PRODUCTION CONTROL SYSTEMS OF NINE TEXAS SHOE MANUFACTURERS

THESIS

Presented to the Graduate Council of the North Texas State College in Partial Fulfillment of the Requirements For the Degree of

MASTER OF BUSINESS ADMINISTRATION

By

George Dow Worley Jr., B. B. A.

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PRODUCTION CONTROL SYSTEMS OF NINE
TEXAS SHOE MANUFACTURERS

APPROVED:

C. L. Littlefield
Major Professor

John N. Schuman
Minor Professor

O. T. Curley
Dean of the School of Business Administration

Jack Johnson
Dean of the Graduate School
CHAPTER I

INTRODUCTION

Statement of the Problem

Production control is a science which has come to be considered more and more important in the efficient and successful operation of a business, especially the larger businesses. Most of the larger businesses employ production control systems and have realized the advantages that are derived from the systematic management of production.

Small businesses have not advanced as rapidly as larger businesses in the use of production control. Small businesses are usually slower to follow new trends and developments; however, it stands to reason that sound production control techniques would be of equal value to small as well as large businesses. Although not thought of as such, small businesses do have production plans which are used in the operation of their business. Generally, these plans are not formal or written, but they exist either definitely or vaguely in the mind of the person who is operating the business. These production plans, however, are not definite enough to be completely understood either by the businesses using them or by other interested persons.
The shoe manufacturing industry is one of the more important types of business. It is also unique in its production control systems, in that it utilizes a form of production control which is part mass production and part job lot. The operations and conditions found in this type of industry are usually fairly representative of those in other types of small business. The general production control practices of the shoe industry are basically similar to the production planning of other small businesses in the consumer field. This study will reduce to concrete form the types of production control used by the shoe industry of Texas.

Purpose of the Study

A study and analysis of such production control systems will put in a definite and tangible form the existing systems and controls found in the shoe industries of Texas. Small businesses and especially shoe industries, when supplied with such information, along with other information as to what is considered good production control practices, can begin to see where their production practices fall short in comparison with sound production practices. These businesses will then have definite information with which to work and a basis for improvement of the production practices in their particular businesses.
Limitations

This study will be limited to Texas firms in the shoe industry within a 125 mile radius of the city of Denton. This area includes nine shoe producing firms. The area serviced by all concerns is of national or international scope.

The companies were selected, by the number of people employed, from the frequency distribution shown below:

<table>
<thead>
<tr>
<th>Number of Employees</th>
<th>Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>250-499</td>
<td>1</td>
</tr>
<tr>
<td>100-249</td>
<td>2</td>
</tr>
<tr>
<td>50-99</td>
<td>2</td>
</tr>
<tr>
<td>25-49</td>
<td>2</td>
</tr>
<tr>
<td>8-24</td>
<td>2</td>
</tr>
</tbody>
</table>

It is felt that such a sample will give a representative picture of the shoe industries of Texas.

Production control plans were treated with regard to forecasting, scheduling, routing, dispatching, and follow-up. It is felt that if other operations of the businesses were covered, which are adjacent to production control, such a study would be too extensive for the scope of this thesis.

Sources of Data and Procedure

Data for this study were secured through the use of personal interviews. The interviews were based on a "check-list" of the production control policies considered important in the proper operation of a business. The production control
practices to be checked were determined by consulting several books on production control and from the experience of the writer in the field of production control.

The interviews were held with the production managers, production supervisors, or the manager of the company surveyed. The results of these interviews were then classified according to the five functions of production control covered by this study. The interviews, and the library treatment of production control form the main body of this study.

Definition of Terms

The following is a list of terms that will be used throughout this study. Familiarity with these terms will be necessary for a complete understanding of the information to be presented.

**Mass production** -- This refers to the type of production in which the equipment can be set up to perform a certain function, without change, for months or years. The term continuous manufacturing will have this same meaning.

**Job-lot production** -- This refers to situations in which a given machinery set-up is used for a short time and then changed to make a different product. It applies, therefore, to factories having short runs of a great variety of products. At times a given machine set-up is used but a few minutes or a few hours. When the required quantity is produced, new set-ups are made for the next product. The term intermittent production will have this same meaning.
Production control — This may be defined as the coordination of a series of functions according to a plan which will economically utilize the plant facilities and regulate the orderly movement of goods through their entire manufacturing cycle, from the procurement of all materials to the shipping of the finished goods at a predetermined rate.

Forecasting — This term shall indicate the function used by a business to determine the future course, objectives, probable markets, possible products, plant requirements and the impact of competition and economic trends upon the business concerned.

Routing — This is the function which lists the operations required to produce a part or product and the order in which these operations should be performed.

Scheduling — This is the function which introduces the element of time to the work to be performed. For example, the starting and completion dates and times for a product or process to begin and end.

Dispatching — This refers to the issuance of orders or the release of authority from the planning department to the shop.

Follow-up — This refers to the finding, following, and at times "pushing," or increasing the rate of movement of an order or product through the manufacturing or business process. The term expediting will have this same meaning.
Related Studies

No studies which dealt exclusively with production control have been made at North Texas State College. Within the field of industrial management, however, two theses have been written. Jack Orr made a study of the development of an industrial management curriculum for N. T. S. C. Floyd Jenkins surveyed several companies to show the typical responsibilities and needed qualifications of the industrial foreman. While both of the above studies are in the field which includes production control, they do not yield the desired information. Related studies seem to be very limited in the field of production systems, and very little research seems to have been undertaken concerning the production control systems of the shoe industry.

Abstracts of theses and other research projects from other schools were surveyed; however, few reports could be found. One which was more closely related to this study than others found was a thesis from Columbia University's department of industrial engineering on the production control operations of Wright Aeronautical Corporation, written by Robert Keck.

Organization of the Study

The first chapter of this study is composed of the introduction. The production control policies that require specific formulation are discussed in Chapter II. The production control systems of the shoe industry are shown in Chapter III. In Chapter IV, the case studies of the shoe companies surveyed are found. The summary, conclusions, and findings are presented in Chapter V.
CHAPTER II

EXPLANATION OF METHODS OF PRODUCTION CONTROL

Method of Determination

In order to determine the types of policies and also practices likely to be of major importance in production control, it was decided that several books in the field of production control would first be consulted for the purpose of establishing major policy areas of general importance in the management of production. This study was conducted so as to follow the five steps found in production control. These five steps are: forecasting, routing, scheduling, dispatching, and follow-up.

Forecasting

A sales forecast is the usual starting point for production planning. Two principal approaches are available in preparing such a forecast. The first tries to build a picture of total sales in some future period by summing up and combining estimates drawn from the sources of the company's business. The second relates general economic trends to particular industries and then works back to the company's share of an industry's business. By either process, however, the end result is a picture of total sales.  

1William E. Ritchie, Production and Inventory Control, p. 38.
Any forecast of the volume of production of a business enterprise for a future period must be based on a forecast of sales for that period tempered with contemplated changes in the inventory of finished goods. Furthermore, sales forecasts by products and lines determine the extent to which improvements in production methods may be desirable or, depending on volume, even economically possible. The forecast will also reveal needs for expansion in production facilities and the amount and types of productive labor that will be required. The sales forecast is usually based in turn on several factors, the determination of which is the degree to which each tends to affect the volume of business of a particular company. This is one of the major problems of the management of a business. In fact, the foresight of management in this connection often is largely responsible for the success of the enterprise. Any management that has no definite policy for long-range forecasting is inviting business blunders and sooner or later will find itself in serious trouble.²

Routing

The function of routing is intimately associated with product analysis, the tools used, and the subsequent planning for the product in the shop. Routing includes the assignment of a definite sequence of operations, the selection of the proper machines or production centers with adequate tools

²L. L. Bethel, Production Control, p. 24.
specified, and sometimes the specification of the proper personnel to do the work. The net effect of these decisions is to determine the shortest and most economical path that each part is to follow from the time it arrives as raw material until it leaves as finished product.\(^3\)

**Effect of method on routing** -- Routing is necessarily related closely to the job and the method to be used. There are usually many different methods of doing a job. A given surface on a small casting may be finished by hammer, chisel, file, scraper, shaper or planer. Any or all of these could be used in some shops, depending in a large measure upon the number of castings and the availability of a particular machine when the casting is needed. Any of these could do the job. However, the time to procure equal quality by the different methods would vary greatly. The object then of good routing would be to use the best method available under current conditions. Of course, it is not always possible to use the most economical machine, so another method must sometimes be used in order to avoid a hold up in production caused by waiting until the best machine is available.

**Effect of product and plant design on routing** -- Some types of manufacturing are quite simple and require practically no routing procedures after the plant is designed and built. For example, the path of bread in a mechanized bakery is often fixed

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by the plant design and machinery layout. Since products of this type are seldom changed, the routing function can almost be forgotten after the machinery layout is complete. However, products such as airplanes and other mass-produced articles, which change models at varied periods of time, have a minimum of routing to do for current work going through the plant. These plants plan their operations and routing with the greatest care at the time the models are changed. Usually, the planning and routing for a new model of airplane or automobile is begun many months before the model is ready for the public. Each change is analyzed in detail, and the effect of the change on the layout of machinery, conveyors, and other means of transportation are studied and recorded on scale drawings for each department affected. Then, before the model changes are begun, the production facilities for the old model may be closed down to allow for the new layout to be completed. This procedure will greatly aid in minimizing confusion. By using this method, the routing of parts is fixed by following the production line as it was planned in advance. Straight-line production, as this is called, means a minimum of transportation. This is because parts move from one production center to the next one adjacent to it. A heat-treating furnace may be preceded in the line by a broaching machine which in turn is preceded by a multiple-spindle drill press. A sequence of operations is selected that will do the job, and the machines
and equipment are brought in line to carry out the sequence. Only special problems would require special routing instructions.  

Master route sheets are of great importance in efficient production control. When the sequence of operations has been determined, the sequence should be made a permanent record by listing it on a master route sheet (sometimes called operation sheet). The master route sheet should list every separate operation to be performed. If a special adjustment of a machine is to be made for an operation, or if special tools or fixtures must be placed on the machine, each of these operations will then be listed opposite the operation. These should be listed together with the machinery or work-place at which these operations are to be performed.  

Time should be stated in hours or minutes per single piece, except time for set-ups or adjustments, which should be counted as a total time for each job, lot, or group of pieces. The reason for this practice is that operations are repeated for each piece in each lot, while set-up or adjustment time is made once for a lot. Exception to this practice of separating set-up or adjustment time from operation time may be made when work is put through in standard lots which do not vary in size. Set-up and adjustment time may then be

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4 Bethel, op. cit., p. 248.*

divided by the number of pieces in the lot, and the time thus found entered on the master route sheet as time per piece. 6

Routing for job shops — Perhaps the most efficient method used by the job shops, is to route each new job as it is released to the shop. The preliminary study usually begins after the sales order has been received unless for speed the design room releases advance information. The blueprint or specification for each part or ingredient is studied to see how it can be made with the equipment available in the shop. Often it is necessary to follow a sequence of operations in a more or less fixed pattern. Sometimes the sequence can be shifted and still produce a good job. However, unless there is some definite reason for shifting, the original routing should be used. In the most efficient shops, the foreman cannot change the operation sequence or type of machine used. He must first get permission from the production control office through the dispatcher. This is not done to bolster the authority of the production control group but to prevent major changes in machine loading which might unbalance the scheduled loads on the machines. One of the best methods in designing the routing is not only to indicate the standard or most appropriate machine or production center for performing an operation, but to list possible alternates as second, third, and

6Ibid., p. 173.
fourth choices. This allows flexibility of the machine load if too much is scheduled for the first choice of machine. If the load scheduled for the best equipment is too great, the job may be sub-contracted to some other machine or production center in order that the schedule may be met. The selection of the machine for the job-lot shop is often influenced by the

<table>
<thead>
<tr>
<th>Oper. No.</th>
<th>Description</th>
<th>Operator</th>
<th>Scheduled start</th>
<th>Assigned to mach.</th>
<th>Moved</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Face flange</td>
<td></td>
<td></td>
<td>6-3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Drill flange</td>
<td></td>
<td></td>
<td>4-5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Mill-Bore</td>
<td></td>
<td></td>
<td>6-3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Drill-Taps</td>
<td></td>
<td></td>
<td>4-5</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1.—Simple hand-written route sheet

comparative cost of setting up for the job. In many cases, a general purpose machine requiring little set-up is preferred to a special purpose machine requiring a complicated set-up.
Routing for job order shops is often hand-written on a simple prepared form such as shown in Figure 1.7

**Phases of routing** -- The work of routing consists of six phases or steps. These steps are not necessarily taken each time a production order is planned because the information may be available in the files as a result of the planning of a previous order. The phases of routing are as follows: 8

The parts necessary for the final assembly of the product and also the subassemblies are listed, and their specifications are stated. This means, to list all the parts which are necessary for the completion of a product. For example, a bicycle is composed of a seat, a chain, handlebars, two mud guards, and two wheels. These parts are called subassemblies because they are each composed of two or more parts.

The sequence in which the parts are to be manufactured or assembled is determined. Of course, the perfect planning and production schedule would be to have all parts reach the assembly line at the exact time they are needed. However, this ideal situation is not readily found to exist in most industries. A great many plants produce parts for stock to be withdrawn from the store room as needed. The maintenance of a reserve bank of parts at each workplace along the line may be desirable to prevent delays and interruptions.

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7 Koepke, op. cit., p. 208.
8 Richard N. Owens, Management of Industrial Enterprises, p. 554.
The materials necessary to the manufacture of each part and the quantities of each material are fixed. If parts are produced and stored in advance of production, the parts are included in the list of material. The list of parts and materials required for the production of an article is called a bill of materials. As the product becomes more and more complicated, the bill of materials will become longer and longer. An example of a bill of materials is shown in Figure 2.

<table>
<thead>
<tr>
<th>BILL OF MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME OF PRODUCT</td>
</tr>
<tr>
<td>MODEL NO.</td>
</tr>
<tr>
<td>DRAWING NO.</td>
</tr>
<tr>
<td>NO. OF SHEETS</td>
</tr>
<tr>
<td>SHEET NO.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>UNITS</th>
<th>PART OR MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>27213</td>
<td>2</td>
<td>bearing</td>
</tr>
<tr>
<td>27335</td>
<td>4</td>
<td>bracket</td>
</tr>
<tr>
<td>11620</td>
<td>2</td>
<td>hinge</td>
</tr>
<tr>
<td>45601</td>
<td>1</td>
<td>base</td>
</tr>
<tr>
<td>25219</td>
<td>1</td>
<td>clutch</td>
</tr>
<tr>
<td>21702</td>
<td>6</td>
<td>spark plug</td>
</tr>
<tr>
<td>34822</td>
<td>16</td>
<td>bolt</td>
</tr>
<tr>
<td>17109</td>
<td>6</td>
<td>bushing</td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td>etc.</td>
</tr>
</tbody>
</table>

Fig. 2--Bill of materials

\[9\] Ibid., p. 553.
The steps or operations necessary to the manufacturing of each part are listed. The jigs, cutting tools, gages, and fixtures which will be needed in the manufacture of the product are determined and listed. When the flow of work is planned, the job is first routed by departments, and then to specific machines. An example of this is as follows:

Machine shop operation: Lathe, mill, shape, drill, grind, inspect and ship out or move to different location.

Foundry operation: Patterns, cores, flasks, molding, cleaning, inspection, and ship out or move to different location.

The detailed operations are listed on an operation ticket (route sheet) which is sometimes used as a shop travel card to follow the material as it travels through the plant. An operation ticket generally shows the following information:

1. Part number and name
2. Quantity to be manufactured
3. Operation name and number
4. Department and machine number
5. Number and specification of tools to be used
6. Estimated time required for each operation

Forms for use in dispatching are prepared and filed. Several forms may be prepared as a part of the work of routing. The purpose of the forms are, first, to notify a department of the work to be done and, second, to provide a report of
all work which has been accomplished or completed. Where many persons are concerned with the work, it is often possible to include on one form the information which may be required by two or more departments. These forms may also be prepared in different colors for the use of various departments. An example of this is as follows:

White—Engineering department
Ecru—Central production order control form
Green—Department production order control form
Buff—Traveling production order form
Salmon—Material requisition form
Blue—Parts requisition form
Pink—Cost department notification form

Generally, these forms are not sent to the departments concerned until materials, tools, and drawings are available and the work has been scheduled. Other forms which are prepared as a part of the work of routing generally include the following:

Material Requisition—This is sent to the storeroom and authorizes the issuance of definite articles.

Move Ticket—Indicates the sequence of operations and the department the job is to move to next.

\[\text{Ibid.}, \text{p. 557.}\]
Inspection Ticket—Used to notify the inspection department that the work is ready for inspection.

Shipping Order—Sent to the shipping department to ship stated quantities to a customer, or to a branch industry.

Scheduling

Scheduling is closely related to routing, because routing cannot be completed without reference to the work previously scheduled for each department. The scheduling of work introduces the element of time. It may provide only for starting and completion dates; or it may provide starting, completion, and transfer dates from one department to another. Usually, the date of completion or delivery to stock is first determined and then the date when work is to be completed in any department is determined by working backward from the completion date. The purposes of scheduling are as follows:

1. Delivery dates may be planned and promises made to customers with the assurance that they can be kept.

2. Completion dates may be integrated with plans for advertising the product and for stocking retail stores, or something of this nature.

3. Departments may know the amount of work ahead and make their plans for personnel, extra shifts, overtime, machine repair, and other adjustments.

4. Provision may be made for the purchase of supplies, tools, or other equipment.
5. The production plans may be integrated with the plans of contractors.

6. Foremen and workers may know what is expected of them and can determine for themselves whether work is on schedule.

7. The planning department knows at each stage of production whether an order is on schedule and whether corrective action will be necessary.

8. If a machine or a department is becoming overloaded, the fact is known in time to permit rerouting of some of the work, declining of additional customer orders, or making other plans.

