

1950

Production functions in the manufacture of apparatus

<https://hdl.handle.net/2144/4616>

"Downloaded from OpenBU. Boston University's institutional repository."

BOSTON UNIVERSITY
College of Business Administration

THESIS

Production Functions in the Manufacture of Apparatus

by

Charles Francis Flannery
(A.B. Boston College 1933)

Submitted in partial fulfillment of
the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

1950

PREFACE

Production is a subject which is much discussed because it plays such an important part in the welfare of the nation. Many books have been written concerning this field. For the most part, however, the writings cover the subject in a general way and do not draw a very distinct line between the factory group which actually performs physical work on materials and the office group which is responsible for providing the factory group with tools and materials necessary to turn out completed units according to a definite time schedule. Usually the underlying principles governing all groups engaged in the overall manufacturing process are given specific attention but the actual detailed operations of any one group are neglected.

The writer feels this is particularly true in the case of the production department with its very important responsibilities of providing satisfactory customer service contributing to profit by efficient administration of scheduling, ordering, and material control functions.

It is a well recognized fact that no single production system is applicable to all types of manufacturing because each type of business has its own peculiarities and local conditions to which a production system must be adapted.

In the present instance an attempt has been made to bring out the importance of production functions by

5-16-50
41102
* 558.5
F 595

describing in detail the functions of a production department in the electrical apparatus field where the ultimate goal is the efficient, economical and profitable manufacture of steam turbines, generators, transformers and floodlights. The importance of production functions in this field is particularly true because here are manufactured large, heavy and complicated pieces of apparatus involving large investments in machinery and materials.

It is hoped that this thesis will give a better understanding of the complicated operations and the important part played by the production department of large electrical industries. The treatment of the subject is based on the writer's several years experience with one of the large manufacturers in this field.

TABLE OF CONTENTS

	Page
CHAPTER I	
Introduction	4
CHAPTER II	
Receipt of Requisition or Order for Apparatus.	9
A. Origin of the order	
B. Manufacturing wheels set in motion	
CHAPTER III	
Ordering of Materials.	40
A. Efficient and economical ordering	
B. Present trends in ordering systems	
CHAPTER IV	
Production Following	73
A. Definition and purpose	
1. Duties of a production follower	
CHAPTER V	
Material Handling and Storage.	83
A. Importance	
B. The stock department	
C. Expediting materials	
CHAPTER VI	
Present Trends in Production Organization.	106
A. Plant and management decentralization	

CHAPTER VII		Page
Relation of Supervision to Production Organization.	.	114
A. Production and section supervisors		
B. Supervision and education		

CHAPTER VIII		
Conclusion.	125
A. Relation of individual functions to overall business		
B. Progress		
Bibliography	130

TABLE OF EXHIBITS

	Page
Exhibit 1 - Typical Requisition or Customer's Order.	8
Exhibit 2 - Progress of New Order from Central Office to Manufacturing Division	14
Exhibit 3 - Production Department Organization Chart	16
Exhibit 4 - Requisition Performance Chart	18
Exhibit 5 - Comparison between Budgeted Output and Actual Output	20
Exhibit 6 - Comparison between Budgeted and Actual Labor Costs.	21
Exhibit 7 - Path of New Requisition from Receipt up to Point of Ordering Parts	26
Exhibit 8 - Paper Generation and Flow	31
Exhibit 9 - Unwise Ordering and Resulting Inventories	39
Exhibit 10 - Order Clerk - Paper Work Flow	46
Exhibit 11 - Standard Stock Card.	53
Exhibit 12 - Order Card for Special Item.	54
Exhibit 13 - Outside Vendor Order Card	55
Exhibit 14 - Peg Board List of Basic Models	59
Exhibit 15 - Peg Board List of Component Parts	60
Exhibit 16 - Peg Board Contributing Department Source Sheet	61
Exhibit 17 - Capacity Schedule	76
Exhibit 18 - Manufacturing Schedule	77
Exhibit 19 - Old General Office Type Organization	105
Exhibit 20 - New Decentralized Type Organization.	108

CHAPTER I

Introduction

The term apparatus is one which may be interpreted in various ways. In the present instance it is used to signify such products as transformers, turbines and floodlights to name only a few. Such items are usually produced by large electrical manufacturers. The equipment manufactured by these concerns is generally used to perform one of three major functions in the electrical field. For example, turbines turn generators which produce electricity and thereby provide electric power necessary to do work, transformers change from a high to a low potential without changing electrical energy and thereby control and convert flow of electricity, floodlights change electrical current into an end product, light, which is necessary for both work and recreation. Usually these products are composed of many parts, are complicated, and are very often made to fit special needs. This does not mean that some types even though large, heavy and of complicated construction are not manufactured on a stock basis. That is to say, some are manufactured in advance and stored in warehouses awaiting future sale. The basis for this latter procedure is sales estimates provided by the commercial department. Upon the written authorization of this department, units are manufactured at a rate which it is believed will meet future sales. In contrast to this type there are the strictly special or semi-special types which are manu-

factured only as a result of actual sales. The contract to build is made before manufacture takes place.

This type of manufacturing differs considerably from the type where only small items of small size, light weight and standardized makes are produced on a repetitive basis. Larger investments are at stake and many more problems exist.

Essential to and of very great importance to the manufacturing of apparatus is the production department.

The term production as applied in the general manufacturing field is often interpreted in a loose way to mean all processes necessary to plan and make a product. In the manufacture of apparatus as presented here it means the satisfactory servicing of customers' orders and stock orders from the time the orders are received until the finished apparatus has been completed and shipped. It does not include the factory processes where actual physical work is performed on materials by men and machines. It is presented as a separate department which plays an essential and important part in the overall manufacturing process. This department is charged with the difficult duty of satisfying customers in regard to cost, quality, and delivery of finished apparatus and at the same time performing this task in a manner which will contribute in no small degree to meeting competition on equal footing while bringing a fair return on investment.

Production is presented here as the writer has

observed it in actual operation within a large electrical manufacturing company operating on a national scale.

