current manufacturing conditions are. Bar charts, pictorial charts, and line graphs are used showing scheduled performance in one color and actual performance in another color. This room is open at all times to all employees and customers in order that each may be informed of current conditions. This method has increased production, achieved the desired coordination between the production control and sales departments, and provides a time-saving method of effective follow-up.

The follow-up men of the production control department serve as reporters and at times trouble-shooters. The follow-up men provide information to the foremen regarding the sequence of operations and inform the production office of the progress of work.[13] These men are staff men and should never order foremen to take steps but should make recommendations to the foremen and suggest the steps to be taken when necessary. The follow-up men are important because through this constant check of production and their information about current operating conditions they aid in telling customers when the best delivery dates are possible and aid the production control department in achieving and maintaining the best control of schedules.

Footnotes

1. L. E. Bethel, W. L. Tenn, F. S. Atwater, and E. E. Rung, Production Control, p. 111.

2. C. A. Koepke, Plant Production Control, p. 54.

3. Bethel, Tenn, Atwater, and Rung, ~~p. 212.~~ op. cit., p. 212

4. C. A. Koepke, ~~pp. 55-58.~~ op. cit., pp. 55-59

5. Bethel, Tenn, Atwater, and Rung, ~~p. 213.~~ op. cit., p. 213

6. Ibid., p. 213.

7. W. R. Spriegel, Industrial Management, pp. 455-456.

8. Bethel, Tenn, Atwater, and Rung, ~~p. 215.~~ op. cit., p. 215

9. Ibid., pp. 216-217.

10. Ibid., p. 218.

11. Ibid., p. 219.

12. W. H. Snyder, "Better Production Control With All Charts in One Place," Factory Management and Maintenance, March, 1948, pp. 102-104.

13. Bethel, Tenn, Atwater, and Rung, ~~p. 221.~~ op. cit., p. 221