Before the element of time can be made a part of the production planning, however, the following information should be available:

1. Operations necessary for the manufacture of the product as established by the product design department and by routing.

2. Machine capacity and number of hours a day or week a machine can be expected to operate.

3. Dates when materials will be available for beginning work.

4. Time required for the transfer of the product from one department to another.

5. Standard time for various tasks as established by motion and time study.

Owens, op. cit., p. 561.
6. Desired dates for completion of the product and for delivery to stock, or shipment to customer.

Determine machine capacity — Obviously, machine capacity is an important factor which must be considered for effective scheduling. When estimating machine capacity, the first thing to determine is the number of hours per week the machines of each type may be in operation. This estimate is based upon the number of machines, the number of days per week the plant will be in operation, the number of shifts, and the estimated percent of efficiency. By using all of these factors, capacity is determined by multiplying the number of like machines times the number of labor shifts, times the hours per shift, times the number of days of plant operation per week times the estimated percentage of efficiency. An example of this type of estimate is as follows:

| Machines | 3 |
| Shifts | 2 |
| Hours per shift | 8 |
| Days of plant operation (per week) | 5 |
| Percentage of efficiency | 80 |

\[3 \times 2 \times 8 \times 5 \times 80\% = 192 \text{ hours weekly capacity}\]

This type of calculation will show, for the various types of machines and workplaces, the maximum amount of work to be scheduled for each department. A Gantt chart may be used to show the machine load of the different machines. An example of this type of Gantt chart is shown by Figure 4 on the next page.
In addition to these Gantt charts, bulletin boards, or other forms of filing such as Instant Visual Information (IVI) files may be used. This type of recording of machine load, allows for more flexibility than the Gantt chart, since additional information may be added or deleted from the files in a much easier manner than can be from the Gantt chart. This makes it possible to cut down on production costs and increases efficiency in production records departments.

When an order is to be scheduled, the parts lists and the operation ticket are taken from the files. The parts list shows what parts are required for an assembly, and the operation ticket shows the operations necessary to the manufacture of each part. Next, the balance of parts available in the storeroom are found and those short must be manufactured or ordered for stock.

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Owens, op. cit., p. 565.
In scheduling the manufacture of any part, the dispatch clerk refers to the machine load data, or chart. If any machine to be used in the manufacture of the parts is already heavily loaded, he schedules the operations for these machines first. The schedule is then projected through the subsequent operations to determine the finish date for the part. He then estimates the time required for assembly operations and determines the date for the completion of the order.

One of the most important points to be considered in scheduling production with demand is whether the rate of output is to be stabilized from month to month, or varied according to changes in the volume of sales. If production can be stabilized, the advantages gained are as follows:\(^14\)

1. Decreased turnover of labor, due to continuous work.
2. Decreased cost in employing, training, and inducting of workers.
4. Increased efficiency of machinery and equipment.
5. Simplified production control, because of continuous nature of production—no peaks and slumps—production is on an even keel.

One method of stabilizing production when there has been no uniform quantities produced from month to month is to meet an increase in sales with a partial increase in production.

\(^{14}\) Ibid., p. 856.
and also to draw from the storeroom stock produced during months of low sales volume.

In scheduling monthly and weekly production the first thing to accomplish is to estimate the monthly delivery to customers and the monthly delivery to stock. It is necessary that an estimate of customer deliveries be made since, as in the case of automobiles, customers will want different colors, body styles, and different kinds of upholstery. A check list which is used to determine customer demands is as follows:

1. Market conditions
   a. Conditions in material market
   b. Plans of competitors
   c. Trends in business conditions
   d. Reports of salesmen or other sales outlets

2. Conditions within the business
   a. Analysis of sales last year and other years
   b. Advertising plans
   c. New sales outlets to be opened
   d. Changes in design of product
   e. Labor conditions affecting production
   f. Financial plans for raising new capital

As an aid to scheduling the production of the parts and assemblies, a chart showing the flow of work from one department to another may be prepared. When using such a chart, the flow of materials for each of the various parts is timed
throughout each of the succeeding departments. This gives information which can be used to determine when to start each part through production so that there will be no delay when the parts are to be assembled. An example of this type of chart is shown by Figure 5.15

Fig. 5.--Chart showing the flow of work from one department to another.

15 Automobile Facts, December, 1939, pp. 4-5.
One thing to watch for when scheduling work to begin through production is to keep the factory float as low as possible. The reason this is important is, while the product is in the float, factors such as idle capital, possible deterioration, obsolescence of parts, and crowding of workplaces may result.

The daily run sheet is an order of what is to be done and produced for the day. This daily run sheet is distributed to the head of each department which feeds into the main assembly line. The manner of scheduling after the daily run sheet has been prepared may be seen by reference to Figure 5. This figure shows that a car which is to be finished at 2:20 P. M. on Friday will start on the final assembly line at 1:00 P. M. on the same day. The rear assembly will be started on Monday at 8:00 A. M., while the gear assembly will be started at Monday Noon. After assemblies are timed to start in a similar manner. The production of each part need not be timed as precisely as the chart seems to indicate, however, because many parts are interchangeable and will fit into the assembly of any auto along the line. Such parts are planned only in the necessary quantities. They may be stored in bins at each station, or they may be moved by overhead conveyors.

Dispatching

Dispatching is concerned with the smooth introduction of work to the shop. It may be a very simple procedure or a
highly formalized routine. Dispatching of an order to the shop implies that any prints or instructions necessary for its performance are also sent along. The dispatcher may be responsible for a final check on the availability of materials, tools, gages, or fixtures required for the job and he may even have to see that these are delivered to the work center when the order is about to run. 16

Dispatching is the last thing done by the production control department prior to the operation and is more a part of concurrent than preliminary control.

Dispatch offices--Branch offices of the production control department, called dispatch offices, are located in the various producing departments. In these small dispatch offices are kept all the job tickets, drawings, move orders, etc., which are made up ahead for jobs to be done in the respective departments. The production papers (drawings, tool orders, move orders, etc.) are made up or assembled ahead of time by the central production control office and sent to the dispatch offices, where they are held until the operator is ready to start. Job tickets for the later operation on an order are not released to the factory with the papers needed for the first operation, but are released just ahead of the performance of each operation. It has already been said that

16 Ritchie, op. cit., p. 118.
the dispatch office issues job tickets and other production papers to the machine operator. He appears at the dispatch office window ready for a work assignment for his machine and is given the papers. 17

The most important functions in dispatching are: 18

1. The procurement for the workman of all tools and fixtures necessary for each operation in advance of the time when they will be needed.

2. Initiating the work by giving the workman all work orders, instructions, drawings, etc., at the time when work should begin.

3. Recording the time of starting and completing each operation.

4. Moving the work after completion to the next operation or process listed upon the route sheet.

5. Tracing the progress of all production and making adjustments in the schedule to accommodate necessary changes.

Dispatch boards--Most dispatch stations contain a record of current and available jobs for the machines in the jurisdiction of the station. This record is often graphic or visual in nature but it can be kept in a file box if space is limited. However, dispatching is much easier to follow if the graphic method is used. Each machine or work station is given a unique number which is used as a code on the dispatch board.

17 Franklin G. Moore, Production Control, p. 249.
The simplest board consists of a hook or pocket for each production center. The card designating the current order in the machine is out in front and the jobs next in line are placed in order next to the current outside card. This plan does not graphically present as much chance for control as does a two or three card plan for each production center. When three positions are used in a vertical line, the top card represents the current condition or job for the machine. The middle card shows the next job or situation when the current job is finished. The lowest position of the three is used to store all the available jobs released for that particular work station.\(^{19}\)

Though boards arranged with hooks are the simplest to make, the cards must have holes punched in them; this may not always be convenient. Many companies use small slanting metal pockets made from sheet metal which are nailed to the board. Space can be saved by this procedure and thus the boards for a large department can be smaller in size than when the cards are hung on hooks. An example of a three pocket dispatch board is shown by Figure 6, on the following page.

Dispatching for continuous industries—Dispatching in a continuous industry is almost automatic. Material flows from one operation to another with a minimum amount of control at the time the work is proceeding through the shop. The order of

\(^{19}\text{Koepke, op. cit., pp. 540-541.}\)
work is carefully planned when the production line is designed, and as long as all machines are working properly there is not much routine dispatching to do.\textsuperscript{21}

Dispatching for lot production—Any shop working on a lot production basis or any ordinary job shop may have a very complex dispatching problem. Different jobs are routed over the same machines, and when the shop is busy, there may be considerable confusion unless the work planned for the various machines is skillfully directed. Dispatching has to be organized with a more or less flexible plan to be useful in most shops. Emergency jobs may appear at any time. If the loading and dispatching departments assume a rigid attitude toward emergencies, it will only be a matter of time until the shop

\textsuperscript{20}Ibid., p. 540.
\textsuperscript{21}Ibid., pp. 532-34.
will have to get along without a planning department. However, emergency and rush jobs should be analyzed. Moreover, an estimate of the cost of the extra costs should be made to the proper authorities. Occasionally, however, if the authorities believe that the emergencies are worth the extra costs involved, the production control department should include the extra work as a part of its regular duties.\footnote{Koepke, \textit{op. cit.}, p. 532.}

\textbf{Manufacturing orders}--When a manufacturing order is issued, it is first broken down into parts and assemblies. Route sheets are then made out for each part and assembly. The route sheets indicate material to be used and operations to be performed and their sequence. Against each operation, its time allowance and the date when it should begin and end, and the tools and fixtures required are entered, and the corresponding blueprint gives data for inspection limits and tolerances. To give effect to this information, material, tool, job, inspection, and move orders are made out as soon as dates assigned the operations are known. All these working papers are then filed until the day or two before the job should be put into work. These orders are then issued, released or distributed by the dispatcher to the various persons concerned. The material will be delivered at the machine, tools and fixtures gotten ready, the operations performed on the materials, the pieces inspected, and those which pass inspection moved on to the next operation.\footnote{L. P. Alford, \textit{Production Handbook}, p. 224.}
Move orders—It is not good practice to have machine operators or high-priced assembly mechanics move materials to and from their work stations. The labor cost, when such men are used, is generally higher than that paid to internal transportation people. Often, the most serious expense is overlooked. When the machine operator or assembly man is not running his work station, he can produce nothing and such time is irretrievably lost. The total loss of production due to the machine’s enforced idleness means that the machines are not earning their share of the overhead cost nor are they making a profit. 24

Sometimes, when the machine operator is asked to move materials, he welcomes the chance to leave his station and visit with other workmen which only means more idle machine time and a piling up of extra costs. It is far better to have controlled rest periods to relieve possible monotony than it is to allow uncontrolled visiting while the machine operator is moving material about the shop. 25

The general internal transportation department is usually responsible for all moves from the raw stores to the shipping room. In some companies, the GIT (general internal transportation) moves material only from raw stores to incoming bays. Within the department material is handled by a system of local transportation.

24 Koepke, op. cit., p. 333.
25 Ibid., p. 334.
Regardless of the system for moving materials, the transportation men should not move materials without authority to do so. These men should be carefully trained to see that all materials in a lot are identified properly by comparing orders with the part numbers and quantity in the order. Movers in this kind of a shop should be selected for more than just a strong back. They must be strong and alert and have respect for written orders.

Material orders--The dispatcher controls the movement of raw materials to the first operation by issuing, to the stores, an order calling for delivery at the machine on the scheduled date. When the material leaves the storeroom, one of the original copies of the storeroom order is sent by the stores department to the cost accounting department. Another copy is sent to the inventory control clerk. These forms were prepared and distributed with the other forms when the manufacturing order was originally printed. Thus, by the distribution of the initial manufacturing order papers, the stores department is notified in advance when raw material is needed and how much of it should be moved in this order. If the material is on hand the department simply acknowledges the order by a returned form, but if the material cannot be on hand at the scheduled date, the returned form specifies when it may be had.

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By procedures similar to this everyone who is concerned with material is kept informed about its movements and disposition up to the first operation in the shop. After that only the dispatcher, the shop, and the central planning department are interested in the material until it is ready to enter the finished stores.

**Finished stores order**—As a completed part or assembly, the order again becomes of interest to the stores division. The finished stores department, which is to receive the order, has been notified by the original distribution of the forms when the order may be expected. This notification should serve a dual purpose. The finished stores know space will be required to store the order, and the commitments against the new order usually can be made on or after the scheduled completion date. The dispatcher thus controls the movement of raw, in-progress, and finished materials within the limits of the schedule as closely as shop conditions will permit.²⁸

**Tool orders**—In all machine shops and similar work it is the practice to specify all tools for the job, as well as to list all jigs, fixtures, gages, etc., which will be required. These particulars are listed in a "tool order". A tool order is prepared from the operation study sheets at the time of making out the route sheets and is filled with the other working papers until wanted. As soon as the material is in place,

²⁸Ibid., p. 543.
the tool order is released. The tool room collects the tools and holds them until asked for by the man on the operation specified. Authority is given by presentation of the job order or time ticket for the operation in question.  

**Job orders**—Materials and tools now being provided for, the operation itself may proceed at the scheduled time. Authority to proceed with the work is given by release of a "job order" which serves to identify the work to be done. The amount of detail on job orders varies greatly. In some cases, particularly in repair work, the job is described in as much detail as necessary, but ordinarily actual instructions are obtained from blueprints and instruction cards, whether these are retained by the foreman and verbally explained to the workman, or handed to the latter. Under such circumstances, data on the job order are merely such as will assist in the routine.  

Job orders are made out at the same time as the route sheets. If assigned to machines of which there are several alike (group of machines), only the assignment to the group should be made in the first instance. The actual machine should be assigned by the dispatcher at the time of release of the order.

**Time stamping**—It is advisable, although not absolutely necessary for the purpose of dispatching, to record the times at which jobs are started and completed. If the time is not

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29 Alford, *op. cit.*, p. 149.

recorded, cost accounting will not be possible, records or wage incentives based on standard time cannot be kept, and it will not be possible to fix responsibility for delayed jobs. It is advisable, therefore, to make time recording a function of the dispatcher's job. For this purpose, recording time stamps or time clocks are generally used. Any of the more generally used types of time stamps are satisfactory, but preference is given to those which record the time in figures which are direct reading. Time stamps or clocks controlled by a master clock are recommended for dispatching work where there are a number of dispatch cages in different departments of the plant. When a work order is returned, the order is time stamped and given to the movemen who thereupon move the material and return the ticket to the dispatch cage where it is again time stamped.\textsuperscript{31}

\textbf{Inspection--}In continuous manufacturing and in block and load control industries, inspection sections sometimes do not exist as separate departments. There are inspectors, but they work directly for the producing department foremen. This practice is sometimes followed in order control companies. More often, however, inspection is carried on by a separately organized department.

As a rule in flow, block, and load control, rejections are few, and they rarely create a real problem. Normal losses are expected, and since all parts are being made in a more or

\textsuperscript{31}\textit{Ibid.}, p. 189.
less continuous flow, no problem is presented. Should a considerable number of one item be rejected, the replacement orders for that part would be increased immediately. The small inventories of materials between process would probably permit production to be carried on with a minimum of delay.³²

In order control, however, serious problems sometimes arise as a result of rejection of parts. The relationships between the production control and inspection departments in order control are largely confined to matters dealing with rejected materials. As a general rule, the production control department, relying on past experience, can anticipate and allow for approximately the number of products which will be rejected because of faulty work or materials. As productive operations are performed and as successive inspections (at each of which, perhaps, a few items are rejected) reduce the number passed, reports are sent in by the inspection department. Usually these reports are not solely for production control purposes. Often several copies are made, only one of which goes to production control. In a few companies, the inspector who rejects products decides whether they are repairable and, if they are not, in certain circumstances, originates a replacement order. If the order is for a single large steel casting and it is rejected and judged by the inspector not to be repairable, he originates an order for a replacement.³³

³²Moore, op. cit., p. 382.
³³Ibid., p. 383.
Schedule modifications—Modifications in the scheduled plan are necessary from time to time and usually the most common ones have a procedure to follow. When a machine breaks down or work must stop on a partly finished lot for some other reason, the workman takes his uncompleted job ticket to the dispatcher and punches out. If the machine is down, the operator is either given a waiting-time ticket or is assigned to another job. If the current job is stopped because another order must be rushed through the machine, the rush job is punched in and the partly finished job ticket is placed second position on the planning board, and the order is placed back on the machine when the rush job is finished. 34

Idle time of men and machines—Idle machines are a considerable problem in many plants. Speeding up of machine output, unless accompanied by increased sales, creates a surplus machine capacity in itself. Idle machine time is especially notable with automatic equipment and short-cycle machines. Unless loaded with a constant flow of work these machines, which represent a considerable investment, will amplify the cost of work per unit. Absence of skilled operators is also a factor contributing to idle time, and is often due to irregular machine loading peaks which require additional men. 35

34 Koepke, op. cit., p. 543.
An analysis of the reasons given on a series of waiting-time tickets showed that a large percentage of the trouble was due to assigning work to a station before all the blueprints, tools and materials were at the work station. This, of course, is largely the responsibility of the dispatcher and can be easily corrected if the dispatching system is made to work properly.36

Follow-Up

Follow-up personnel are used to facilitate the flow of work through the plant. A follow-up man usually has had considerable shop experience and often is only concerned with certain types of orders or those of a particular group of customers. Although he spends much of his time on the production floor, he usually has no direct authority over the foremen. On the basis of delivery promises, assembly requirements or the like, he tries to eliminate the causes of delay by recommending action to the foremen or other plant executives.37

The mechanics of follow-up—The mechanics of follow-up are largely determined by the organization of the control system and the method by which routing, scheduling, and dispatching are accomplished. The follow-up function becomes progressively more important as the control desired from the system becomes tighter. The ultimate goal of follow-up

36 Ibid., p. 543.
activities is that of preventing serious delays. The term "serious" is relative; its exact definition will vary in different production situations. The shorter the interval of time before a delay becomes serious, the more accurate follow-up procedures must be.  