This type of work has changed greatly during the years because we have moved from the era when manufacturing was more or less of a small job shop type operation to the present time where manufacturing is on a much larger scale, great technological progress has been made, competition is keener, and the cost of labor is greatly increased.

In order to successfully carry out the duties of production today a definite production system is essential. Production work can no longer be haphazard as it was at times in the past. In performing the major task of customer service, the production department exerts a direct influence on some of the primary considerations of all business such as inventory control and cost.

The production system is comprised of several main functions each an important and integral part of the whole and each contributing to the success or failure of the whole.

These functions are considered separately in relation to each other and in relation to their effect on the business as a whole. To best illustrate these points and to bring out the importance of production in the manufacture of apparatus, each function has been considered in detail.

In general, production is a very detailed process involving careful planning of schedules, ordering, production following, and material handling. Each of these functions includes extensive paper work.

As previously mentioned, this work has undergone continual change over the years in order to meet changing business methods and conditions. The process of change continues today as evidenced by trends such as decentralization of large business and installation of new systems at considerable cost in an effort to improve overall operation and to better attain objectives.

Such an important and detailed process as production on a large scale naturally requires good supervision because without competent direction, no business will long prosper.

Therefore, by consideration of production functions, the important cogs in the main wheel of production, in their various details and relationships an attempt has been made to furnish not only an idea of what production is but also its necessity to the manufacturing process and the important part it plays in the overall success of apparatus manufacturing, a field of large investments.

APPARATUS DEPARTMENT		182381 G.E. REQN. NO. XF-432225	SELECTED BY	MARKED BY
APPARATUS REQUISITION		CONTRACT NO. _____ W.H. OR M.S.# _____	CHECKED BY	PACKED BY
G.E. PROJECT NO. _____		BOXING	TRANSP. CHARGES	POSTAL ZONE
CHARGE TO		FREIGHT CLASS	CAR NO.	
<input type="checkbox"/> SAN FRANCISCO THEATER SUPPLY INC. <input type="checkbox"/> 84 FAIRMOUNT AVE. <input type="checkbox"/> SAN FRANCISCO, CALIFORNIA		SHIP VIA		
SHIP TO		A/c 700		DESTN WE 68
<input type="checkbox"/> SAN FRANCISCO THEATER SUPPLY INC. <input type="checkbox"/> 84 FAIRMOUNT AVE. <input type="checkbox"/> SAN FRANCISCO, CALIFORNIA		SALES FD.	TAX CODE	OFF. TK. REC.
		61	20	89 89
		PURCH. CUST. 78094		USER CUST. 78094
SPECIAL MARKS		COLL. DIST.		
TERMS- NET CASH 60 DAYS		PPD. OR COLL.		
DATE SHIPPED * FROM * No. of PKGS. *		Fo B. POINT OF SHIPMENT		
HOW SHIPPED AND ROUTE *				
ITEM NUMBERS AND QUANTITY	DESCRIPTION	CHECK IF REQUIRED SHOW DETAILS BELOW	INSPEC TION <input type="checkbox"/>	BLUE PRINTS <input type="checkbox"/>
			TEST REPTS. <input type="checkbox"/>	INST. BOOKS <input type="checkbox"/>
2- CC TRANSFORMERS - CAT. 4468773 G.2				
<u>SAMPLE FORM COPY</u>				
		TRANSPORTATION		USE OR SALES TAX
		ALLOW		YES
SHIPMENT REQUIRED 1/20/50				
INVOICE ORG. B/L	COPY B/L	COPIES M/S	SHIP VIA	PLACED ON
3		1	FAST FREIGHT	RIVER WORKS
DIV. QUOT. NO.		EST VAL OR REQN		
SEND SHIPPING SCHEDULE AND M/S TO ISSUING OFFICE AND TO		CONTRIBUTING WORKS	SIGNED BY OFFICE DATE	
			JOHN BAKER SAN FRANCISCO 12/15/49	
1 WAREHOUSE EXHIBIT 1 TYPICAL REQUISITION OR CUSTOMER'S ORDER				

CHAPTER II

RECEIPT OF REQUISITION OR ORDER FOR APPARATUS

A. Origin of Order.

Everyday experience has established the fact that today the majority of people give little or any thought to all the operations, mental and physical, which are necessary to bring about the manufacture of the thousands of items which we find stocked in retail stores and wholesale warehouses throughout the world. Most of us pursue the matter no farther than to walk or ride to the nearest electrical supply store if we need a new electric light bulb or if we need an electric toaster repaired. When we see a child pushing his shiny new cart, a recent Christmas present, perhaps, we do not realize the work and the planning necessary to produce such a simple object. If the cart in question takes our fancy and we have any children in our own family, we take time only to ask ourselves where we can purchase a similar cart in order that we may please our own children. Once our decision has been made, we travel to a nearby hardware store or to the children's section of the nearest department store and proceed to make our purchase. If the store does not have what we want, the first question we ask the clerk is "How soon do you expect to have one on hand?" or "How soon can you obtain one for me?"

Perhaps the store in question has had several recent requests and as a result an order is placed for a shipment of the item in question. This causes a chain reaction.

The paper movement has been set in motion. This in turn will cause the physical motion to begin when the factory receives the order and begins to manufacture the required item in the quantity ordered. We, the final consumers, retain the thought of how soon will we obtain delivery on our order. Often we may become incensed at the retailer if he promised delivery for the 5th but informed us later that it will be the 8th before he can obtain the product in question. This is, of course, a very simple product but it will serve to bring out the fact that basically the reactions caused by a customer's desire to buy are the same whether the item be one comparatively easy to manufacture or whether it be one which is of a highly complicated nature requiring months to manufacture.

When the foregoing is called to the average consumer's attention he may shrug his shoulders and say, "Oh yes, I know that but I just didn't stop to think about it." But again the thinking fails to proceed any further. The important points are disregarded entirely. They are,

1. A market has been created or at least a possible current market increased.
2. All the little orders sorted and funnelled into the various factories and shops cause production wheels to be set in motion.
3. Continued work and means of livelihood for those in the many manufacturing lines is given support.
4. The customer's desire for quick delivery must be satisfied if a continued market is to be maintained.

Naturally these are not the only important factors connected

with manufacturing. There are many more such as customer satisfaction obtained by speedy manufacture of quality products.

1. In the present treatment of production we have divided the subject of orders into two major classifications (a) those which involve items which have an everyday use and (b) those which are made to particular specifications at the request of the customer.

- a) Items in the first classification are of such a nature that under normal conditions there is a constant demand for them and as a result they are stocked on retailers' shelves and in factory warehouses. Due to the fairly constant demand, factories carry inventories of both raw materials and finished parts comprising the component parts of the finished product. At present it is true factory inventories in many cases are at a minimum but enough is stocked so that upon receipt of an order manufacture can at least be started and additional required materials can be obtained quickly enough to keep the order moving toward completion. This class includes all those items which the public in general and tradesmen such as plumbers, electricians, or mechanics, expect to purchase on short notice from either wholesale or retail shelves. They are the people who create the demand upon which factory depends for sustaining orders and their requirements must be filled in an all around satisfactory manner.
- b) Under the second classification are those items or pieces of apparatus which must be manufactured to fill certain definite requirements of the customer. These are products which are long-lived and costly. We may complete manufacture of one such item today and ship promptly. We know that will be the last of its exact specifications which we will manufacture for a long time because that particular customer had one certain job to be performed and only that particular piece of machinery could do that job. When such orders are received, for example orders for steam turbines, they are

usually accompanied by technical requirements worked out by the customer's own engineer. The customer very often supplies blueprints of certain components which vary from something more standard which would ordinarily be used. In the case of turbines very often prior to the placing of an order, the customer's engineer will present his requirements to the manufacturer's sales engineer in the field who in turn will take the matter up with the factory engineer. When they have determined the exact job which must be done by the machine under discussion they consult their records to find the nearest thing to the required machine which they have manufactured in the past. Having located as nearly as possible a similar piece of apparatus the necessary variations are determined by careful study and then the sales engineer consults with the customer's engineer. Sometimes, before a definite decision can be made, the sale completed, contract signed, and an order placed, all three will have to discuss the matter again as the customer's engineer may not be satisfied with the proposals made by the vendor's engineers. In some cases this process consumes months.

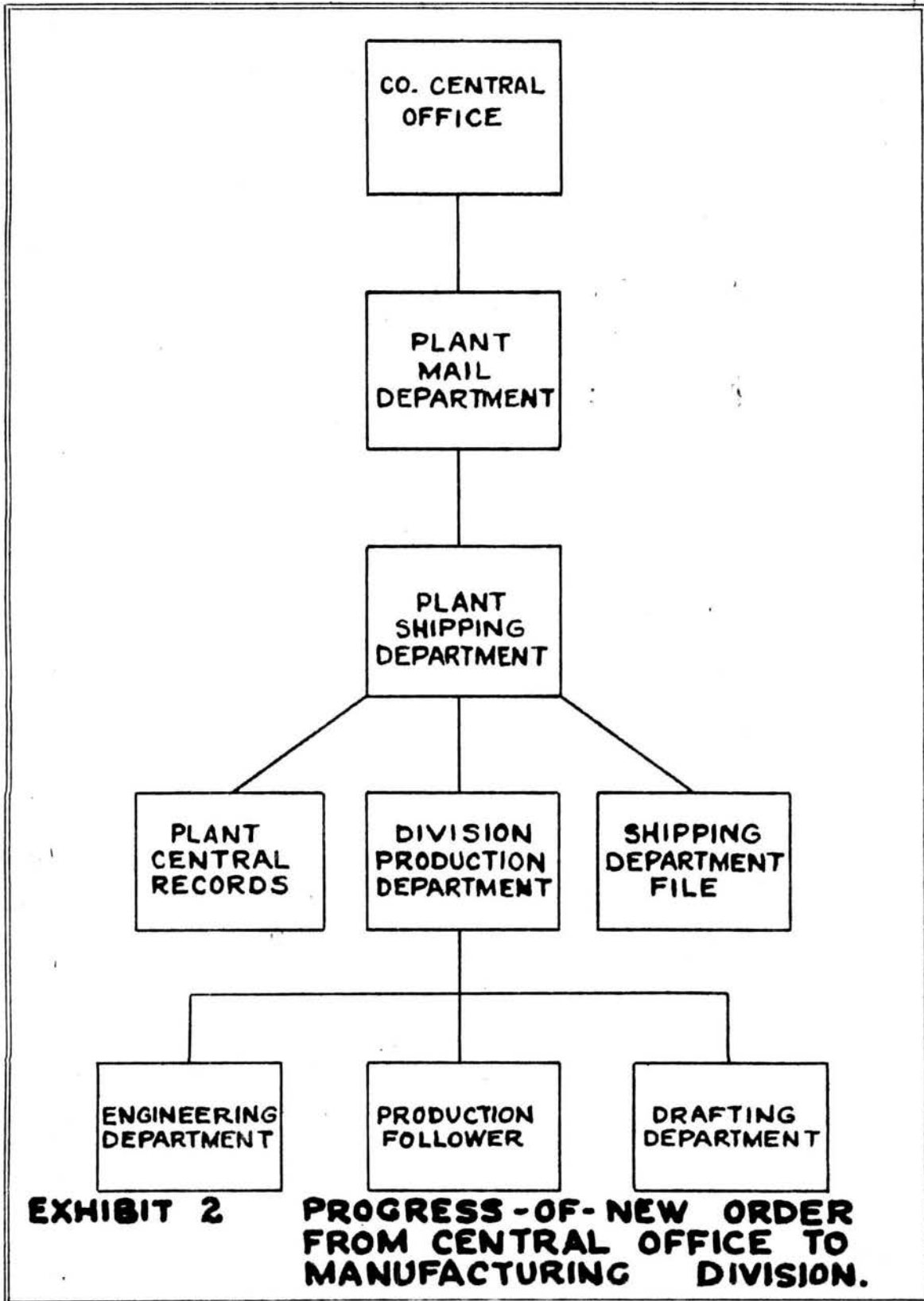
Materials required to fill the orders received under this classification are very costly and are not stocked in anticipation of future orders with the possible exception of some smaller items such as hardware which may be used in any one of a number of different types of apparatus. Even in the case of hardware very often bolts, nuts, and studs, are made only as required since in each piece of apparatus they must undergo different steam pressures, different degrees of heat and different weather conditions if located on an exposed surface.