Organization for follow-up in continuous flow industries—The follow-up procedures required by continuous flow production differ greatly from the type used for job-lot production. In continuous flow production the department foreman and supervisors may perform what is essentially a follow-up function in their daily routine responsibilities of keeping production flowing through their departments. It resembles an endless chain situation in which a broken link means an interruption and everyone's attention is directed to the location of the trouble. Generally a major repair is necessary to get the chain back into operation; the break cannot just be moved to one side and service continue normally.

Organization for follow-up in job-order industries—The situation may be quite different in job-order production, especially where controlled banks at stations are the practice. Usually the next job is "on deck". A shortage of material on the current job may merely mean that that job is temporarily sidetracked in favor of the next for which there is material.

38Ibid., p. 121.

39Bethel, op. cit., p. 136.
However, herein lies a danger if such decisions are left to the operating unit. It is quite easy for an operator or operation group to rationalize that other factors, such as saving on set-up time and added operator earnings might also be sufficient for the rearrangement of predetermined schedule. This danger only emphasizes the need for follow-up by neutrally interested follow-up personnel.

Centralized control of follow-up--In centralized control, all operations and all transportations are controlled, as are all machine schedules, so there should be no question as to where an order is at a given time or, if it is held up, why it is held up. Occasionally, however, an order gets lost and it is necessary for an expediter to locate the order. He must find it and find out why it was delayed and try to get it moving again. The expediter in this case is more a job finder than an investigator or pusher. Investigation of the cause of delays as done by expediters is not extensive. Should there be any occasion for a thorough investigation, the expediter would not be the person to do it but rather a representative of the engineering department or the superintendent's office. After finding the order, the expediter in centralized control need follow it no farther, because the scheduler can see that it is rushed through the remaining operations. In centralized control there is need for very few expediters.

40 Ibid., pp. 137-38.
41 Moore, op. cit., p. 269.
Decentralized control of follow-up—Many companies do not control everything from the central office and find it necessary to use more expediters. In these companies the expediters work for the production control office, but they work in all the parts-producing departments. They keep selected orders moving and do not attempt to speed up production in general. Selected jobs needing to be pushed are those which were accepted by the sales department on the basis of quick delivery and those which have fallen so far behind schedule that it is necessary to give them special attention to get them out. Expediters also occasionally do a mild job of pushing or overseeing on special orders. Often they are orders for important customers on which it is particularly important to meet the promise date and items on materials short lists. Their job is one of watching and pushing if delays occur or threaten. 42

Jobs are pushed through, first of all by finding the order, that is, the material itself, if it is lost. After it is found it must be transported to the next operation. If the lot is small the expeditor may transport it himself with a hand lift truck. If it is large he arranges for a trucker to move it. He next gets the scheduler to assign an early time on a specific machine to do the job. After that is done the expeditor checks back from time to time to see that the job does get put on the machine and that it is being processed. Meanwhile, he arranges

42 Ibid., p. 269.
for machine times with the foremen or schedulers for the succeeding departments, so that the material, when the operation being performed is finished, can be moved and the next operation begun as quickly as possible. Continual checking on the current status is necessary to keep the order moving.43

Combination centralized and decentralized follow-up--A third type of follow-up is a combination of the decentralized and centralized types, whereby departmental expediters concentrate on materials and parts service within their respective departments, while a centralized force is responsible for the follow-up of subassemblies between departments until final assembly is completed.44

Other methods of follow-up--One type of follow-up depends on a secondary flow of paper which first serves some other purpose. There are a number of forms which lend themselves to this. Department schedules may be marked in the shop to show those jobs which have been completed, those which are well under way, those which have just started, and those which have not started at all. This form, which served originally as an operating plan, supplies a record of progress on its return to the control office at the end of the period. A copy of the manufacturing order itself may be forwarded to production control upon completion of the job. The route sheet may be sent back in the same manner when all operations have been completed satisfactorily. Neither

43 Ibid., p. 270.
44 Bethel, op. cit., p. 138.
of these last methods provides a very close check on progress unless the manufacturing interval is short. If this interval runs several days or longer and closer follow-up is desired, it is possible to return a copy of the route sheet after each department finishes its work. The route sheet may be a series of detachable tickets, each representing one operation. As these operations are completed, tickets are torn off and returned to planning. The same tickets may also be used for payroll purposes or to provide instructions for the operator.45

The pegboard which is used for scheduling may be used for dispatching and for following the progress of the work. When work is started on an order, a transparent colored tape of flexible plastic is pulled out from the left side of the board, and the end of the tape is fastened under the starting date by means of a peg or tack. As the work progresses, the tape is pulled farther out to indicate the extent of the progress or the percentage of work done. For example, if the schedule for the first week calls for 400 units and the output is only 300, the tape is pulled three-fourths of the way across the space for the first week. On another order, if the schedule calls for production of 100 units and production is 110, the tape representing the progress of the order is pulled all the way across the space for the first week and one-tenth of the way across the space for the next week. The first order is behind schedule.

45Ritchie, op. cit., pp. 121-22.
and the second is ahead of schedule. The current date is indicated by a string drawn across the board from top to bottom. If all orders are on schedule, the tape for each order will extend to the string representing the current date. If no order is ahead of schedule, no tape will extend beyond the string.

**Expediting into the plant**--Follow-up or expediting procedures are generally recognized as internal necessities, but there are numerous instances where "in transit" follow-up plays an equally important part in supplying needed materials, parts, and products on schedule. This type of follow-up is usually conducted by purchasing and traffic department personnel working through agents of the public transportation carriers. The follow-up may consist of checking shipments that have been made or arranging for special attention to be given to completed shipments in order that they may be kept moving.

**Follow-up of materials**--Best practice dictates that follow-up of materials should start with a follow-up of the requisition on the purchasing department for the material. Possibly the best method of control in this regard is for the production department, in originating the requisition, to make it out in triplicate and to send all copies to the purchasing department after first posting the amount requisitioned on the material-control board. The first copy can be retained permanently by the purchasing department as its record of the requisition.

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46 Owens, *op. cit.*, p. 574.

The second may be retained temporarily by them and may later be sent to the production department as a receiving notice from the purchasing department for the material when it is received, or it may be used to convey piece information to the cost department. The third copy should be marked to show the name of the vendor and the delivery date promised and then returned to the production department. The production department can then use this copy as a means for clearing with the purchasing department on requisitions that become overdue. Routine follow-up of overdue orders may consist of a printed form providing for pertinent information such as that shown by Figure 7.

1. Name and address of vendor ____________
2. Our order # ______ Your order # ______
3. Article __________________________
4. Promised delivery __________________
5. When will you ship? ________________
6. When may we expect delivery? ________
7. Reply desired _____________________

Fig. 7--Routine follow-up form

Follow-up of work in progress--Once the material is received, the receiving inspection department or the purchasing department should notify the production department, and the information

Ibid., p. 140.
should be posted on the material-control records, indicating that the material is available.

Continuous or line production simplifies the problem of the follow-up of material in process, for the problem then becomes one merely of scheduling and dispatching the material in the correct sequence at the first operation. Manufacturing orders and materials may be issued at the time and in the sequence desired to the departments performing the first operation on each part. Once the material enters the process, however, it cannot easily become sidetracked, and it can readily be located at any time. Thus, with continuous or line production, follow-up consists primarily of checking the materials required and watching the maintenance of schedules.\(^{49}\)

The follow-up of work in process in a diversified manufacturing type of industry is usually somewhat more complex than in continuous production. The sequence in which materials and parts enter the process in diversified manufacturing can likewise be controlled at the first operation by scheduling and dispatching, but after the first operation in the manufacture of such products, control may become mainly a matter of follow-up. The sequence in which the orders are run under such conditions will usually be decentralized into the hands of the foremen, subject to the advice and judgement of the follow-up men in whose hands usually rests the responsibility for bringing together at the right time and place all the parts necessary for the assembly.\(^{50}\)

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\(^{49}\)Ibid., p. 141.  
\(^{50}\)Ibid., p. 142.
The more diversified the parts and the products manufactured, the more difficult becomes the task of follow-up.

**Behind schedule report**—A "behind schedule report" may be originated as soon as the foreman realizes that he cannot meet the schedule on an order. This report, which shows the order number and the cause of the delay, is sent to the follow-up section. In some companies, the behind schedule report may originate in the planning department. Delayed orders are spotted by examining the files each day to determine which orders were scheduled to be moved to new locations on the preceding day. If a report of completion of work in a department has not been received, the order is listed as behind schedule. A report is then prepared which identifies the delayed order and indicates the operation number and the department or machine at which the material was last reported, the operation number and the machine at which the order is overdue, and the number of days overdue. Copies of the behind schedule report are distributed to the foremen to notify them of the status of such orders.  

**Report on machine loads**—The follow-up section may prepare a weekly report summarizing the work load of each type of machine and the changes in machine load since the date of the last report. The information included in this report may include: type of machine, number of machines of this type, hours of available work for this type per week, new hours during the week, and work hours used.

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51 Ibid., p. 576.
52 Ibid., pp. 577-78.
Adjusting for machine overload--Some machines may become overloaded as a result of delays or interruptions or as a result of rerouting of orders in adjusting production schedules. The situation is noted on the machine-load chart by means of a peg and a colored plastic signal or a peg of a certain color in the case of the pegboard. When the overload condition becomes known, appropriate corrective action may be taken by adjusting the schedules of certain orders, by authorizing extra shifts or overtime, or by other appropriate action. If orders cannot be delivered on time, customers should be notified. In some cases, additional sales orders may be declined until the situation has been corrected.53

Schedule changes--The personnel responsible for the original schedule should be the ones who evaluate all delays. It is very important that the schedulers receive progress reports frequently enough to catch delays before they become too serious for preventive action. Few operations ever proceed exactly as planned; delays are often frequent and usually inevitable. However, every delay does not call for immediate action. Many times it is not even possible to act on all delays since this would spread available time and talent so thin that nothing would be accomplished. For this reason, progress reports are related to the original plan and delays are evaluated in terms of their over-all effect. Those which appear to have little effect upon other stages of

53Owens, op. cit., p. 578.
production are often left to adjust themselves; those which appear likely to have a marked effect on prime commitments will call for immediate action to remove their cause. One of the major arguments for graphic control lies in this area of follow-up. Comparisons of progress and plans between different components of an assembly, the selection of critical items or the decision on a course of action to minimize the effect of a delay, are sometimes easier to make with the data in chart form than when it is presented in some other way. 54

Personal follow-up--A type of follow-up somewhat different from the production type is a type of personal follow-up that is a part of the daily activities of every production man from the works manager to the foreman and the newest production clerk. It enables the production man to check up on the fulfillment of the promises of others and serves to remind him to carry out his own promises. For example, the schedule clerk may have received a promise from the purchasing agent that a steel shipment needed to make a particular part will arrive at the plant on a certain day. He should then have some method of calling his attention to the expected shipment on the day for which the shipment is promised. Similarly, the clerk may wish to remind himself on a certain day to review the production record of some key machine, that has developed machine trouble, in order

54Ritchie, op. cit., p. 123.
to ascertain what steps may be necessary to make up the production time thus lost. This type of personal follow-up is usually accomplished by the use of a follow-up file or book. Perhaps the simplest and most inexpensive means is by the use of a book with a page for each day of the month. Notes, cards, and memos can be inserted in the book at the day for which the follow-up is desired.55

**Report on departmental accomplishment**—The follow-up section may prepare a report comparing the work done in each department with the amount of work scheduled. The section determines the number of hours originally allotted to the job from the work schedule and the number of hours taken from subsequent reports. The difference between these two is the number of hours of variance from the standard. If a job is still in process, the follow-up section may determine the standard number of pieces per hour and the actual number of pieces completed. This report would show the following information:56

1. Part number and name
2. Operation number
3. Department or machine number
4. Shift
5. Number of pieces completed per hour
6. Standard or scheduled number of pieces per hour

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Usually this report is not prepared for every order but only for those for which performance appears to be unsatisfactory. The report may be of value to the scheduling section in planning future work because it indicates the reliability of standards previously established. It also indicates the orders in progress on which costs will be in excess of standard. Consequently this report permits the management to take action to correct an undesirable trend in costs before the order is completed and before the final cost figures are available.  

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57 Ibid., p. 579.
CHAPTER III

PRODUCTION CONTROL IN THE SHOE INDUSTRY

There are industries which are akin to continuous production in that all products go through almost exactly the same operations, but which differ from continuous production in that production must be directed and controlled by bunches. An example of this hybrid type of control is the shoe industry.

The shoe industry is a hybrid of continuous and job order production control. This type of control must be used because the production is continuous, since it produces only one product, but job order because of the great variety of the product. The variety includes style, color, size, and type of material that is constantly changing, to meet customer demands.

Sometimes production orders are grouped on the basis of equal amounts of time required. If the orders are small, several are grouped together into a block whose total production time requirements equals the capacity of a department for a given time. The production orders are identified by order number or lot number. If an order is large, it may be split into sections, each calling for a block of the department's capacity. A block may be a day's output or the output of some other period of time.¹ A block may also be a given number of boots or shoes.

¹Franklin G. Moore, Production Control, p. 305.
Because of its distinctive characteristics, the best known of these hybrid types is block control, which is found most frequently in semi-process industries, where it is highly important. With this form of control, orders or batches of products 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. The progress of the blocks through their successive departments can be shown easily by means of relatively simple reports and control devices, and any order or batch in a block which is held up can be spotted quickly. When assembled products can be manufactured under these conditions, differences in styles, sizes, and models can be taken care of without great difficulty. It will be noticed that these conditions correspond closely to those in semi-process industry; hence, as would be expected, shoe factories, clothing factories, and printing plants offer excellent examples of block control.²

²Ralph C. Davis, Industrial Organization and Management, p. 250.
Henry P. Dutton has described the nature of block control as it is used in the manufacture of men's suits. This method has been in common use in that industry for many years. It operates as follows: 3

The sale of men's suits to retailers customarily begins several months in advance of the seasons of customer demand. This gives a chance to collect the greatest diversity of combinations of goods, patterns, suit models, styles and sizes, so that as far as possible suits cut from the same pattern of woolens may go out to the shop together.

A suit is like an automobile motor in that there is a general balance of parts and processes. Indeed, it is an even better case for balanced flow production, for about the only major variations in suits is the omission or use of patch pockets, full linings, double rows of buttons, and like details. Consequently, with minor changes in a process here and there, a suit will flow through cutting and assembly or tailoring process to final pressing and inspection, with very little change in the balance of time requirements at each point. Furthermore, since most of the work is done by hand or with sewing machines which require little time change or set-up to switch from one order to the next, orders can follow each other in a practically steady stream.

There remain in men's tailoring only two important production

3 Henry P. Dutton, Production Control, pp. 848, 49, a collection of articles from Factory Management and Maintenance, 1942.
problems. One is to see that instructions, time tickets, and the necessary supplies or "findings" accompany each lot. This problem is solved by making out a standard instruction card and book of time tickets for each order, and putting them together with a supply of findings drawn from stock, with each order as it leaves the cutters.

The other problem is to see that the various parts of a coat, the sleeves and back, for instance, come together at the various stages of assembly. To meet this need, the block system has been developed and has found application in many lines quite different from men's suits.

A block is usually, in the tailoring trade, an interval of a half-day. In the order filling department of a large manufacturer of surgical supplies, the week is divided into 40 (or less, depending upon the amount of business) blocks of one hour each. In order filling in the large mail order house, blocks are 15 minutes in length.

Whatever the length of the block, enough orders are put together to fill it approximately. For example, the plant capacity might be 500 units per half-day. Block No. 1, to start Monday morning, would then contain orders of various quantities to an aggregate of 500 suits.

The weekly schedule would show that block No. 1 was to leave Department 1 by Monday noon. It should be delivered from Department 2 to Department 3 by Monday night, and so on to each department according to the schedule. Longer intervals might
be allowed certain departments subject to interruption, or for delays for transportation, or similar causes.

As each department receives a new block or lot of suits, it signs for it. The foreman's clerk crosses off each suit or order as it is finished, until every order in the block is crossed off. The lot in the block is then sent to the next department and signed for in like manner. As a block is delivered from one department to the next, the block number is reported to the main office as cleared. No block is cleared for any department until it is complete. No block is cleared until every preceding block has been cleaned up. A report of blocks behind schedule goes to the factory manager each day.

As may be imagined, the plan puts a heavy pressure on every department to clean up each block as it comes. A single unit, put aside because it is "fussy" and left till last, may hold up two or three blocks and bring every department in the plant down on the neck of the responsible foreman. In unavoidable delay, the schedule clerk has authority to transfer the delayed order to a later block or to take it out of the production line altogether. If there are too many such interruptions, the system would break down; it is adapted only to line production in which there is a relatively constant and dependable balance of producing capacity.

In addition to industries which find that block control suits their needs, there are other situations where a still different hybrid control serves best. Sometimes the problem is one of apportioning the production time on large, expensive,
fast production equipment among several varieties of almost identical products. Often the periods of time on major equipment required for particular product runs are lengthy rather than short.  

Calculating economic lot sizes—Several authorities have developed approximate formulas for calculating economic lot sizes. While exact mathematical determination is impossible because of the empirical or necessarily assumed nature of some factors, the formulas do include the factors that must be taken into account and insert them in their respective relationship. Thus the formulas become useful guides, but must be employed with judgement. Camp presented a general formula to determine the production order quantity, such that the total cost per unit for setting up plus interest on stores investment would be a minimum. Numerous studies of this kind were subsequently made. Camp's formula is:

Let $S$ = Set-up cost per order in dollars

$C$ = Cost per piece (labor, materials, operating expense, or a portion thereof) in dollars

$R$ = Rate of consumption per year in pieces

$I$ = Interest on investment, dollars per piece (Interest rate $I C$)

$Q$ = Order Quantity

The general formula then is:

$$Q = \sqrt{\frac{2RS}{I}}$$

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4 Moore, op. cit., p. 308.