Reducing the differences between these two major classes of orders to simple language for purposes of future reference we can say that class (a) represents stock apparatus, for general sale and consumption, and class (b) represents "as required" apparatus which must be manufactured exactly to specifications established by the customer.

B. The Wheels Set in Motion.

In a large organization such as that observed by the writer, there are many plants composed of various divisions. Each division specializes in a certain field. Some divisions of a plant are apparatus divisions which produce completed apparatus ready for delivery to the customer while other divisions are contributing divisions which manufacture only component parts required by apparatus divisions. The various plants are spread across the nation. However, there is a central office through which all incoming orders must pass. Here the order is recorded and then sent out to that plant in which is located the division specializing in the particular product called for on the order. Incidentally each plant in turn has a central office through which all orders must pass and here again the same process is repeated. The order is received, the required number of copies are duplicated and fanned out to the division which is to produce the items required to fill the order.

There may be district offices located throughout the nation at points considered best suited to the attainment of business and working out of these offices are the specialists or sales engineers. They are the men who contact the customer directly and who are best qualified to find a solution to the customer's needs and problems. Even though a specialist may know exactly which plant and which division within a plant will fill his order and even though he may



have consulted at length with engineers from that particular division before finally offering the customer a proposition which culminated in a sale his order must follow the procedure outlined in the preceding paragraph.

The natural reaction to such a system frequently is the feeling that in general it is too complicated and expensive. It is a problem that is far reaching and cannot be properly discussed at this particular time but we will take it up later at greater length under the heading "Present Trends in Production Organization."

When an order is received by a plant mailing department, it is sent to the receiving and shipping department. This is the first step in "starting the wheels moving" within a particular plant. Here are duplicated a sufficient number of copies to accommodate all those who are to work on the order. A standard requisition form is used, a typical copy of which is illustrated under Exhibit, Page 8. The various copies are fanned out or distributed as shown in Exhibit 2, Page 14. The shipping department copy remains in an unfilled order file until the apparatus is shipped at which time notification is sent to central records where the order is stamped "completed."

One may very often hear or read of all operations and personnel engaged in manufacturing as production operations or production workers. We wish to draw a line between the group bearing the responsibility for seeing that a cus-

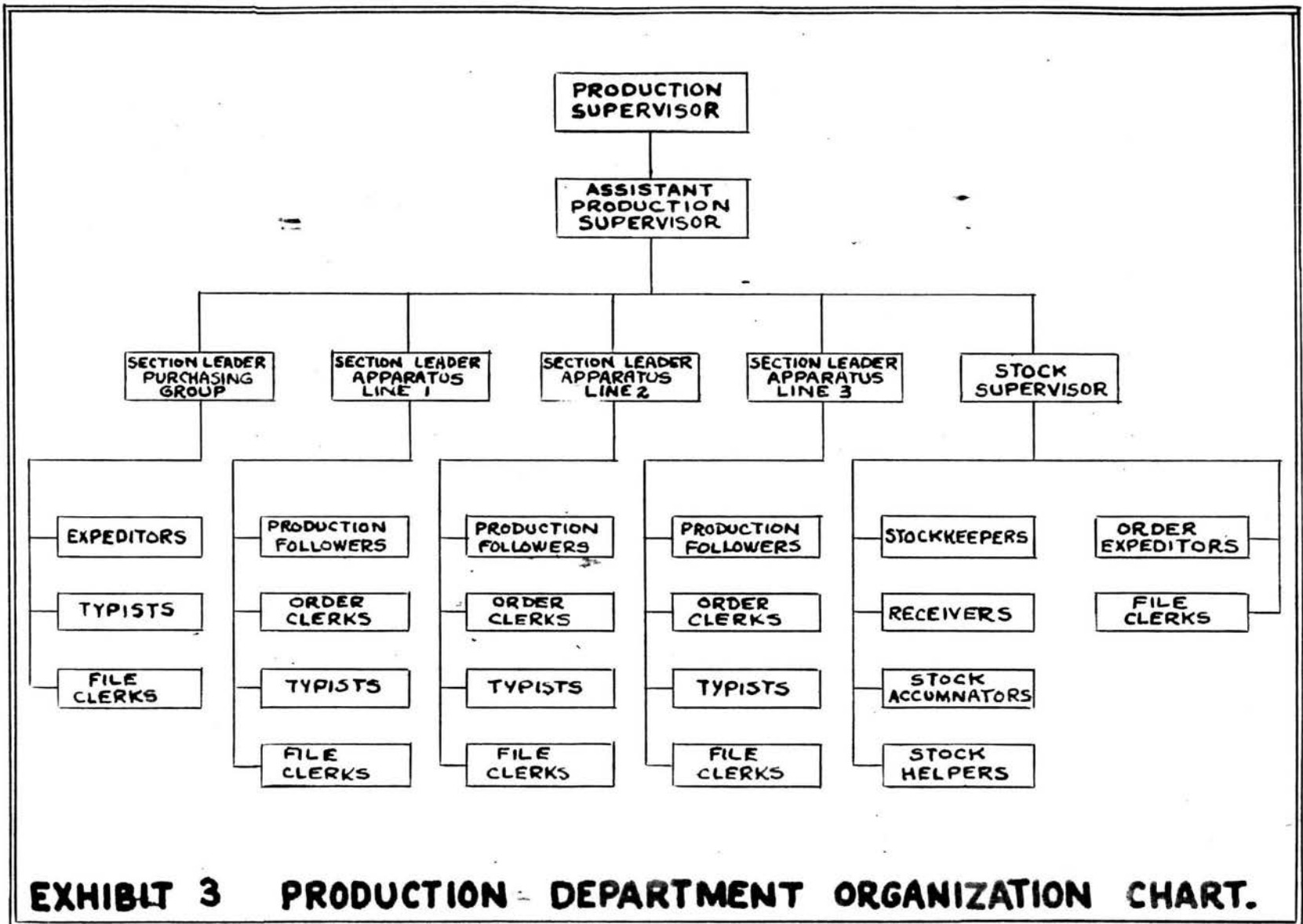


EXHIBIT 3 PRODUCTION DEPARTMENT ORGANIZATION CHART.