This formula is somewhat unwieldy for the reason that the quantity under the square root sign is very large. If the interest rate is standardized for all cases, formula results can be plotted into curves to be used for calculations. Assuming 10% is fixed upon as to the rate to cover interest on the investment in stock and bin-space rental, then:

\[ Q = \sqrt{\frac{20BS}{C}} \]

(1) Let \( K = \sqrt{\frac{20S}{C}} \)

(2) and \( Q = K\sqrt{R} \)

The last two formulas plot into useful curves. Knowing the set-up cost and cost per piece, the value of \( K \) may be read from the chart plotted from formula (1). Introducing the value of \( K \) thus found into the chart plotted from formula (2), and knowing the yearly consumption, the value of \( Q \) may be readily found with sufficient accuracy for all practical purposes.

Provision is made for dividing the order into the proper batches, since the routing of all the material for a production order in one lot or batch may be uneconomical. When the work is routed from one workplace to another, economies may be affected by sending the material through the plant in batches instead of a single lot. The machines need not be reset for each batch, and a part of the material is forwarded to the next department when an operation is completed. By doing this, the whole order is not held in one department until finished, and production may be increased.
The size of the batch will be affected by the following factors:

1. The space required by the material and the amount of space available at each workplace.

2. The method of internal transportation and the cost of moving small batches.

3. The increased investment in the inventory of work in process which would result from holding the material until the operation has been completed.

4. The urgency for getting the work completed.

5. The amount of work already planned ahead for succeeding departments. 6

If departments which perform later operations already have done all of the work they can do, and if a transfer of the material in batches would only result in accumulation of work in later departments, no saving would result from the division of work into batches.

The effect of the division of work into batches is shown in the chart in Figure 3. This chart shows that, if the work is routed in one batch, it cannot be completed until the end of June. If it is routed in two batches it can be completed by the middle of May. The time required in production can be further reduced by dividing the work into a greater number of batches. 7

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7 Ibid., p. 559.
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WORK ROUTED IN ONE BATCH

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WORK ROUTED IN TWO BATCHES

Fig. 8.—Effect of dividing work into batches.
CHAPTER IV

CASE STUDIES OF NINE SELECTED SHOE COMPANIES IN TEXAS

It is the purpose of this chapter to present in case study form the results of the personal interviews held with the officer or person in charge of production control in each of the nine concerns under study. These interviews were carried out in the attempt to determine the general scope of production control in each company. A production control check list was prepared to help guide the interviews. Questions for this check-list were based upon the production control policies advanced in the combination of authoritative opinions in the preceding two chapters.

Although the companies range in size from very large to very small, many of them use common points for controlling their production. Due to this condition, some paragraphs or sections of each case study may contain exact or similar wording.

Some of the persons interviewed answered in a very detailed fashion, answering not only the question at hand but volunteering information or adjacent areas as well. A majority of the persons answered only the direct questions. When volunteered, detailed information was included in the case study.
Company A

Forecasting

All of the forecasting is done by the sales department. The sales department uses, as a basis for their forecast, the sales orders and reports that are sent to the company by its salesmen. The company then tries to build a picture of total sales for some future period by summing up and combining these reports, and using estimates drawn from the company's records. The company also tries to relate the general economic trends to their company, and apply this to their forecast.

Routing

Plant planning and design.--The plant planning and design function was carried out by an engineering firm. This firm had for an objective of their planning the straight line system of manufacturing. To aid in their planning, the plant engineer worked with this independent engineering firm. The planning started by listing each operation to take place. Next, the machine or work center that was necessary to perform each operation was found. In a large majority of cases, special purpose machines were chosen. The next step was to work out a machine layout chart that arranged the operations in a sequence, and the machines or work areas that were to perform them. With this completed, a careful check was made to see if the machine layout chart started with the first operation and step by step, in a straight line fashion, moved to the last
operation. The last thing done was to design the plant, so as to accommodate the design of the machine layout chart.

Method of doing an operation.—No planning is necessary to determine the method of performing an operation. Because of the straight line flow of work, the method of doing an operation works out automatically. From the beginning to the end of the manufacturing process, there is a machine or work center to perform each operation.

Route sheets.—Route sheets, which list each separate operation, are used. These route sheets are placed with each order that is scheduled for production. They list the operation, material, and specifications for each order. There is also a place on this sheet for the operator to place his number, after he has completed an operation. No time estimates are given on this route sheet.

Job order routing.—No job order routing is necessary. The styles and types of shoes have been standardized and all orders for shoes or boots are from a pattern book which shows each shoe in its finished form. The company has a great variety of products, however, each one is from a standard lot.

Phases of routing.—There are several special purpose machines which can do an operation, however, the plant engineer routes orders so that no machine will have to be changed or set up to perform an altogether different operation than usual. To be sure, simple adjustments are necessary, however these cause no problem in routing. To avoid changes in machine setup,
the plant engineer sends orders over one of the production lines that does all of this type of work. If this is not possible, he waits until he has several orders that are similar and then sends them through in a series of batches. Each batch is similar or nearly similar in nature. Special setup time for machines is counted as part of the time necessary to produce an order. Special setup time is avoided if possible, because of the increase of cost in producing an order.

**Manufacturing orders.**—Material requisitions, movement of finished orders, and shipping orders are originated by the plant engineer upon the request of the various plant foremen. The stock room has a minimum inventory allowance, and when this is approached, the stock room foreman originates a material request, which is approved or disapproved by the plant engineer, and given to the purchasing department for procurement. Movement of all finished orders, or materials that are needed, are moved by move men who act upon the order of the plant engineer.

**Scheduling**

**Organization of scheduling.**—All scheduling of work is done by the plant engineer. Upon occasions the plant superintendent is consulted about some of the aspects of scheduling which will be discussed later. The start date is the only date that is assigned. The plant operates on a 15 day manufacturing cycle. Scheduling is done so as to have work scheduled for two weeks in advance of plant operation.
Planning for variable production factors.—If it becomes necessary to add extra personnel, extra shifts, additional machines, or overtime, this is done by the plant engineer and the plant superintendent. These two people are also the ones to decide whether to buy new tools, or other equipment. These extras are added to increase production and catch up with scheduling. Loss of schedule time is the main reason for these additions.

Relationship of foremen with scheduling.—All of the scheduling, with the exception of extra shifts etc., is done by the plant engineer. The foremen are not in any way consulted about setting a schedule. All extras are handled as mentioned above.

Assigning a time to a product.—The first step toward assigning a time to a product or order, is to find the operations necessary to produce it. This is done by consulting a route sheet for this operation. The route sheet shows each operation in the sequence in which they must be performed.

The next step is to find how much time it will require to perform these different operations. This data is taken from the time study records of the company. Each operation has a standard time for its completion. This time study information is not on the route sheets, however, the foremen may secure it from the plant engineer.

Machine capacity is figured as the third step. The number of hours a week or day that a machine may be expected to
operate is found. It is not necessary to find the time needed from process to process, because no time is lost by this movement of material.

As the fourth step, the stock room is called and asked if they have the necessary materials on hand to produce the order. If the stock room does not have the supplies, a material order is sent to the purchasing department, by the plant engineer, and the materials are ordered.

With these four steps in mind, the plant engineer maps out the schedule for the next series of orders. Assignment is not made to each department, but only when it will start the manufacturing process. As the parts move down the line, the schedule will work itself out for the various departments.

**Machine capacity calculations.**—Machines x Shifts x Hours per shift x Days of operation x Percent of efficiency = Hours of capacity. $4 \times 2 \times 8 \times 5 \times 75\% = 240$ hours of weekly capacity. Machine loads are shown on a master schedule sheet, which is revised from time to time, and shows which order is at what machine.

"Peaks" and "slumps" of production.—Production is never varied. The backlog of orders is always so large that there is never any lag in production. The production rate is a stable 15 day manufacturing cycle, which does not vary to any noticeable extent.
Dispatching

Organization of dispatching.—Dispatching is highly centralized. The organization structure consists of the plant engineer, who originates or approves all work papers, and the shop foremen, who do any dispatching that is necessary. The foremen of the departments secure any tools that are needed, assign workers to their tasks, and make out any material orders that are needed. For coordination of dispatching with production control, the foremen report directly to the plant engineer.

Tools and fixtures.—As mentioned in the above paragraph, the foremen of the departments secure any tools that are needed for production. These tools are drawn from the store room if the old tool is worn out or broken. In all other cases, the tools and fixtures are kept at the producing machine needing them.

Time stamping and move orders.—Only the start date for an order is scheduled. No time stamping is done in any fashion that will indicate the time a process is started or completed, after it leaves the first work station. The plant engineer controls the movement of raw materials to the first station, from then until the last, the foremen control the movement of material. The plant engineer does control the movement of finished orders. He does this by having move men take the finished orders to shipping or to the warehouse or stockroom. All movement of parts in process is done by the workers.
Assignment of work.—Work is not assigned to the individual machines by the plant engineer. The plant engineer assigns batches to the first work center, and from then, the assignment is automatic, or done by the foreman. If any special instructions are necessary for a particular job, the foreman gives them to the worker verbally, or has an experienced worker do the operation. Special instructions about a batch in general are given by the plant engineer.

Inspection.—Inspection is a separate department. All finished work must pass through the inspection department. 100% of all the orders are inspected. The normal amount of rejections has been determined, and should the rejections exceed these limits, the plant engineer makes an investigation.

The inspection department decides if a part is reparable or not. If it is not, the rejects are discarded. If the rejects are reparable, they are rescheduled, and routed to the place in the line that will repair them. They are not scheduled individually, but in batches. Each batch having a common fault that is to be repaired.

Lost production time.—Lost machine time due to worker absentees, which could be a bad hazard, is at a minimum and causes no serious problem. Very little time is lost from overloading the machines. When a machine is down, the maintenance people are notified, and repair is performed as quickly as possible. While the machine is being repaired, its operator is given some other kind of work. Occasionally, labor disputes
will cause a loss of machine time. This lost time is regained by overtime, or if necessary, by adding an extra shift. Should a series of lost time occur, the plant engineer makes an investigation, and tries to correct the situation.

Follow-Up

**Organization.**—Follow-up is very highly centralized. The plant engineer does his follow-up by a flow of papers to his office. The foremen in the shop do the follow-up of goods in process.

**Follow-up by foremen.**—The foremen do all of the follow-up in the shop. In addition to the follow-up function that the foremen perform, they are also responsible for the dispatching within their departments. Foremen can make changes in the schedule, if these changes will not interrupt the flow of work through the other departments. Changes in the schedule are made by the foremen, in most cases, to catch up with scheduling. The foremen make daily reports to the plant engineer about the progress within their departments. Should the plant engineer desire follow-up information on a particular item, he calls the foreman concerned and has him do the follow-up. The foreman will call the plant engineer by phone and give him the follow-up information that he has found.

**Centralized follow-up.**—The plant engineer does most of his follow-up by using a secondary flow of papers, plus the scheduling and routing information that is located in his office.
The notations that are made on the route sheets by the workers, and foremen are used as one means of follow-up. This route sheet is sent to the plant engineer when a department finishes its part of an order. The schedule forms that are sent to the plant engineer are another means of follow-up. The foremen make notations on the schedule forms and send them to the plant engineer. The plant engineer keeps all of this information in file cabinets, or loose leaf notebooks.

**Expediting orders and raw materials**—The plant engineer, through the purchasing department, does all expediting of materials. He causes expediting, by rushing the order through the purchasing department, or by having the purchasing department expedite the vendors' delivery.

Expediting of orders through the plant is done by the individual department foremen. No rush orders are accepted by the plant. All orders take the same time to go through the manufacturing process. The only need for expediting is to maintain the schedule, and the steady flow of material in process.

**Production reports**—The department foremen send in a behind-schedule report, if they cannot make the scheduling for their department. The foremen try to correct the cause of delay themselves, but if they cannot, this report is sent to the plant engineer.

The foremen send in a report of daily accomplishment. This report tells what was done by the department for that day. Other reports are made through the day, by calling the plant
engineer by way of the telephone, or sending route sheets and schedule forms to his office.

**Company B**

*Forecasting*

The forecasting of sales is done by the sales department. This department uses the reports that are sent to the company by its salesmen, and the records of past sales, to determine its sales forecast. From these two sources of information, the company tries to build a picture of total sales for some future period by combining the two reports.

*Routing*

**Plant planning and design.**—Before the plant was built, and any of the machinery was installed, a study of work flow was made. As a result of this study, two different production lines were planned and put into use. One of the production lines was designed to produce standard orders, and the other to produce special orders. The principle of straight line flow of material is used by both production lines. This type of work flow was produced by first determining the operations that were necessary to produce an order, and then buying the machines to perform these operations. The machines were placed so as to not interrupt the sequence of operations.

**Method of performing an operation.**—The method of doing an operation is determined by starting the work order at the
necessary point on the assembly line. The straight line flow of work causes the part in work to move from one machine to another in a more or less automatic fashion. When one operator finishes with his function, the next operator takes over and performs his function. The placement of the work centers and machines determine the method of operation.

**Route sheets.**—Route sheets are used, however, they do not list each separate operation. They list only the major operations that are necessary to produce an order. The production manager uses these major operations, that are listed on the route sheet, to determine how an order will be routed. He routes work in department size lots, with the exception of special orders. Special orders may be routed singly or collectively over the production line which has been designed for their production.

There are no time estimates given for the performance of the various tasks. The only time schedule to meet is the start and end date of an order.

**Job order routing.**—For special order routing, each order is routed as it is received. The plant has a special production line set-up for these special orders, and they are not produced over the line that does their standard orders. A complete description of the special order is formulated and broken down into the major operations necessary for its production. The production manager then routes the order to the various special order departments. The worker must draw upon his
knowledge of past operations in order to perform the necessary operations that he is to do.

**Phases of routing.**—The major item which decides the route plan is whether the order is a special order or a standard order. If it is a standard order, it is routed over the main production line. If it is a special order, it is routed over the special order production line. In either case, however, the work starts at the first work station and proceeds through the processes in a straight line fashion.

The foreman, in the first department, gets the route sheet from the production manager's office. He is not consulted about the routing, and the foreman cannot change the plan.

**Manufacturing orders.**—The production manager prepares all material requisitions, move tickets, inspection orders, and shipping orders. All of these orders with the exception of the material requisition, are released at the proper time by the department foremen.

**Scheduling**

**Organization.**—All scheduling is done by the production manager. He assigns the start and end date for all orders or lots. The foremen are not consulted about their schedule loads.

**Planning for variable production factors.**—The production manager decides if there will be any over-time, extra personnel, or extra shifts. He does this to speed production and increase output. As a rule, overtime work for the present employees
will take care of any need for extra production. The foremen are notified by the production manager of the extras, and the foremen tell the workers.

**Relationship of the foreman with scheduling.**—The foremen do not have anything to say about the scheduling for their departments. The production manager does all of the scheduling for the shop. The foreman makes frequent checks to see if work conforms with scheduling, however he cannot change any schedules at any time.

**Assigning a time to a product.**—To assign a time to a product, the operations that are necessary for its production are found. This is taken from past route sheets, and past experience. Next, machine capacity is found. This also is taken from past experience. The production manager has a capacity figure for each machine which is in the operation process. This machine capacity figure is the result of an estimate which is time proven. Next, the date when materials will be available, for the production on the order, is found. No time is lost when the material has entered the manufacturing process, so this is not considered. With all of this information in mind, the production manager works backward from the desired date of completion and sets the start date for an order. The end date for an order is determined by adding six weeks to the start date. The production manager releases the job order, and the other manufacturing papers to the cutting room, which is the first department, shortly before an operation is to begin. From this point, everything will work out in an automatic fashion.
Machine capacity calculations.--No calculations, by the use of a standard formula is used. The production manager has made a record of how much time was required to perform the various operations of manufacturing. From these past time figures, the production manager has set a variable time estimate as to how much machine capacity he can expect from each machine. The variable machine capacity is expressed in hours like 190-203 hours weekly capacity for a given group of machines.

"Peaks" and "slumps".--Production is varied very little during the year. The manufacturing cycle is six weeks, and there is very little variance from this figure. The chief method of stabilizing production, is to manufacture standard orders to stock. These orders are shipped to the various salesmen or customers during the Christmas rush seasons. All other demands for immediate orders are filled from this backlog of finished goods.

Dispatching

Organization of dispatching.--The dispatching is decentralized to the foremen. All of the work papers are originated by the production manager, and delivered to the foremen by his secretary. From this point, the foremen of the various departments do the dispatching, that cannot be handled in an automatic fashion.

Tools and fixtures.--The tools and fixtures that are necessary for the performance of an operation are kept at the machine or work center requiring their use. The foreman procures
any tools that are needed should the old one break, wear out, or need repair. The foreman has all machines repaired by the maintenance people, who operate from a pool.

**Time stamping and move orders.**—The time when an operation is started or ended is not recorded. As soon as an operator finished one order, there is another order waiting to be put into work. The production control manager controls the issuance of raw materials, job order instructions, and movement of finished goods. He does this by the issuance of a manufacturing order.

The movement of goods in process is done by the workers. When one worker finishes his operation on a lot of 24 pairs of boots, he pushes the rack or cart containing them, into the next work station. This procedure is carried on down the line, until the order is finished.

**Assignment of work.**—The work is not assigned to individuals either by the production control manager or the foreman of a department, except in the rarest of cases. The work will assign itself, as it moves from one work station to another. All instructions that the worker needs are contained in the manufacturing order. If the occasion should arise, the foreman will give special instructions to a worker that does not know how to perform a necessary operation.

**Inspection.**—Inspection exists as a separate department. There is a 100% inspection performed. After the last operation is performed and the order is completed, the boots move through
the inspection department. The inspectors determine if the order is satisfactory, and if it is not, the necessary corrective action is taken. The inspectors make a note of the corrective action to be performed, and take the reject to the repair department. This department corrects the flaw and sends the boat back to the inspection department. All orders are shipped to the customer or to the stock room, after the inspectors have passed on them.