customer's order is satisfactorily filled according to schedule and the group actually bearing the responsibility of physically machining and assembling the apparatus necessary to fill an order. The first group is known as the production group. Members of this group are all office or what is commonly known as "white collar" workers. They are paid on the basis of a weekly salary. The second group is strictly a manufacturing group composed of three main classes: foremen, machine operators, and assemblers. The foremen are on salary and the majority of workmen are on piece work. This latter group is responsible for the physical work connected with the manufacture of an item once the production group has provided the necessary tools and materials. The production group must provide the manufacturing group with everything necessary to build the apparatus. This means that they must provide piece work papers, blueprints, and schedules as well as the tools and materials enumerated above.

The production department is organized as shown in Exhibit 3 (Page 16). It is the production supervisor's duty to see that the entire group operates efficiently and to so direct the operations of the department that each individual performs his or her work satisfactorily. This is nothing more or less than is required of a supervisor in any business. It is but one of his many duties for which he is directly responsible to the division superintendent and in some matters directly to the home office where the top men

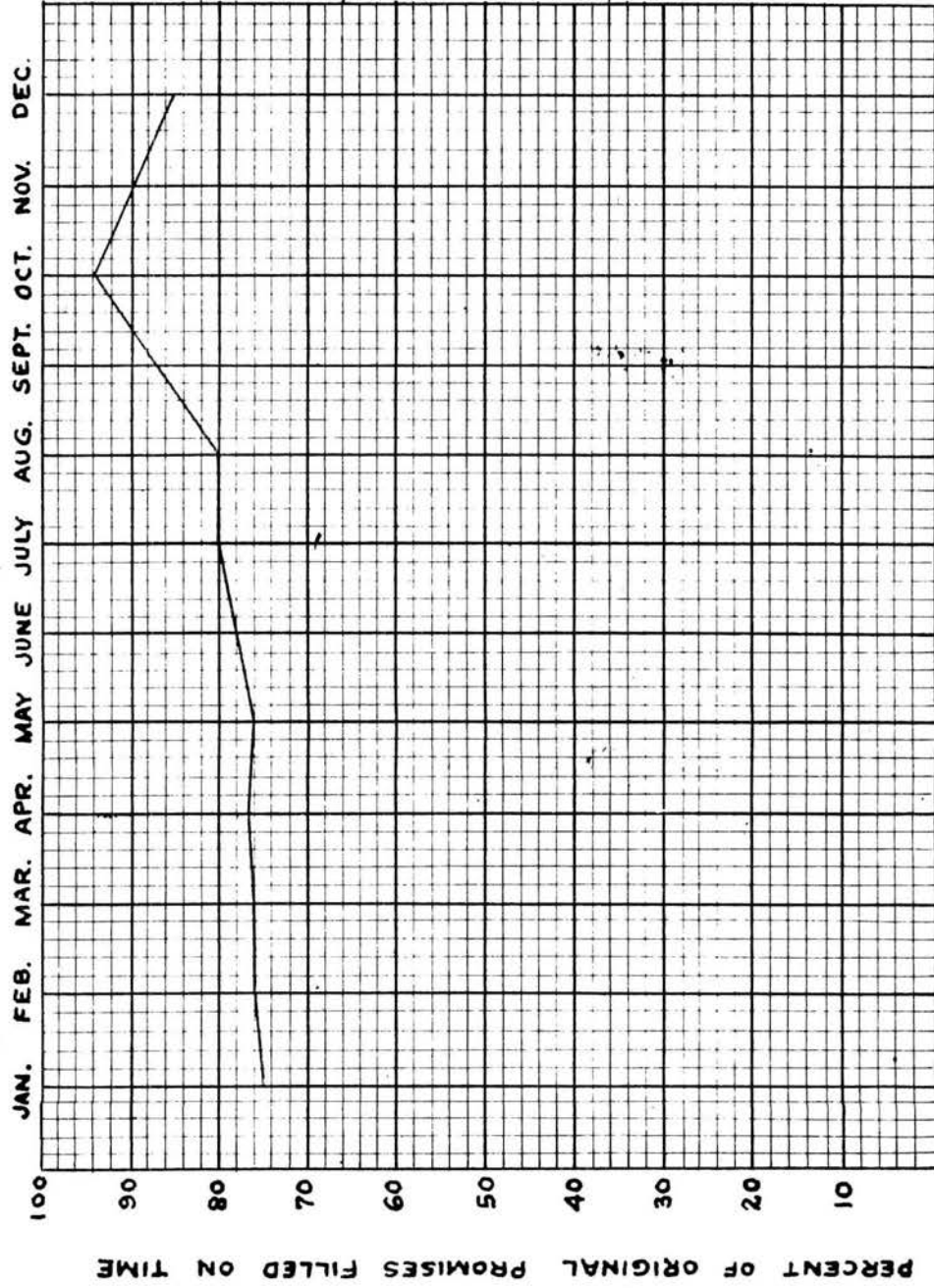


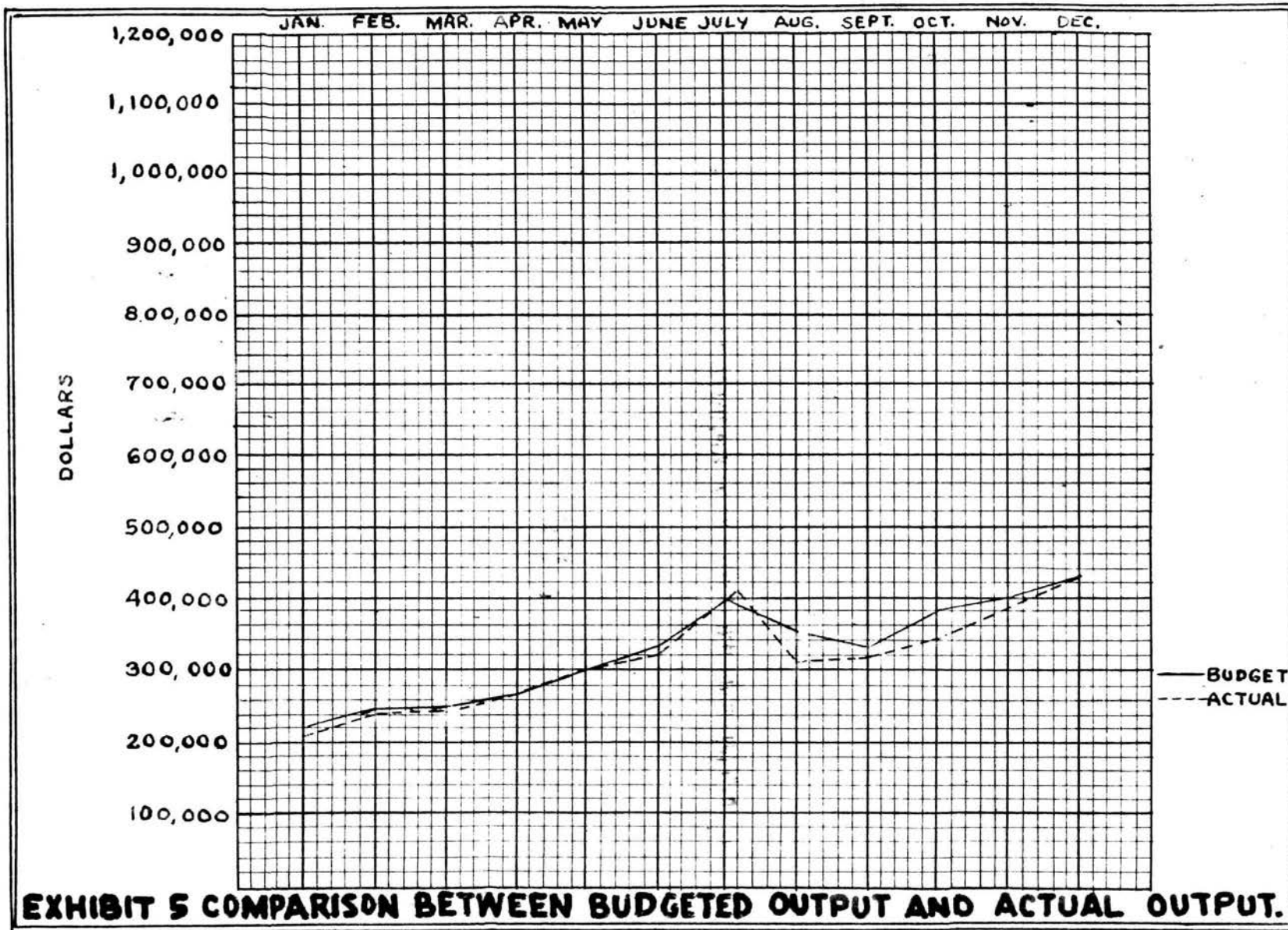
EXHIBIT 4 REQUISITION PERFORMANCE.

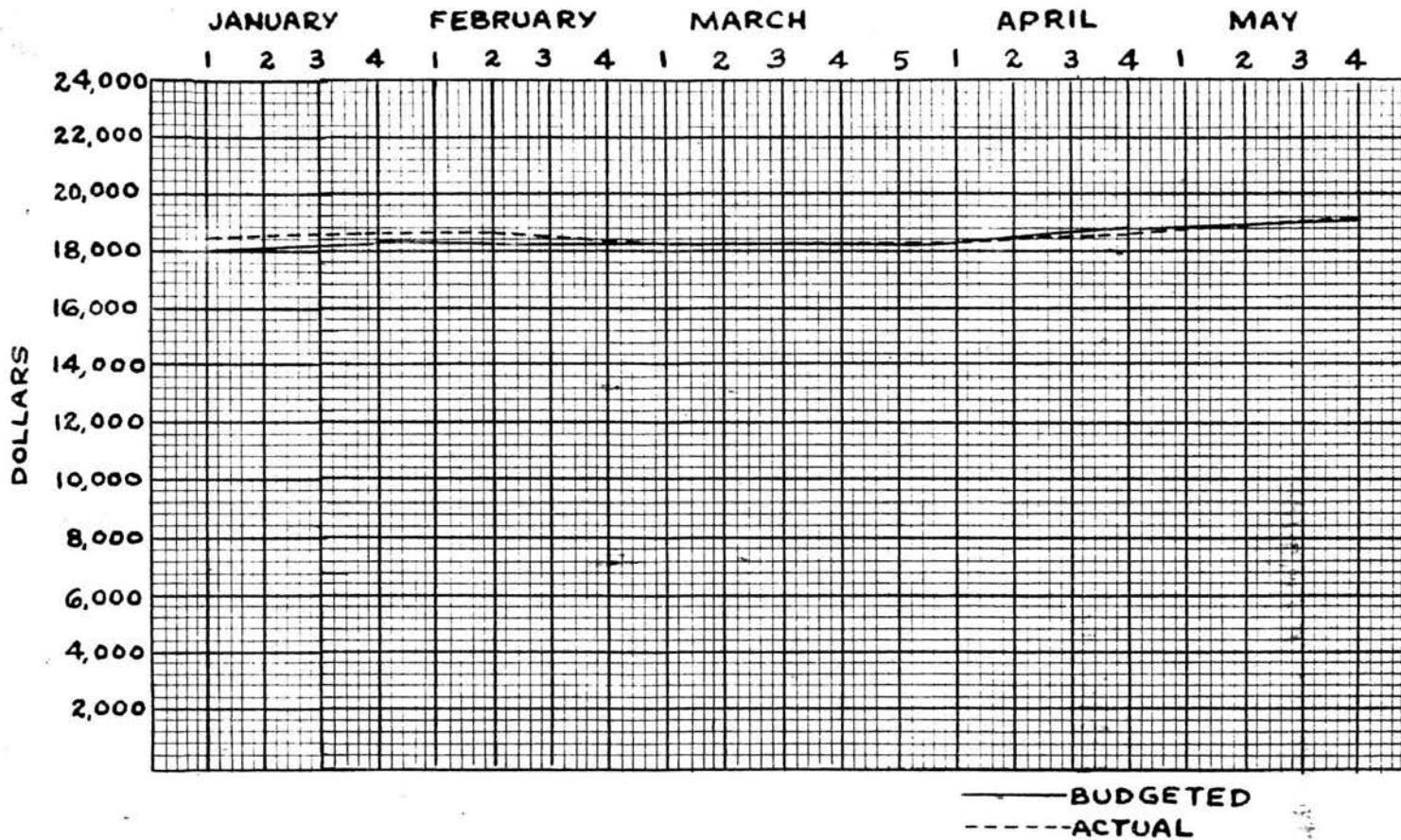
of the production department are located. As one example he is responsible to the home office for inventory control and it is from the same place that he receives the various production policies to be put into effect.

One may immediately inquire "Why isn't the division superintendent the last word on all matters?" It is a good question but the answer should be taken up later in the discussion of "Decentralization" in the reference to present trends in production organization.

The production supervisor also handles all labor grievances and problems providing the section leaders in his department have been unable to deal satisfactorily with the union representatives presenting grievances. This is a phase of his work which must be handled very carefully in order to avoid labor difficulties which could easily impair the satisfactory operation of his department.

He must know at all times the exact percentage performance on all requisitions received by his department. This is accomplished by periodic checks which show the number of requisitions shipped (See Exhibit 4, Page 18) as originally promised, the number which have been extended once, twice, or more times. This check is made by each section leader and indicates the performance of each production follower under his jurisdiction. It also indicates when a certain line is not performing satisfactorily. It is a barometer or yard stick of performance which is simple, is presented in chart





**EXHIBIT 6 COMPARISON BETWEEN BUDGETED
AND ACTUAL LABOR COSTS.**

form and permits difficulties to be quickly brought to attention so that prompt action may be taken to remove them immediately. In a similar manner the supervisor keeps his finger on the pulse of the business by various checks supplied by his section leaders and in each case these checks are reduced to chart form. For example the estimated production over a six-month period is charted and then each month over that same period actual production as proved by billing figures supplied by the accounting department is also charted. Budgeted direct and indirect labor are charted and then actual labor expense is plotted monthly in contrast to the budgeted figures. (Refer to Exhibits 5 and 6, Pages 20,21). The supervisor must handle complaints from the field and be ever ready to supply his personnel with the added pressure necessary to get a job done when they have exhausted their resources in an effort to overcome the difficulty encountered. There are many other details which the supervisor must handle. We have mentioned here only a few, those which are general but which actually control the production performance. Actually a treatise could be written on requisite attributes of a good supervisor in any line of business. Later on in Chapter VII we will discuss the supervisor and section leader at greater length. The production supervisor is the functional head of and the one responsible for the production output. The responsibility is a great one because upon the production performance depends the future business, for

broken delivery promises or poor quality can have but one result, an increase in business for competitors.

The assistant supervisor aids the supervisor in all his duties and in particular deals directly with the section leaders who are responsible for the performance of their various lines of apparatus.

The title, section leader, is synonymous with that of "foreman" but distinguishes one as leader of an office group whereas the title of foreman distinguishes one as a leader of a factory group actually engaged in physically manufacturing a line of apparatus.

The production section leader must answer for the production performance of his group. He deals directly with the production followers, order clerks, typists, and filing clerks in his section. Their problems are his problems whether it be a hold-up which they cannot overcome or a labor grievance. He must know how the work should be done, must give clear, simple instructions which can be readily understood and he must give help whenever and wherever it is needed. He must judge correctly the capabilities of an employee and either retain or remove the employee according to these capabilities. Also he must quickly recognize when he cannot solve a problem fast enough to insure required production and then take his problem to his supervisor in order to obtain additional pressure or influence necessary. He must establish a system of regular but simple checks which show

him how his particular line is performing.

Next in line is the production follower. As the new requisitions are received they are assigned according to type of apparatus to the production follower. Once a requisition is received it becomes and remains his responsibility until the apparatus called for on the requisition has been built, tested and shipped. The actual duties of a production follower will be taken up in detail under the heading of "Production Following."

A special section is set up to handle all orders placed with vendors. Here the section leader has the responsibility of handling all transactions with firms from which component parts are purchased. In addition to obtaining materials on time to meet production schedules, quotations and bids must be obtained before placing orders so that benefit of discounts, price breaks, and lower prices may be realized. Added to this is the handling of all rejections on vendors' material. He must know where to buy quickly and at the lowest price.

Next there is the position of stock supervisor. This position, although bearing the title of "Supervisor" is equivalent to that of "Section Leader." This leader is responsible both for a group of office personnel and the stockkeepers and general stock help in the factory. He is responsible for expediting all component parts ordered from contributing divisions located in the same plant, for receiving and storing all materials, both from contributing divisions

and outside vendors, and for servicing the manufacturing department with all materials and parts necessary to build apparatus. One may wonder why this particular phase of the work is included under the heading of production. This is so because the production department is responsible for:

1. Inventory Control
2. Expediting Parts to Meet Schedules
3. Providing Manufacturing with All Materials Necessary to Build
4. I.M.E. (Indirect Manufacturing Expense)
The stock men are day workers and are paid on a weekly salary basis which is classified as indirect manufacturing expense.