Lost production time.—Little machine time is lost, due to any reason. The item that causes the largest amount of lost time is worker absenteeism. This does not create any serious problem, however, and it is not thought of as a bad problem. Machine breakdown causes very little lost time, because of the preventive maintenance and the rapid repairs that are performed. All repairs are made by the maintenance department. If the repairs will take more than a few minutes, the worker is put on some other type of work. Should there be enough loss of machine time to cause a delay of scheduling, an investigation is made by the production control manager.

Follow-Up

Organization of follow-up.—Follow-up is highly centralized. The production manager can find the department in which an order is located, by referring to the consolidated list of returned route sheets. For a special order that has become lost, he will call the foreman and ask if the lost order is in his department. He will continue calling foremen until the order is located.
Follow-up by foremen.—The different department foremen make frequent checks within their departments, to determine how the work flow is progressing. The foreman expedites all needed materials or job orders into his department, so that there will not be a delay in scheduling. For any order that is to be rushed, and placed ahead of previous work, the foreman receives his release of authority from the production control manager. This release of authority is in the form of a red tag, with the word RUSH printed upon it. To rush an order, the production control manager attaches this tag to the first page of the manufacturing order and sends it to the cutting room. Work is not rushed once it enters the manufacturing process.

Centralized follow-up.—A secondary flow of papers and a daily run sheet is used by the production manager to assist him with his follow-up. Schedule sheets and route sheets are returned to the production control department, when a department finishes with its function. The daily run sheet is used as a guide to what has been scheduled for that particular day. All the returned route sheets and schedule forms are compiled into a master report, by the production control secretary. This report provides a quick, easy way to compare production with scheduling, and to do follow-up.

Expediting orders and raw materials.—As previously explained, the production control manager expedites or rushes an order by attaching a red rush tag to the manufacturing order.
Any red tagged orders that come into a department are given special attention. The foreman will rush this order ahead of present or current production, and get it out of his department as soon as possible.

To expedite materials into the plant, the production manager will call the vendor by means of the telephone. The usual cause of delay is in the common carriers that deliver the goods to the factory.

Production reports.--The major report that is sent into the production control office by the foreman is his report of departmental accomplishment. This report is submitted to the production office one hour after work begins in the morning, and it tells what his department did during the past day. The foremen also send the route sheet or schedule form into the production control office, when they have finished the order or lot.

Any other report is telephoned into the production control office by the foreman. These reports include such things as behind schedule reports, and material shortages, or anything that is bothering the foreman.

Company C

Forecasting

This company does no forecasting of sales for any future period. The only forecasting that is done is the forecasting of the need for raw materials. This forecast is for a very
short term. The forecasting for raw materials is for a period of two weeks in advance of production.

Routing

Plant planning and design.--A complete study of plant layout and design was made before any machinery was bought or the plant was built. The machinery layout is the straight line type, and the building is constructed to conform to this type of production.

Method of performing an operation.--The straight line nature of the machine layout causes the method of doing an operation to be chosen almost automatically. Only on special jobs is special routing necessary. Even with special jobs, a lot of the routing is done in the same manner as with routine orders.

Route sheets.--The proper sequence of operations, for the manufacturing of an order, has been determined and a permanent record made. This route sheet lists every separate operation and the department that is to perform them. No time estimate is given for the performance of these operations.

This route sheet is composed of several coupons which are detached when the department concerned has finished its function. These coupons will be discussed in the follow-up sections of this case study.

Job order routing.--Some orders require special attention. These orders consist of odd size shoes, and special decoration
which the customer has ordered. When a special order is received, a preliminary study is made to determine what work will be necessary for its production. Usually, most of the work can be done in a routine manner. That which cannot, is routed to whichever work center or machine that is necessary. Special instructions are sent with this type of order, when it is put into work. The foreman can have whichever man he wants to do the work on this or any other order. The foreman can reroute the order, within his department, if he can improve upon efficiency of production.

**Phases of routing.**—The main point which determines routing, other than routine orders, is the comparative cost of setting up for the job. Routing is done so that a minimum of set-up time will be expended, and production can start as soon as possible. As much of the order as possible is sent over the regular production line; the rest is given special routing.

Routing is not influenced by previous scheduling of work for a machine. If the machine is overloaded, there is no change in the route plan. Work is still scheduled and routed over this machine, and not routed over an alternate work center or machine.

All routing is done by use of route sheets. These sheets list every separate operation that is to be performed. The operations are listed, in groups, by departments, and the production control director uses this information when routing work to the various departments. No work is routed to individuals, or individual work areas.
Manufacturing orders.--Manufacturing orders, such as material, move, inspection, and shipping orders, are originated and processed by the department foremen. The foremen requisition all material for their departments, and have one of their men get it from the stockroom and return it to their department. The foremen also issue move orders, so that one department will know when they can get more work from the department behind them. The foremen ship anything that is not going to the next department, to the storeroom. Inspection tickets are placed with the finished orders, and the inspectors use this as a means of identification and release of authority for inspection.

Scheduling

Organization of scheduling.--All scheduling is done by the production control director. His scheduling may be influenced by the plant foremen, if the various foremen have some valid reason for a schedule change. The starting and ending dates are assigned each order by adding eleven days to the day the order is put into work.

Planning for variable production factors.--When the various foremen receive the schedule of work that is to pass through their departments, they make an estimate of the number of people that will be needed, and how long it will take, in man hours, to do the job. If there are enough people to do the work, within the regular work period, nothing is done to get extra workers.
If overtime, extra personnel, or an extra shift is needed, the foreman concerned makes a request for these extras through the production control director, and they are granted or denied by him.

**Relationship of foremen with scheduling.**—The scheduling of routine orders is done by the production control director. If it becomes necessary to schedule more work than a department can perform, the foreman of that department assists the director in making provisions for extra personnel, or overtime. The foreman can make schedule changes within his department, if it does not cause a delay in the production line.

**Assigning a time to a product.**—Assigning a time to a product is performed by first finding the operations that are necessary to produce the order. This is taken from a route sheet.

With the sequence of operations in mind, the production control director estimates how long each department will take to perform its function. This is done in most cases, by a reference to past experience. Machine capacity is not figured by use of any formula, only estimates are given.

The stockroom is called and asked if they have the needed supplies on hand. If the stockroom does have the needed material, actual dates for production to start is determined. Otherwise, the needed materials must be procured through purchasing.
The production control director coordinates all of the necessary factors mentioned above, and sets a start date for production to begin. The end date is determined by adding eleven days to the start date.

**Machine capacity calculations.**--All machine capacity figures are estimates. There is no rule or formula that is used to calculate the various machine capacities. All estimates are taken from past experience, or company records showing about how long a department works to complete its function.

"Peaks" and "slumps".--Production is never varied. The same even rate of production continues through the season. If the plant is not working at full capacity to produce customer orders, production is made to stock.

**Dispatching**

**Organization of dispatching.**--The dispatching works almost automatically. All of the work papers move with the orders concerned, in the form of travelers. Most all of the reports are given verbally by the foremen to the production control director. Any written reports are delivered to the production control office by the foreman or one of his workers.

**Tools and fixtures.**--The tools and fixtures that are necessary for the performance of an operation are kept at the machine or work center. The only time new tools must be procured by the workers is when the old tool is worn out, broken, or being repaired. If, for these reasons a new tool or fixture
is required, the foreman gets them for the worker or has the maintenance people repair the old one.

Time stamping and move orders.--The time when an operation begins or ends is not recorded. There is no time stamping of any type used. The movement of materials is automatic. When one operator has completed his operation, the next operator takes the order and performs his operation. The operators are so near to each other that no time is lost in transfer of materials.

Assignment of work.--If any special instructions are necessary for a special job, the foreman explains and demonstrates how the job should be performed. No assignment is made as to the particular machine or work center that is to do a particular job. The work will assign itself, as it moves from one operation to another. This is due to the straight line nature of the machine layout. The department foreman, for special orders, will sometimes assign an experienced operator to do an operation that cannot be performed by the regular machine operator. For production control purposes, however, work is scheduled in department size lots.

Inspection.--Inspection exists as a separate department. All of the finished boots or shoes pass through the inspection department where a 100% inspection is performed. The inspectors decide if a boot or shoe is repairable or not. If the order is repairable, the inspectors make a note of the repairs that are needed, and send the order to the repair department.
This department makes any necessary repairs and places the boot with its original order.

Lost machine time.--Lost machine time due to worker absentees is negligible. At times, machine overloading causes a loss of machine time in areas following the overloaded machine. When a machine is down, the worker is put on some other type of work. If there is a lot of idle time caused by breakdown or worker absentees, the production control director makes an investigation, and tries to correct the cause of these delays.

Follow-Up

Organization.--Follow-up is highly centralized. The production control director does most of his follow-up by reference to records. The source of information, for these records, is the returned departmental stub which is torn from the route sheet when the department has finished its operations, and taken into the production control office by a worker, or by the foreman himself.

Follow-up by foremen.--As previously mentioned, the follow-up is highly centralized. The main source of information is a secondary flow of papers or forms. Another source of information is gained by having the foremen do all of the follow-up for their departments. If the production control director needs any information that he does not have, he calls the foremen concerned and asks about the order in question.
Expediting of orders and raw materials.--All expediting of orders and raw materials, that are within the plant, is done by the foremen. The foreman will rush an order if it is behind schedule, or upon the request of the production control director. The foreman makes any schedule changes that are necessary to expedite an order, and then notifies the production control office of the change. The foreman will also rush material from the stockroom to his department, or from another department to his own. Expediting materials into the plant is the job of the production control director. He does this by writing or calling the vendor, and asking for faster delivery.

Production reports.--The only formal production report used, is the coupon or stub that is torn from the route sheet and sent to the production control office. Any other report that is necessary is usually given verbally by the foremen.

Company D

Forecasting

No sales forecasting is performed. There is no forecasting for any period of time whatsoever. Any forecasting that is done is for material that will be needed in the very near future.

Routing

Plant planning and design.--No planning of machine layout
or of building design was performed. The company moved into a building that would provide enough space for the necessary functioning of their present operations. During the next few years, the company grew larger and needed more space. This space was gained by annexing buildings to the old plant. At present, there is evidence of straight line movement of goods in progress, however, much time and loss of capital was spent to accomplish this.

Method of performing an operation.—The method of doing an operation is determined by starting the work at the first work station. The present straight line method of machine layout causes the method to be determined, as the part moves from process to process.

Route sheets.—No route sheets are used whatsoever. The nearest approach to them is the job order that moves along the line with each order. The job order describes what is to be produced, but leaves the method of production and the sequence of operations to the worker.

Job order routing.—Job order routing is no different from the routine routing that is done. For special orders, the job order is sent with each order, and the operator of a machine or work center decides for himself what the sequence of operations will be, and how they will be performed.

Phases of routing.—When routing an order, all that is taken into consideration is, can the machine do the job, and
does the operator know how to perform the necessary operations. No account for machine set-up is considered. Routing all starts at one place, which is the first operation center of the production line. From this point the worker or the foreman does all of the routing.

Manufacturing orders.--Material orders are not used. When the foremen of the departments receive their job orders, they estimate the amount of materials that they will need. A worker is sent to the stockroom to get this material and deliver it to the department receiving station. No move orders are used; the workers do all of the movement of materials upon the request of the foremen, or bring new work into their area from the area below them.

Shipping orders are prepared by the production control department and sent to the finished stores stockroom. The stockroom will then send out the orders to the buyers.

Scheduling

Organization of scheduling.--All scheduling of work is done by the production control supervisor. To schedule the work for the various departments, the foremen of the departments are consulted as to when they can start on an order. The start date of the order is determined, and the end date is determined by adding 14 days to the start date. Work is scheduled by departments only.

Planning for variable production factors.--The plant
foremen are the people who decide if there will be any overtime, added employees, or extra shifts. They decide this by seeing how many work orders they have to do, and how long it will take to do them. If the regular work complement is not enough, or more time is needed, the foremen add these extras. The foremen then report to the production control supervisor, and tell him why they have added these extras.

**Relationship of foremen with scheduling.**--The foremen play a large part in the scheduling procedure. The production control supervisor schedules the work for the first operation, after he has consulted the foremen as to when they can begin on the order. The foremen can change the scheduling in their department at any time they wish. They should, however, try to keep production up, and flowing evenly.

**Assigning a time to a product.**--To assign a time to a product, the operations that are necessary to produce the product are not considered. The only factors considered are how long it will take each department to do the necessary operations, and whether the storeroom has enough material to make the order. The time that is necessary to perform an operation is estimated. The foremen use past experience for this estimate. Machine capacity is not calculated; only the time that an order must be in a department is estimated. If the stockroom cannot supply the production line with the needed material, an estimate is made as to when the material can be procured.

With the information that they have, the production
control supervisor, and the foreman of the first department will set a time that each order is to begin. After starting the order in the first department, the order will move down the line in automatic fashion.

**Machine capacity calculations.**—No machine capacity calculations are used. The machine loads are not figured, but estimates are made by the foremen. These estimates are drawn from past experience, as to how long a similar operation took at sometime in the past.

"Peaks" and "slumps".—Production is varied during the major holiday seasons such as Christmas and the rodeo season. A little production is made to stock, but most of it is made to customer orders.

The production cycle is generally the same; however, during the holiday seasons, the cycle fluctuates up and down with the amount of orders to be produced. No standard lot sizes are used. The lot may run from one pair of boots, to 36 pairs of boots, according to the "whim" of the production control supervisor.

**Dispatching**

**Organization of dispatching.**—The organization of the dispatching function consists of the production control supervisor, and the plant foremen. The production control supervisor originates all job orders and sends them to the first work center by an office clerk, or by delivering them himself. The foremen
of each department secure any tools that are needed, assigns workers to their tasks, and make out any material orders that are needed. For any coordination of dispatching with production control, the foremen report to the production control supervisor.

**Tools and fixtures.**—As mentioned in the above paragraph, the foremen of the departments secure any tools that are needed for production. These tools are drawn from the storeroom if the old tool is broken or worn out. The foreman gets the tools himself as needed. In all other cases, the tools and fixtures are kept at the production center needing them.

**Time stamping and move orders.**—The starting and ending date for an order is scheduled, however, no record of when an order actually started or ended is made. No time stamping whatsoever is used, in any fashion. Movement of materials is handled by the foremen, if the move involves the entire department. Otherwise, the workers move all materials such as goods in process, etc.; no formalized move orders are used.

**Assignment of work.**—Assignment of work is done by departments, for production control purposes. The foremen assign each individual to any special job that must be produced, otherwise, they work at their regular work stations. If any special instructions are necessary, the foremen give them to the workers verbally.

**Inspection.**—Inspection does not exist as a separate department. No definite personnel have been delegated as
inspectors. The workers at each work center act as inspectors, and decide if the part is repairable or not. If the part is repairable, the worker takes the reject to the past operator, or department, and has someone repair it. The reject then enters the normal work flow again, and moves on down the line. If the part is not repairable, the worker throws the boot away. No investigation is made if rejections exceed limits.

Lost production time.—Lost machine time due to worker absentees is at a minimum. The major cause of loss of machine time is overloading of departments or work centers, and shortage of materials. Overloading of work centers results from bad scheduling of work through the previous departments. Some machine time is lost when a machine is broken down. This is due to the fact that the workers on the different machines must do the minor maintenance on their machines. When major repair is necessary, the workers help the maintenance worker, stand around and watch, or are put on some other type of work. No investigation is made if a series of losses occur.

Follow-Up

Organization.—All follow-up is done by the foremen. Upon occasions, the production control supervisor will do some personal follow-up, to determine the status of a special order.

Follow-up by foremen.—The foremen do all of the follow-up in the shop. In addition to the follow-up function of the
foremen, they must also do all of the dispatching within their departments. Foremen can change schedules or routing of orders within their departments. The production control supervisor receives most of his information by talking with the foremen in the shop.

Centralized follow-up.—The only centralized follow-up that is performed is the return of the finished job order. No form or report is returned after each department finishes with its operation, with the exception of the last department. This department returns the finished job order to the production control supervisor.

Expediting orders and raw materials.—The foremen do all of the expediting of orders. They do this to try to stay on schedule, or to rush special orders. If a material shortage is impending, the foremen will notify the production control supervisor. The production control supervisor will order additional material, or write the vendor and ask for faster delivery.

Production reports.—No report is made about departmental accomplishments, unless the production control supervisor requests them. The only report sent in is the finished job order, which the last department sends in to the office.

Company E

Forecasting

The sales department does the forecasting for any future period. This department tries to build a picture of total
sales in some future period by summing up and combining estimates drawn from the sources of the company's business.

Routing

Plant planning and design.--Before the plant was built, and any of the machinery was installed, a study of work flow was made. The object of this work flow study was to try and cause a straight line flow of work as much as possible. This study was made by using a "series of operations" paper, which listed each operation that was to be performed. The plant engineering people then determined which machines would be necessary to perform those operations and how they should place them in the plant for an efficient work flow.

Method of performing an operation.--The method of doing an operation is determined by starting the work order at the necessary point on the assembly line. The straight line flow of work causes the part in work to move from one machine to another in a more or less automatic fashion. When one operator finishes with his function, the next operator takes over and does his work.

Route sheets.--After the proper sequence of operations had been determined, no permanent record of operations, in the form of operation sheets, was made. The production engineer is the only one to use the series of operation sheets, and he uses them to formulate his planning. The operator of a certain machine must be able to perform his operation by drawing upon his knowledge of how he did past operations of this type.
There are no time estimates given for the performance of the various operations. The worker has no time set to finish a particular job. The worker must stay busy and not loaf; other than this, there is no time requirement for the worker to meet.

**Job order routing.**—Each order is routed as it is released to the shop. When a sales order is received, a preliminary study is begun. The object of this study is to try to determine the most appropriate machine or production center to produce the order. Generally, there is a standard or most appropriate machine or production center to perform an operation. All of this routing is done by the production engineer, and any major change in the routing plan must be done through him. The foreman can, however, make simple changes in the route plan without the consent of the production engineer.

**Phases of routing.**—The major item which decides the route plan is the cost of setting up for the job. There are a great many general purpose machines and a few special purpose machines used by this plant. The production engineer tries to use the general purpose machines with less setup time, rather than to use a special purpose machine with a complicated set-up. The shorter the set-up time, the lower the cost of operation will be. Scheduling of previous work also has an effect on routing. If one work center is overloaded, or behind schedule, the work is routed over another route. The work will not be routed over another route, however, if
the cost of setting up for the operation is too high. Should it be too expensive to use an alternate route for an order, the order will be routed over the standard path, and produced for a later promised date.

The foreman receives his routing information from the office of the production engineer. No printed instructions are used; instead, all of the route sheets are hand written by the production engineer, and then sent to the shop.

Manufacturing orders.--In addition to preparing the route order, the production engineer also prepares all material and shipping orders. When work is routed through a certain department, material orders are also prepared. Shipping orders are prepared when the shop sends in a completed order form to the production control office.

Scheduling

Organization of scheduling.--All scheduling is done by the production engineer. Only the starting and ending dates are assigned to an order. This starting and ending date is determined by working backward from the promised date of delivery. Schedules for orders are also arranged so as to be integrated with the advertising of the retail stores.

Planning for variable production factors.--If it becomes necessary to add extra personnel, extra shifts, or overtime, this is done by the production engineer. He does this upon the request of the foremen or upon his personnel survey of the
situation. These extra shifts, overtime, or extra personnel may be added to speed the production of an order, or to regain lost production caused by breakdown or some other delaying action.

**Relationship of foremen with scheduling.**—The foremen do not have anything to do with the scheduling of work by departments. The production engineer, by his knowledge of the operations to be performed, can schedule the orders in the correct amounts to the various departments. The production engineer checks to see if a machine is overloaded by a personal reconnaissance, or by the report of the production foreman.

**Assigning a time to a product.**—To assign a time to a product, the first thing is to determine the operations necessary for the manufacturing of that product. This is done by reference to past experience, or company records. Next, the machine capacity is determined, and the number of hours a week or day that a machine may be expected to operate is found. With this done, the dates when materials will be available for the product to be manufactured are found. It is not necessary to find the time needed to move material from process to process, because the material moves such a short distance that no time is lost. Materials are procured by the production engineer and sent to the department that will be needing them, shortly before the actual production of an order is to begin. A time study for each operation has been made. This information is not available to the workers, nor is it available to the foremen.
This information is used by the production engineer when he makes out the schedules. By reference to this time study, the production engineer can schedule work for the different departments so that there will not be too much work allocated to any department.

**Machine capacity calculations.**—Machines x Shifts x Hours per shift x Days of operation x Percent of efficiency = Hours of capacity. \(3 \times 2 \times 8 \times 5 \times 80\% = 192\) Hours of weekly capacity.

Machine loads are shown in no graphic way whatsoever. The way machine loads are shown is by reference to past scheduling, or going out into the plant and looking around.

"Peaks" and "slumps" of production.—Production is not varied to any noticeable extent, from month to month. Production is scheduled so as to avoid "peaks" one month and "slumps" the next. This is done by producing to stock when there are not enough orders to keep production up. A daily run sheet is sent to each department, telling the department foreman what is to be done, or produced, for that day.

**Dispatching**

**Organization of dispatching.**—The dispatching system of this plant is highly centralized. The organization structure consists of the production engineer, who originates all dispatching papers, his secretary, who delivers all working papers to the department foremen, and the foremen who give the necessary papers to the workers. No dispatching offices are used, since the only active dispatcher is the secretary of the production engineer.
Tools and fixtures.--The tools and fixtures that are necessary for the performance of an operation are kept at the machine to do the operation requiring their use. If they are not at the machine, they are at the next adjacent machine.

Time stamping and move orders.--The time of starting and completing an operation is not recorded. When one order is completed, another order is begun as soon as possible. The production engineer controls the movement of all raw materials, issuance of instructions about an order in general and movement of the finished product. Movement of the parts in process is performed by the operators or department movement. The straight line nature of the plant causes the parts in process to be moved only short distances, and little time is lost due to their movement.

Assignment of work.--If the operator of a machine requires any special instructions, they are issued by the department foreman or leadman. This special instruction is done verbally. All dispatch papers are issued in department size lots. The foreman assigns work to the various machines or work centers in his department.

Inspection.--Inspection exists as a separate department. The inspectors do not work for the producing departments, but operate as a pool. All work must pass through an inspection station before it goes to finished stores. The inspectors also inspect 50% of all of the finished shoes. This department determines if rejects are reparable or not. Should rejections
exceed the desired limits, no action is taken unless the rejections continue over a long period of time.

Lost production time.—Lost machine time due to worker absentees, or excess rejections is negligible. Little or no time is lost from overloading of machines. Only a small bit of time is lost due to breakdown of equipment. When a machine is down, the operator of the machine is put on some other type of work. When the machine is repaired, the operator returns to his regular job. Should there be a series of delays due to idle time of men or machines, the production engineer makes a personal investigation of the situation, and then tries to correct the causes of the delays.

Follow-Up

Organization.—Follow-up is extremely centralized. The production engineer does most of his follow-up by reference to routing or scheduling records. If a job is lost in the plant, the production engineer will send his secretary out into the plant to find the lost order. When the secretary finds the order, she reports to him and he takes whatever action he deems necessary.

Follow-up by foremen.—The different department foremen may also do follow-up for their departments. The production engineer may call one of the foremen by telephone and ask about the disposition of a certain order. The foremen can make no schedule modifications unless they be very simple ones which will not disrupt the flow of work through the plant.
Centralized follow-up.—A secondary flow of papers is also used to assist the production engineer in his follow-up. Schedule forms and route sheets are returned to the production engineer when a particular department finishes the operation that they direct. Bulletin boards are also used by the production engineer to assist him in keeping track of work in process. On these bulletin boards are memos, master schedules, and returned work papers.

Expediting of orders and raw materials.—The production engineer does all of the expediting of parts in work, and materials into the plant. He causes faster production by changing schedules or adding extra shifts or personnel. He may also change the routing of an order so as to speed an order through the process. If there is a delay on the part of the vendor in getting raw materials to the plant, the production engineer sends a letter to the vendor and asks for faster delivery.

Production reports.—If the department foreman, for one reason or another, finds that he cannot meet the schedule on an order, he sends in a behind schedule report to the production engineer. At the close of each work day, the foreman also sends in a report of departmental accomplishments. All of these forms are collected from the various foremen in the shop by the production engineers secretary, who delivers them directly to him. The production engineer then makes any changes or takes whatever action he deems necessary.
Company F

Forecasting

Forecasting is done in a very simple manner. To find what the probable sales of the company will be in some future period, reference is made to company records. To find out the probable sales for some month or period in the future, the company finds what their sales were for that period during the past year. Revisions of this forecast are made by the opinion of top management as to whether sales will go up or down.

Routing

Plant planning and design.--Several years ago when this company was very small, it was moved to its present location. Production was limited to the labor of three workers, who were the founders of the company. As the company grew and more workers and machines were needed, modifications of the building and rearrangement of equipment was performed. At present the company has three floors. The first floor is a retail and wholesale store, the second is the factory part of the building, and the third is a storehouse of finished orders and raw materials. Arrangement of the machines and work centers are now in a single phase, straight line order.

Method of performing an operation.--The method of doing an operation is determined altogether by starting all work at the first work station. Because of the pure straight line manner of manufacturing of goods, the routing is automatic.
Units of twelve pairs of boots or shoes move from one operation to another until they are finished.

**Route sheets.**—Route sheets are nothing more than a description of what is to be done. These route sheets do not list each separate operation, nor do they give a time estimate for each operation. The operator of a machine or work center decides for himself how he will do the required work. In almost all cases, however, there is a standard way to perform an operation, by the use of a tool or machine that has been adapted to do this type of work.

**Job order routing.**—When producing to customer orders, the sequence of operations is not changed to any noticeable extent. It is quite possible for one lot of shoes or boots to consist of twelve different types and styles altogether. To produce these, a route sheet, which is nothing more than a job order, is sent with each pair as it moves throughout the manufacturing process. The operator of the machine follows the description of the shoes that is given by the route sheet, and completes the lot. Even though the lot is actually twelve different orders, it is processed as if it were one.

**Manufacturing orders.**—Material orders are made by the storekeeper of raw supplies, and approved by the factory superintendent. Requisitions from the departments or work stations are kept to things such as needles, thread, and other things of this type. The major part of the materials move from work station to work station and only very minor things must be procured by the worker.
Shipping orders are prepared when the line finishes a batch or lot. These orders are either stored in the warehouse, put on sale in the first floor shop, or shipped to the buyer.

Scheduling

**Organization of scheduling.**—All scheduling is done by the production supervisor. Only the starting and ending dates are assigned to an order. These dates are determined by working backward from the promised date of delivery. For large size orders, schedules are arranged so as to be integrated with the advertising of the retail stores buying them.

**Planning for variable production factors.**—If it becomes necessary to add extra personnel, extra shifts, or overtime, this must be approved by the owners of the company. The production supervisor makes his request directly to the owners of the company. If they think that it is necessary, these extra items are approved. The need for anything except overtime does not occur very often. The only time when extra work must be added is around Christmas time, and during the stock show.

**Relationship of foremen with scheduling.**—For small lots, the foremen are not consulted as to the scheduling for their departments. If a large order should be placed with the company, the foremen are consulted as to how many men will be needed, any extra hours of overtime, or if the order can be handled as always. The foremen also help to set a promised date of delivery.
Assigning a time to an order.--To assign a time to a product, the operations necessary to produce the order are evaluated. This is done by reference to past experience. The most complicated orders are usually combinations of standard operations. Next, the machine capacity is determined, and the number of hours a week or day that a machine may be expected to operate is found. The stockroom is asked if they can deliver the necessary materials, and if they cannot, the dates when the materials can be procured are found. No time is lost by movement from process to process, so this will cause no interference with scheduling. No time study has been made. The production supervisor can, however, estimate approximately how long a job will take. With these factors in mind, the production supervisor will assign a time for production to start and end on a particular order.

Machine capacity.--The formula to find machine capacity follows: Machines $\times$ Shifts $\times$ Hours per shift $\times$ Days of operation $\times$ Percent of efficiency = Hours of capacity.

\[ 1 \times 1 \times 8 \times 5\frac{1}{2} \times 85\% = 37.40 \text{ hours of weekly capacity} \]

Machine loads are not shown graphically. The way machine loads are shown is by reference to past scheduling, or at the production centers themselves.

"Peaks" and "slumps" of production.--Production is varied at only two times. One of these times is during the Christmas season, and the other time is during the fat stock show. These two periods cause an increase in production, and plant operation
is stepped up. During the rest of the year, production is stable. The line has enough orders to fill to keep production at a steady pace at any time other than the two holiday seasons.

Dispatching

Organization of dispatching.--The dispatching works almost automatically. All of the work papers move down the line with the order being produced. Any of the papers, such as departmental reports, are delivered to the production supervisor by the foremen. Most of the reports are very simple, and are given verbally, at times, by the foreman.

Tools and fixtures.--The tools and fixtures that are necessary for the performance of an operation are kept at the machine or work center. The only time new tools must be procured by the workers is when the old tool is worn out, broken, or being repaired. If for any reason a new tool or fixture is required, the foreman gets it for the worker or has the maintenance people repair the old one.

Time stamping and move orders.--The time when an operation begins or ends is not recorded. There is no time stamping of any kind, the only record of time is the day when an order is completed. The movement of materials is automatic, because of the straight line nature of the plant. No release of authority is necessary for the movement of parts in process or finished orders. The workers themselves move all material. They move the parts in process from the preceding work center
to their work center. The workers obtain all material that is necessary for the operation they are to perform.

**Assignment of work.**—If any special instructions are necessary for a special job, the foreman explains and demonstrates how the job should be done. No assignment is made as to the particular machine or work center to do a job. As the work flows from one position to another, the work will more or less assign itself. This is due to the fashion by which the work flows evenly down the line.

**Inspection.**—Inspection exists as a separate department. All of the finished boots or shoes pass through the inspection department where a 100% inspection is performed. The inspectors decide if rejects are repairable or must be discarded. If the rejected boot or shoe is to be repaired, the inspectors make a note of the action necessary to repair the order and have the foreman start it at the necessary point on the production line. Should rejections exceed the desired limit, no action is taken unless the rejections would cause a considerable loss of money or production time.

**Lost production time.**—Lost machine time due to worker absentees, which could be a serious thing is negligible. Very little time is lost from overloading of machines, or breakdown of equipment. When a machine is down, the worker is put on some other type of work. If there is a lot of idle time caused by breakdown or worker absentees, the owner of the company makes an investigation, and tries to correct the cause.
Follow-Up

Organization.—Follow-up is highly centralized. The production supervisor does most of his follow-up by reference to records. Schedules and completed order forms constitute the major items of follow-up. Should an order be lost, the production supervisor himself will go to the production line and locate it.

Follow-up by foremen.—To insure the smooth flow of work within his department, each foreman makes frequent follow-up and checks to see how production is progressing. The foremen can make schedule changes within his department. These changes are made to rush special orders through the plant, or to cause better departmental efficiency.

Centralized follow-up.—As previously mentioned, the follow-up is highly centralized. The two main sources of information being a secondary flow of papers, and information gained from the foremen by the production supervisor. The secondary flow of papers are in the form of notes on schedule sheets, and returned job orders.

Expediting of orders and raw materials.—Expediting of orders is done by the production supervisor, with the cooperation of the foremen in the plant. If the production supervisor has an order that he wants rushed, he goes to the shop and has the foreman change the scheduling on the work that he is doing. The foremen then rush the order through their respective departments, and the production supervisor changes the
scheduling on orders that have not been put into work. The production supervisor is responsible for all expediting of materials into the plant. This is done by calling the vendor by phone, or by writing a letter and asking for faster delivery.

Production reports.--Behind schedule reports are sent to the production supervisor by the foremen when they realize they cannot meet the schedule. The foremen in the plant try to avoid dropping behind schedule by changing the schedules within their departments, or by some other method. At the close of each day, each department foreman sends in a departmental accomplishment report to the production supervisor. These reports are delivered to the production supervisor by the foreman concerned, or by one of the men in his department.

Company G

Forecasting

Forecasting is done in a very simple manner. To forecast the sales for some future period, reference is made to company records. These company records show what sales were in the past, and the company plans to sell the same quantity during the corresponding period in the future.

Routing

Plant planning and design.--No plant planning was made. The company does not have a large volume of output, nor a large number on the payroll. This being a small scale company,
any building that is large enough to house the company will provide ample space, and will not hinder production. Very few machines are used. A large majority of the work is done by hand. The machines that are used are not in straight line order, but are grouped or placed at various production centers.

Method of performing an operation.--The method of performing an operation is determined by the worker. The worker reads the job order, and decides for himself how an operation will be performed.

Route sheets.--No route sheets are used in any fashion. The job order describes the boot to be produced and the worker decides upon the sequence of operations, and how to do them. There are no time estimates for the various tasks.

Job order routing.--All routing is done on a job order basis. Each order is routed to the shop, as it is received from the customer. A large majority of the orders consist of single unit orders. The orders may range from one pair of boots to any number. When an order is received, a description of the boot is made, and put with the orders that are to be worked. No preliminary study of the order is made.

Manufacturing orders.--The only manufacturing order that is used is the job order. Material, move, inspection, or any other type of order is not used. When a worker finishes an order, he places it in a bin with other finished orders. The owner of the plant inspects the boots and has them sent to the various buyers.
Scheduling

Organization of scheduling.—No scheduling, that is formalized, is used. The orders are put in a file, in the order that they are received from the customer. The owner of the plant releases these orders to the worker, as the worker finishes the order that was previously assigned to him. No starting or finishing date is assigned to a product. Estimates are sometimes made as to when an order will be completed, if the customer requests.

Planning for variable production factors.—If it becomes necessary to add extra personnel, extra shifts, or overtime, this must be approved by the owner of the company. Usually, the need for overtime is seen by the worker. The worker tells the owner of the plant why he thinks overtime is necessary, and if the owner thinks the reason is good enough, the overtime is granted. Occasionally, the owner of the plant will authorize overtime to rush orders through the plant.

Relationship of foremen with scheduling.—The owner of the plant acts as the foreman. He does all of the scheduling, and routing of work to the workers. The owner-foreman, must approve all material purchases, and extras that are to be used.

Assigning a time to a product.—To assign a time to a product, the operations necessary to produce the product are not considered. The time that it will take to do the various operations is not estimated. The method that is used sets no time for starting or ending work on an order. As the orders
come into the plant, they are filed in the same order that they are received. If several are received at once, the small orders are placed first in the file. The first order in the file is sent to the shop, and when that order is near completion, the second order is released, and so on through the file. No starting or ending date is given. Estimates may be obtained from the owner of the plant, about these dates, if the customer requests them.

The material requirements for an order are not specified, the worker makes all material estimates, and gets them from the raw material supply. No form or release of authority is necessary for the worker to draw materials, since no supply personnel are used. The materials are kept in an open bin and all the worker has to do is pick them up and take them to his machine or work center.

**Machine capacity.**—Machine capacity is not figured or estimated unless the customer requests the date of delivery of his order. Even when the customer requests a delivery date, the owner-foreman makes a general estimate as to how long it will be until work will start on the order. The owner-foreman makes his estimate as to when the order will be completed by guessing how long it will take to complete the order after it enters work.

"**Peaks" and "slumps".**—Production is constantly being varied. The time that production is the most varied is around Christmas. No effort is made to produce stock in large enough orders to stabilize production.
Dispatching

Organization of dispatching.--The dispatching function consists of the owner-foreman handing the job order to the worker. The worker sometimes performs a part of the dispatching function by reporting to the owner-foreman about some condition in the shop.

Tools and fixtures.--The tools and fixtures that are necessary for the performance of an operation are kept at the machine or work center. The only time new tools must be procured by the worker is when the old tool is worn out or broken. The worker gets all tools that he needs by going to the stock bin and getting them. If his machine is broken down, he fixes it himself, or has one of the other workers fix it. No maintenance people are used.

Time stamping and move orders.--No time stamping or recording is used. Also, no move orders are used. The worker moves all goods in process, from his work center to the next, as soon as he finishes his operation.

Assignment of work.--All assignment of work is done by the owner-foreman. This assignment is made when the owner-foreman takes the job order to the shop and puts it in work. If any special instructions are necessary, he gives them to the worker personally.

Inspection.--Inspection is performed by each worker. He inspects the work of the preceding worker, and if he finds something wrong with the part, he takes it back and has the
worker fix it. No action is taken if rejections exceed the desired limits. The rejected part is almost always repairable, and is rarely if ever thrown away or used for scrap.

Lost production time. -- The major item of lost production time is worker absentees. These absentees are caused by illness, in a majority of the cases; however, the loss of production is still felt. Overloading of machines or machine breakdown causes very little loss of time. Occasionally, a material shortage will cause a loss of production time on one order. This is not serious because work can be shifted to another order for which there is material. No investigation is made if there is excessive loss of machine time, unless it continues for a long period.

Follow-Up

Organization of follow-up. -- Follow-up is very simple. Any follow-up is done by the worker or the owner-foreman. The workers send in to the office the finished order form, or they tell the owner-foreman the status of an order. The owner-foreman makes some personal follow-up, however most of it is done by the worker.

Expediting of orders and raw materials. -- The owner-foreman can rush special orders, by moving them toward the front of the job order file. If he wants it to be put into work next, he puts the order in the first position. By moving the order toward the front, he can cause the order to be produced earlier.
No expediting is done of goods in process. The owner-foreman does all of the expediting of goods into the plant. To do this, he writes the vendor and asks for faster delivery.

**Production reports.**—The only production report that is used is the returned job order. No other regular report is submitted. If the worker wants a new tool that is not available at the shop supply, he goes directly to the owner-foreman and puts in a request for the item. Only this type of production report, other than the returned job order, is used.

**Company H**

**Forecasting**

Sales forecasting is done by reference to records of past sales. These records show what sales were in the past, and the company plans to sell the same quantity during the corresponding period in the future.

**Routing**

**Plant planning and design.**—Until recently, no plant planning was performed. However, the need for expansion caused the company management to perform such a study. The result of this study was to relocate some of the machines, and to put some new machines into the manufacturing process. These machines were placed so as to be in a straight line order, by special groups of machines.

**Method of performing an operation.**—The method of performing
an operation is determined by the line superintendent, who routes the orders to the various departments. Within the department the foreman does the routing, by sending the order to the appropriate machine or work center. The worker, using the machine to which he has been assigned, performs his part of the operation by using past experience.

**Route sheets.**—No form is used which lists each separate operation. The line superintendent, by his knowledge of what must be done to produce an order or lot, routes the work to the various departments that can and do perform these operations. As mentioned previously, the routing is done by department by the line superintendent, and by machine by the foreman.

**Job order routing.**—For special orders or for single orders, the routing is similar to that which is done normally. The difference in routing is performed by the line superintendent. He reviews the work that is in progress, and tries to route the special order over a similar route. If this is not possible, he will route a single order or special order in the same way that he would route the standard order, being careful to note the special work that is to be done.

**Phases of routing.**—To route an order the line superintendent has to consider several things. First, he must review the work in progress. This is done to see if he can route the order or lot over a path that has been set up for this type of work. This cuts down on machine set-up time and cuts down on
the cost per order. He then determines if there are enough men in the department to handle the order, and sees if there is ample material available. With these points in mind, he selects the route that can fulfill these requirements most effectively. After selecting the most efficient department, he sees how much work is scheduled for the department. If it is overloaded, he gives the work to the next best department.

Manufacturing orders.--To notify each department of the work that they must do, a simple handwritten form is sent to the foremen. This information may be written on the job order, or on a separate piece of paper in the form of a memorandum.

Material estimates are made by the line superintendent, but they are not listed on the job order. The foreman must make his own estimate of the material needs. This is done so that the foreman can use any material that was left over from a previous order. One of the workers in the department will then get the necessary materials and return them to the department.

Shipping orders are prepared by the last department in a manufacturing process. A copy of the shipping order is sent to the line superintendent as an information copy.

Scheduling

Organization of scheduling.--Scheduling of work starts with the line superintendent. He schedules work in department size lots only. Schedule modifications are made within the
departments by the foremen. The line superintendent schedules only the start dates.

Planning for variable production factors. -- Planning for overtime, extra shifts, or extra personnel is done by the line superintendent and the foremen. The foreman makes a request for these extras, and if the line superintendent thinks they are necessary, the extras are added.

Relationship of foreman with scheduling. -- The foreman cannot influence the amount of work that is scheduled for his department. The line superintendent will not overload a department, unless he thinks that it is necessary. If the department is overloaded, the foreman cannot change it.

Assigning a time to a product. -- Assigning a time to a product is performed by referring to its routing, and finding the operations that a department must do to produce it.

The next step is to estimate how long it will take for each department to perform the necessary operations. No calculations by use of formulae are used. These estimates are taken from past experience that the line superintendent has had with similar orders.

The materials that are necessary to produce an order are estimated, and a check is made to see if the stock room can supply them. If the stock room cannot supply them, the date is found when the materials will be available.

Machine capacity calculations. -- No calculations are made. All the information about machine capacity is in the form of
estimates that are made by the line superintendent. He makes his estimates by his knowledge of similar orders that were done in the past.

"Peaks" and "slumps".—Peaks and slumps are handled by two different methods. To help control peaks, production is made to stock. This production to stock, however, is very limited and cannot prevent peaks from occurring. To produce orders during the peak seasons, new employees are hired and overtime is given to the other workers. When the peak is over, the new employees are discharged, and no overtime is given to the other workers.

Dispatching

Organization of dispatching.—The dispatching is done by the department foremen and the line superintendent. The line superintendent originates all work orders, and the foremen come to his office to get them. Once within the department, the work papers move with the order from one station to the next in an automatic fashion.

Tools and fixtures.—The tools and fixtures that are necessary for the performance of an operation are kept at the machine or work center. The only time additional tools must be procured by the worker is when the old tool is worn out, broken, or being repaired. If for any of these reasons a new tool or fixture is required, the foreman gets them for the worker from the supply room.

Time stamping and move orders.—The time when an operation
begins and ends is not recorded. There is no time stamping of any type used. The movement of materials is automatic, once they have entered the manufacturing process. When the operator has completed his operation, the next operator takes the order and performs his work. The work stations are so near to one another that no time is lost in transfer of materials.

**Assignment of work.**--The foreman will not assign an order to a definite worker, since the work will assign itself as it moves through the department. The foreman will sometimes assign an experienced worker to some special order, so that it will be more efficiently performed.

**Inspection.**--Inspection exists as a separate department. Although the department consists of only two men, it is a separate department. The inspection department performs a 100% inspection. This department decides if a pair of boots is repairable or not. If the order is repairable, the inspectors make a note of the repair that is necessary, and take it to the foreman concerned. The foreman then puts the order into the work flow, and it is repaired. After being repaired, it is sent to the inspection department again for their approval or disapproval.

**Follow-Up**

**Organization.**--Follow-up is not centralized. To find the status of an order, the line superintendent must go to the shop and look around, or ask a foreman.
Follow-up by foremen.—A majority of the follow-up is performed by the foremen. The foremen make frequent checks of the work within their departments to insure a smooth flow of work. As previously mentioned, the foreman can make schedule or routing changes within his department, if it will increase departmental efficiency, or rush orders through the process.

Centralized follow-up.—This form of follow-up is not used to any noticeable extent. The only possible type of centralized follow-up that is used is when the last department informs the line superintendent that they have shipped or are ready to ship an order.

Expediting of orders and raw materials.—The expediting of orders is done by two levels of supervision, the line superintendent and the department foremen. Actually, the foreman does all of the expediting. He may act upon the request of the line superintendent when doing the expediting, but he is the one that rushes the order through the department.

Expediting of raw materials is performed by the line superintendent. He does this upon the request of the stock room, the department foreman, or upon his own initiative. To do this, he writes, or telephones the vendor and asks for faster delivery.

Production reports.—No production report, other than the shipping report is regularly used. If the line superintendent wants some report about a particular department, he will talk to the foreman concerned, or have the foreman submit a report.
to him. Most of the production reports are verbal, from the
foreman to the line superintendent.

Company I

Forecasting

Sales forecasting is not performed for the entire year,
but for special periods during the year. These periods are
not holiday seasons, but are periods during the year when
the need for their product increases. The sale of shoes
increases a bit during the Christmas season, but not to any
great extent.

Routing

Plant design and planning.—No planning of machine layout
or of building design was performed. The company, because of
their small number of employees and machines, can utilize the
space of most any building similar to those found in small
towns. Machine layout is not straight line, but grouped
according to the operation they perform.

Method of doing an operation.—The method of doing an
operation is determined by the worker. The worker reads the
job order and decides for himself how to perform the necessary
operations.

Route sheets.—No route sheets are used. The job order
describes the shoe, and the worker decides upon the sequence
of operations as well as the method of operations. There are
no time estimates for the various tasks.
Job order routing.--Job order routing is no different from the routine routing that is done. For special orders to customer specifications, the job order is sent with each pair of shoes. The worker decides how to produce the order, after it is given to him by the owner-foreman.

Phases of routing.--When routing an order, all that is taken into consideration is can the machine do the job, and does the operator know how to perform the necessary operations. Machine set-up is not considered. Routing starts by the owner-foreman giving the job order to the operator. The operator is chosen by the amount of work that he has before him. If he has a lot of work to do, some other operator will get the job order. If all of the workers are busy, the work is sometimes farmed out to the ladies of the town that can knit or crochet, and the worker is put on another type of job.

Manufacturing orders.--The only simlance of a manufacturing order is the job order. No other order or form is used. Any release of authority that is needed, other than the job order, is received verbally from the owner-foreman.

Scheduling

Organization of scheduling.--All scheduling of work is done by the owner-foreman. He schedules the work to the individual, or to groups of similar machines.

The starting and ending dates are not assigned. The orders are given to the operator in the sequence that they are to be
produced. When the operator finishes with the top or number one order, he goes to the next.

Planning for variable production factors.---The owner-foreman plans for all overtime or extra personnel that will be needed. He adds these to speed production or to obtain a larger volume of goods.

Relationship of foreman with scheduling.---The owner-foreman does all of the scheduling. He does all of the scheduling for overtime, extra personnel, and release of job orders. The worker is not consulted about how much work he has assigned to him.

Assigning a time to a product.---The factors that are considered when assigning a time to a product are promised delivery date, time required to produce an order, and materials that are available. A promised delivery date is not given on all orders. The owner-foreman first estimates how many man hours will be needed to produce an order. He makes this estimate from past experience. Next, he sees if there are ample materials to produce the order. With the answers to these questions in mind, he places the order on top if the promised date of delivery is near, and toward the back if the delivery date is further away. No time is assigned for it to begin or end; only the sequence it is to be put into work is determined.

Machine capacity calculations.---No machine capacity calculations are made. To produce a given order, the owner-foreman estimates the time that will be required to produce the order.
All estimates are taken from his experience as to how long each order will take.

"Peaks" and "slumps".--Production is varied during the year. These production peaks are handled by employing more personnel. The slumps are handled by letting the extra employees go.

Dispatching

Organization of dispatching.--The organization structure consists of the owner-foreman, who delivers the job order to the worker, and the workers, who make any necessary reports to the owner-foreman. The workers also do any dispatching function necessary, after they receive the job order.

Tools and fixtures.--Tools that are required to perform an operation are kept at the various work centers or machines. If a tool replacement is necessary, the worker gets it himself from the tool supply bin. If the tool supply bin has expended its stock of a particular tool, the worker requests that the owner-foreman procure a new supply.

Time stamping and move orders.--The starting and ending date for an order is not scheduled or recorded. No time stamping of any kind is used for an order.

Movement of all materials is performed by the individual worker. His release of authority to move materials is the job order.

Assignment of work.--Assignment is made by the owner-foreman
to the individual operator, except in rare cases where the order is assigned to several individuals. The owner-foreman gives any special instructions that are necessary.

**Inspection.**—Inspection does not exist as a separate department. The inspection is done by the individual worker and the owner-foreman. If a part is rejected, the worker will take it to the person that performed the operation and have it corrected. The owner-foreman decides if there are too many rejections or not, and if he decides that there are, he tries to correct the situation himself.

**Lost production time.**—Very little production time is lost. The time that is lost results from worker absentees, and shortage of materials. An investigation is not made if a series of lost time occurs.

**Follow-Up**

**Organization.**—Follow-up is performed by almost everyone in the plant. The owner-foreman and the workers do the follow-up that is necessary.

**Follow-up by foremen.**—The follow-up that is done by the foremen consists of going out into the shop and talking to the workers. The owner-foreman, by using the information he has received from the worker, can locate any order.

**Centralized follow-up.**—Follow-up is not centralized. Instead, the follow-up is highly decentralized. Information is gathered from each worker, or by the owner-foreman going out to the shop and looking around.
Expediting orders and raw materials.--The owner-foreman does all of the expediting of goods in process, and goods to be scheduled for work. He does this by moving the rush order toward the front of the stack of job orders. This causes the order to be put into work at an earlier time, and causes the order to be produced more rapidly.

The owner-foreman expedites materials into the plant by writing to the vendor and asking for faster delivery.

Production reports.--No report is made about individual accomplishment, nor about departmental accomplishment. Any report concerning production is given to the owner-foreman by the worker, upon the request of the owner-foreman.
CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

From the findings of the preceding chapters, certain general conclusions may be drawn. These conclusions will be grouped according to the five divisions of production control. These five divisions are forecasting, routing, scheduling, dispatching, and follow-up.

From the nine companies studied, only four had personnel that were strictly production control in their functions. These companies were the companies above the 25-49 category. The companies below this level combined the production control function with other duties, such as supervision of production and its workers.

One point worth mentioning is the amazing amount of mass production techniques that are utilized. Even though the orders differ considerably in their appearance, the operations to produce them have been almost entirely standardized. This caused the production to be nearer to the continuous than the intermittent type of production.

On the following pages are found the conclusions and findings of the survey of nine shoe producing firms.
Forecasting

The forecasting of future sales is performed, in a majority of the cases, by a reference to past sales. To find the probable sales for a period of time in the future, the company finds what the sales were for that period of time in the past. The company then assumes that the sales will be nearly the same.

Routing

Plant planning and design.—The findings of this survey indicate the most workable plans concerning the plant and its design were formulated and used by the companies above the 25-49 category. The companies below this level made very little planning for expansion or machine layout. These small companies have now seen the advantages of plant planning and have modified their buildings and machine layout, so as to cut production costs and increase the rate of production. Without exception, all of the plants have a pure or modified-pure straight line flow of materials in process. Machine groupings are by departments, and the departments are arranged so that work will flow from one department to the next, in a straight line method of movement.

Method of performing an operation.—In the companies above the 25-49 level, the method is determined by the straight line method of machine layout. Below this, it is a combination of worker know how, and the straight line flow of materials.
Route sheets. -- Route sheets, which listed each operation to be performed, were used by only one company. This company was in the 250-499 category. The companies in the 100-249 group used route sheets that listed only the major operations. Companies below this level used the job order as the route sheet and allowed the foremen or the worker to determine the sequence and method of operation.

Job order routing. -- Job order routing was performed in all companies, for the production of special or odd customer orders. This routing consisted of routing each order as it was received. In only one company were the orders placed in batches before they were sent to the production line.

Phases of routing. -- In the large companies, the routing was determined by the straight line flow of work. In the smaller companies, the route plan was constructed so as to cut down on machine set-up time. To formulate a plan for routing, these points were considered: operations necessary to produce an order, time required, workers available, and materials on hand.

Manufacturing orders. -- Manufacturing orders for the large companies of 100 employees and above consisted of the following: route, job, material, shipping, and movement of finished goods orders. These orders originated by the production control office and given to the foremen who use them as release of authority to perform their departmental functions.

In the smaller group, the production control office, or
the person performing the production control function, issues only the job orders. All other orders are originated by the foreman, or the worker.

Scheduling

Organization of scheduling.—In all of the companies, the scheduling is performed by the production control office, or the person that is performing the production control function. In the large companies, the starting and ending dates are assigned. In the smaller companies, the foremen of the departments release the work to fit the department needs, or let the workers do their own scheduling for individual orders.

Planning for variable production factors.—Variable production factors are: extra personnel, extra shifts, additional machines, and overtime. The need for these extras is determined by the production control office, in the 250-499 and the 100-249 categories. Below this level, the foremen and the production control man determine the need for extras.

Relationship of foremen with scheduling.—In the top two categories, the foremen are not consulted as to the scheduled start and end dates for orders that will pass through their departments, and they cannot change it.

In the small companies, the foremen play a large part in the scheduling function. The foremen can change the scheduling of work, if it is within their department. The foremen can also have scheduling changed, by telling the person that is
acting as the production control man, the reason scheduling must be changed. In the 3-2\frac{1}{2} category, the worker schedules all of his work, with the exception of the sequence to which each order is to be produced.

Assigning a time to a product.--In the large companies, such as the 250-499 and the 100-249 categories, the starting date is determined, and the number of days in the manufacturing cycle added to this to obtain the end date.

To assign a start date to a product the following points are considered. The operations that are necessary to produce an order are taken from the route sheet. The time study is consulted to determine the time requirement for the production of the order. If there is no time study for the operations, the production control manager estimates the time that will be needed. The stock room is called to see if they can supply the materials for the order. All of these factors are coordinated, and the start date is set at the earliest available date. Assignment is made without reference to the foremen. All work is issued in department size lots, unless it is a special order. Special orders are assigned individually.

The smaller companies have conferences with the department foremen, and work out the start date by determining how much time it will require to produce an order. The previous scheduling is reviewed, and the earliest available date is set for the start date. The end date may be estimated, however, the manufacturing cycle is not constant and cannot be added to the start date to obtain the end date.
In the 25-49 category there is somewhat the same type of time assignment that is used by the 8-24 category. In the 8-24 group, there is no start date or end date set. The orders are arranged in the order that they are to enter production, and when the top order is finished, the next order is started.

Machine capacity calculations.—The only company to use a calculated machine capacity, by use of a formula, was the one in the 250-499 group. All of the other companies made estimates, which were based on past experience.

"Peaks" and "slumps".—In the top three categories, "peaks" and "slumps" are controlled by a backlog of orders from customers, or by producing to stock. Production is not varied greatly during the year. If any adjustment is made, it is to give overtime to the present employees.

In the last two categories, "peaks" and "slumps" are not controlled to any effective degree. To produce to meet "peaks", new employees are hired and overtime is given to the regular employees. No or little attempt is made to produce to stock. To cope with the "slumps", production is cut down, and the new employees are laid off.

Dispatching

Organization of dispatching.—The production control office, in the 250-499 and 100-249 categories, does all of the dispatching from their office to the foremen by using the production control secretary. The orders move with the goods in process, in an automatic fashion throughout each department.
This indicates a highly centralized system of dispatching whereby the foremen act more as expediters than dispatchers.

The trend away from centralization begins in the 50-99 category. Within this category, the foreman does the dispatching function, or has one of his workers do it for him. He can release orders to the shop at will, and do most all of the other dispatching functions that are necessary.

Within the 25-49 category, there is a strong tendency toward almost total decentralization of dispatching. This trend becomes common practice in the 8-24 category.

In all companies surveyed, the tools and fixtures that were needed for production were kept at the producing center, or work station. The individual worker did not have to hunt for tools that were necessary to perform his function. The foremen procured any tools that were needed to replace the old, broken, or damaged tools. He also calls for any maintenance needed.

**Time stamping and move orders.**—No time stamping is performed by any of the companies surveyed. There is no record of time, as to when an operation commenced or stopped.

One point that was common in all of the industries was the automatic movement of goods in process, after leaving the first work station. Once the work has been processed through the first station, the workers move the goods in process from their station to the next. Their release of authority to move materials is to complete their function on that order.
Move orders or job orders are used as a release of authority for movement of raw materials into the first work station. They are not used as move orders, once they leave the first work station.

**Assignment of work.**—The origination of work assignment begins with the production control office in the large business and with the owner in the smaller ones. The owner-foreman begins with the 25-49 category, and from this category down, he assigns the work.

In the large businesses, the production control office assigns work by department only. The foremen must see that work is carried out within their departments. The straight line flow of work will normally assign the work to the workers.

Beginning with the 25-49 category, and being the rule in the 8-24 category, the foremen will assign the worker to his task or operation center. He will do this for all orders.

**Inspection.**—Inspection exists as a separate department in the top two categories. A strong trend toward decentralizing the inspection function to the worker begins in the 50-99 category. Inspection, whether it is by a separate department or by the worker, is on a 100% basis.

Where inspection is a separate department, they decide if a part is repairable or not, and they are responsible for seeing that it is rerouted and rescheduled for the corrective action that is necessary. Even when decentralized to the individual worker, this same system of inspection is employed.
A majority of the companies indicate that there is no investigation made, should inspections exceed desired limits. Any investigation that is made is usually made by the foreman, who reports his findings to the owner or production control office.

Lost production time.—The companies in the top two categories indicate that they have lost production time cut to a minimum, and that it is not a problem. Worker absences are very low and do not cause any bad loss of time. When a worker is absent, work is routed around his station, or a temporary worker is put in his place. If a machine is broken down, the company has a maintenance crew that is called to the location of the down machine, and repairs are made very rapidly. While the machine is being repaired, the operator is put on some other type of work.

In the small companies, the cause of lost production time is due to absenteeism, inefficient scheduling, and shortage of materials. This loss seems to be caused from the over decentralization of the production control function.

Follow-Up

Organization of follow-up.—In the top two categories the follow-up is highly centralized. The production control office can do almost all of its follow-up function by reference to records and charts. That which cannot be done by reference to charts and records is done by the foreman and reported to the production office.
In the third category, the 50-99, the trend toward decentralization of follow-up to the foremen begins. The records in the production office are not complete enough to follow the order from worker to worker or even from department to department. A large part of the follow-up is done by talking with the foremen. In the lower categories, the foremen do all of the follow-up.

Follow-up by foremen.—In all of the companies, the follow-up function of the foremen is to insure a smooth flow of work through their department. The foremen make frequent checks to see if all is well, and if it is not, he tries to correct it.

In the top two categories, the foremen also act as the reporting agency that send follow-up information into the production control office. These reports are returned route sheets, reports on department actions, and any other report that is requested by the production control office.

In the lower categories, the foremen are more expeditors than anything else. They try to keep the workers supplied with work and materials. They also try to keep their department at a top producing level, and will change schedules or route plans to try to do this.

Centralized follow-up.—The centralized type of follow-up that is found in the top two categories results from a secondary flow of papers and the daily report that are sent into the production office by the foremen. These secondary papers are items such as the stubs that are torn from route sheets, notations
on schedule forms, and the return of route sheets. The daily reports that are sent in by the foremen consist of reports of departmental accomplishments, and behind schedule reports.

In the 50-99 and the 25-49 categories the trend is away from the centralized type of follow-up. The follow-up is left to the foremen, and reports are not sent into the production control office unless they are requested. In the last category, the follow-up is entirely decentralized.

Expediting orders and raw materials.—In the 250-499 category, there is no expediting of orders. All orders take the same time to go through the manufacturing process. The foremen do, however, try to keep production flowing smooth through their departments. The expediting that is performed by the foremen is to keep the workers busy, and to keep a steady flow of work coming into their departments.

In the second category, orders are rushed through the manufacturing process by notations on the route sheet. When the foremen receive a rush order, they have the authority to place it above all other orders, and to speed it through their department.

In the last three categories, an order is rushed by the foreman himself or upon the request of the production control official. The foremen have the authority to rush orders any time they see one that is behind schedule. The foremen will also rush orders if the person that is acting as the production
control man requests that they do so. Requests to rush an order are given verbally to the foremen.

All companies agree upon the method of expediting materials into the plant. The method by which to do this is by telephoning or writing the vendor of raw materials and asking for faster delivery.

Recommendations

Production control is of great importance if efficiency of operation is a concern of business. Too often, the management of small businesses overlook or minimize the importance of production control. The larger businesses realize the desirable results which can be obtained from the proper application of production control and are striving to increase its use within their plants.

To further the success of the businesses surveyed, in employing an effective and efficient production control system, the following recommendations are offered:

1. The forecasting function could be greatly improved. The companies should not use past sales alone for their forecast, but should project their past sales into the future and adjust them to market and economic conditions.

2. Plant planning and design should be stressed more. These companies should begin long term planning for future advancement and growth. By performing this function now, the companies will have a systematic plan to follow to keep their production methods modern.
3. Route sheets should be formulated and put into use by the companies that are now without them. This could provide a means for training new workers, as well as a way to improve different phases of the production control system.

4. More planning and attention should be directed toward the determination of economic lots or batches. The large companies have this in operation, or planning is being conducted in this direction. The small companies, however, seem unaware of the existence of economic lots and batches.

5. When planning for extra hours, shifts, or personnel, there should be a closer cooperation between the production control office and the foremen. The foremen are more closely related to the producing department than the production control office, and because of this they may be able to offer valuable information which has been overlooked.

6. For scheduling, there should be a closer liaison between the production control office and the foremen. As was mentioned in the above recommendation, the foreman may have a better knowledge on some points of production than the production control office.

7. There should be more study and planning performed to control "peaks" and "slumps". This could be improved by gearing production to the sales forecast for producing to stock, or by use of a shorter work week.

8. There should be one person in charge of dispatching, to insure against the workers or foremen shoving the easier
orders through their departments at the expense of the larger or more difficult orders.

9. Time stamping should be used. This would provide an excellent method of finding operations that consumed too much time and needed method improvement.

10. Inspection should exist as a separate department or section. This will aid in removing undue influence from the foremen to the worker or inspector. This undue influence could cause rejectable orders to be passed by the workers or inspectors because the foremen may be too conscious of volume production.

11. There should be a secondary flow of forms or papers to aid in the follow-up. These could be route sheets, or schedule sheets, or even job orders.

12. Foremen should submit to the production control office daily reports about departmental accomplishments and behind schedule activities. This could aid in the avoidance or decrease of lost production, since the production control office could see a bad situation developing and make their plans accordingly.

13. A standard operation procedure for expediting orders should be developed for use by the production control office and the foremen. This would avoid a lot of confusion, and cut the cycle time for each rush order.

14. Other studies of this type should be made in other fields of industry, as well as in the major divisions of this
thesis. Production control is such a broad subject that there could be valuable research done in most any of the sub-divisions of this treatment of the subject.

Within these companies surveyed, and within all of industry, there should be a constant effort directed toward the future solution of their present difficulties of production. Planning now for future advancement and improvement may well mean the difference between success and failure.
APPENDIX

"CHECK-LIST" FOR PRODUCTION CONTROL SYSTEMS

Forecasting

1. Is a sales forecast made?
2. What method is used to do this?
   A. Try to build a picture of total sales in some future period by summing up and combining estimates drawn from the company's business.
   B. Relate general economic trends to particular industries and then work back to the company's share of an industry's business.
   C. Other.

Routing

1. Effect of product and plant design on routing.
   (This could have a lot to do with the method of performing a certain operation; for example, straight line flow of work in a bakery would require little routing after machine layout is completed.)
   A. When plant was designed, had a study of flow of work been determined?
   B. When installing machinery and equipment, was this done to cause a straight line flow of work?
   C. Is routing done prior to a model change of product, or new operations performed on the product?
   D. Was a sequence of operations selected first, and then machines bought to perform these operations in the desired sequence?
2. Effect of method on routing.

A. How is the method of doing an operation determined?

B. When the method of doing an operation has been determined, is an alternate method also found?

3. Master route sheets (operation sheets).

A. After the proper sequence of operations has been determined, is a permanent record of these operations made?

B. Does this sequence list every separate operation to be performed?

C. Is special adjustment of a machine, or use of special tools for each operation listed on this operation sheet?

D. Is a time estimate given for each operation on an operation sheet?

E. Is set-up time or adjustment time counted as total time toward performing the desired operation on a batch, lot, group of jobs, or single job?

4. Routing for job shops.

A. Is each order routed as it is released to the shop?

B. Is a preliminary study usually begun after the sales order has been received?

C. When routing is done, is a standard or most appropriate machine or production center for performing an operation given?

D. Is an alternate method (s) given?

E. Can the foreman change the routing of work?

F. Is routing influenced by the comparative cost of setting up for the job considered?

G. Are any handwritten route sheets used?
5. Phases of routing.

A. Is routing begun by listing all the parts or sub-assemblies necessary to complete the product?

B. Is a sequence for each part to follow formulated?

C. Is a bill of materials used?

D. Is routing done by department first, and then to the machines, or is some other method used?

E. Is the sequence of operations taken from the route sheet?

F. Does the routing department or the route man prepare the forms for the dispatching people?

   (1) Material requisitions.
   (2) Move tickets.
   (3) Inspection tickets.
   (4) Shipping order.

6. Does the scheduling on previous work influence routing?

Scheduling

1. Do the scheduling people assign only the starting and ending date for an item, or do they also schedule the time for movement of material from place to place?

2. Is the date for the completion of a product determined by working backward from the promised date of delivery, or the desired date for completion?

3. Phases of scheduling.

   A. Are scheduled completion dates integrated with plans for advertising the product and for stocking retail stores?

   B. When departments are informed of the amount of work ahead, do the department supervisors make their plans for needed personnel, extra shifts, overtime, et cetera?
C. Does the scheduling department make provisions for supplies, tools and other equipment which will be needed?

D. Are the production plans of the company integrated with the plans of your buyers, or distributors?

E. Do the foremen in the plant have anything to say about the scheduling procedure or plans?

F. How do you check to find out if a machine is overloaded or not?

4. In order to assign a time to a product, do you

A. First find out or determine the operations necessary for the manufacturing of the product?

B. Determine machine capacity and number of hours a week or day that a machine may be expected to operate?

C. Find the dates when materials will be available for the product to be manufactured?

D. Find the time required for the transfer of the product from one department to another?

E. Have standard times for various tasks as set by time and motion study?

5. Determining machine capacity.

A. Is machine capacity determined by the use of a formula similar to the one shown below?

\[
\text{Machines} \times \text{Shifts} \times \text{Hours per shift} \times \text{Days of operation} \times \text{Percentage of efficiency} \\
3 \times 2 \times 8 \times 5 \times 80\% = 192 \text{ hours per week}
\]

B. Is some other method used?

6. How are machine loads shown?

A. Gantt charts.

B. IVI files.

C. Bulletin boards.

D. Other.
7. If the best machine to use for a given operation is overloaded, how is scheduling done for this desired operation?

8. Stabilizing production ("peaks" and "slumps").
   A. Is production varied from month to month?
   B. Is production varied so as to avoid "peaks" and "slumps"?

9. Graphic aids.
   A. As an aid to scheduling, do you use any charts which show the flow of work through the plant?
   B. Other.

10. Is the factory float kept as low as possible?

11. Is the daily run sheet used?

**Dispatching**

1. Do dispatchers introduce job-orders, tool orders, et cetera, to the shop?

2. Are dispatch offices used?

3. Are all the production papers kept at the dispatch offices?

4. Functions of dispatching.
   A. Do the dispatchers procure the workmen for each operation in advance of the time they are needed?
   B. Do the dispatchers secure all tools, fixtures and materials for the operations before the operations are to begin?
   C. Do the dispatchers give the workmen all work orders, instructions, drawings, et cetera, at the time when work should begin?
   D. Is the time of starting and completion of each operation recorded?
   E. Do dispatchers control the movement of materials from one operation to another as indicated on the route sheet?
F. Do dispatchers make any schedule modifications?

5. Dispatch boards.

A. Are any kind of dispatch boards used? What kind?

B. How do the dispatchers keep track of work in progress?


A. (Move orders). Who moves materials from one operation to another?

(1) Is any release of authority necessary for movement of materials?

(2) Are "move men" used? If so, are they controlled departmentally or by the dispatchers?

(3) Who moves raw materials to the machines or work places?

B. (Material orders). Does the dispatcher control the issue of raw materials?

(1) How soon before an operation is to start is the material order released?

(2) How does the dispatcher know when to release a material order?

C. (Finished goods order). When a sub-assembly or a part is completed, is there any form sent in to the production control office telling about this?

D. (Tool orders). Does the dispatcher control the release of tool orders?

E. (Job orders). Does the dispatcher control the release of authority to begin a job?

(1) How much detail is given on a job order?

(2) Does the worker receive any instructions as to how a job should be done? If so, does the foreman tell the worker, or are instruction cards used?
(3) Does the dispatcher assign work to a particular machine or does he release the work in departmental sizes and let the foreman assign them to a specific machine?

7. Time stamping.
   A. Does the dispatcher time stamp all orders?
   B. What method of time stamping is used?
   C. Are work standards or wages influenced by this information?

8. Inspection.
   A. Does inspection exist as a separate department?
   B. If not, how are the inspectors controlled?
   C. Do the inspectors work for the producing department?
   D. What action is taken when rejections exceed desired limits?
   E. Do the inspection people decide if a product is repairable or not?
   F. How much inspection is done? (Sample, Random, 100%).

   A. Is there some plan to follow when a schedule modification is necessary?
   B. Can the dispatcher modify schedules when the modification is of a simple nature?

10. Idle time of men and machines.
    A. Is there any lost time because of worker absentees?
    B. Any lost time from overloading of a particular machine or work center?
    C. When a machine is broken down, is the worker (s) from this machine (s) put on some other type of work?
D. If not, what does he do?

E. If a series of lost time occurs, is an investigation of its cause made?

Follow-Up

1. Organization.

A. Is the follow-up and dispatching function combined?

B. Are definite people assigned as follow-up personnel?

C. Does the foreman of a department do any follow-up?

D. Centralized follow-up.

   (1) By reference to charts or records, can the location of an order be determined?

   (2) If a job is lost or held up, does the follow-up man find the order and then report to the production control office for their action on the matter?

   (3) Is investigation by expeditors extensive?

E. Decentralized follow-up.

   (1) Do the expeditors "push or rush" certain orders through the plant?

   (2) Who tells the follow-up men which orders to rush?

   (3) Do these men work in the producing department or follow the work all the way through the plant?

   (4) Does the expeditor have the scheduler change the start date on rush orders, so that work can start earlier?

   (5) Can the expeditor rush materials and tools needed for an operation?
2. Methods of follow-up.

A. Is a secondary flow of papers used to perform the follow-up function?
   (1) Notations on schedule form.
   (2) Notation on route sheet.
   (3) Notation on job order.
   (4) Other.

B. Is there any graphic presentation of follow-up?
   (1) Peg-board.
   (2) Gantt charts.
   (3) Bulletin boards.
   (4) Other.

3. How are goods expedited into the plant?

4. What follow-up is done of goods in process?

5. If the foreman realizes, for some reason, that he cannot meet the schedule on an order, does he send in a behind schedule report?

6. Does the follow-up section make a report on machine loads, and to whom is the report sent?

7. May the follow-up men modify schedules?

8. Do the various departments send in, from time to time, a report on departmental accomplishments?
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