The process carried out once an order is received in the production department is as follows. First, it is assigned to a production follower. It is scanned to see if the apparatus called for is standard or special. If standard the order is normally shipped from warehouse stock on date requested. A stock requisition may then be started to replenish warehouse supply. If it is an order for an off standard or special piece of apparatus to be made to customer's requirements, copies of the requisition are sent to the engineering and drafting departments. These departments in turn process the order and issue necessary papers to the planning department so that they in turn can perform the functions required to get the order into production on schedule. Through all these steps it is the responsibility of production to see that each department involved carries out its duties quickly so that requirements are known and scheduling and

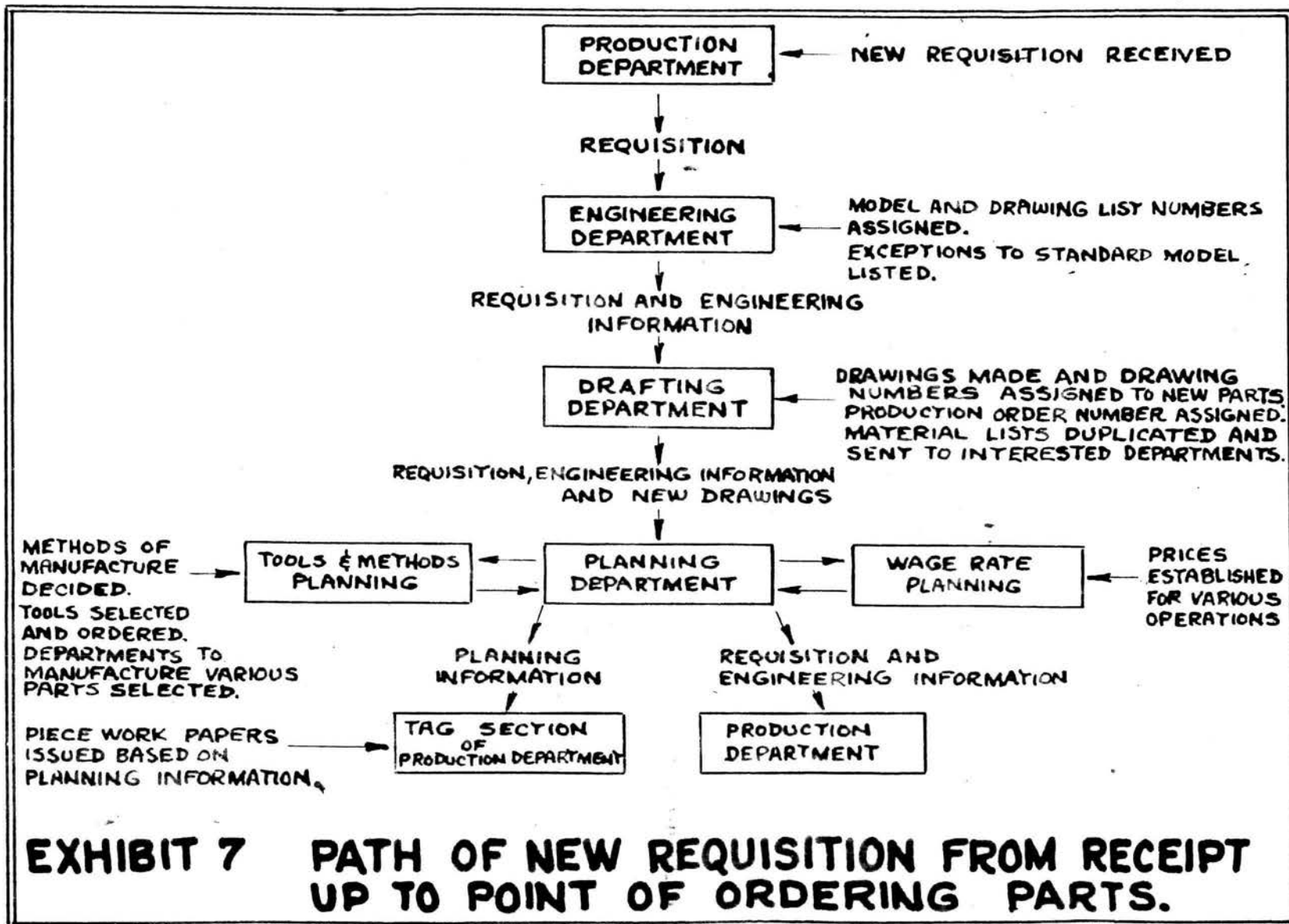


EXHIBIT 7 PATH OF NEW REQUISITION FROM RECEIPT UP TO POINT OF ORDERING PARTS.

ordering can be started. Exhibit 7 on page 26 shows path requisition travels from the time it is first received in the production department until it is ready for ordering of component parts necessary to make required apparatus.

What takes place from this point on will be covered in subsequent chapters on "Production Following" and "Ordering of Materials."

2. Exhibit 7 indicates that an order must pass through engineering, drafting and planning before the production department can proceed to take further steps in the direction of its ultimate goal, shipment of the apparatus on the customer's requested delivery date.

The engineering department is organized basically in the same manner as the production department inasmuch as certain lines of apparatus are assigned to certain engineers. In other words, just as the section leaders in production specialize in certain lines so do the engineers specialize in certain lines. When an order for a transformer is received it always goes to those engineers specializing in transformers. We will use this example to outline briefly what takes place in the engineering, drafting, and planning departments.

The engineer considers carefully the requirements contained in the requisition to determine whether the apparatus in question is the same or similar to any of the specifications which are ordinarily manufactured or whether it is a very special machine. The decision is based on the engineer's

knowledge of transformers and reference to records which show what has been manufactured previously.

- a) If it is a strictly special item a new drawing list number (DL) is assigned, the various components determined and the requirements are passed on to the drafting department for new drawings to be issued.
- b) If it is basically the same as a machine manufactured previously the drawing list of that machine is assigned and the variations are noted. This information then passes on to the drafting department.

In many cases the production department receives what is known as a "proposition" before an order has actually been obtained. Under these circumstances some of the preliminary work outlined above is actually performed in advance. The purpose of the "proposition" is to determine whether

- a) The customer's requirements can be met.
- b) The required apparatus can be manufactured at a profit.
- c) The delivery time required can be met.

These questions must be answered to the customer's satisfaction before he will actually place the order.

3. In the drafting department each draftsman is assigned a certain line of apparatus. When requirements for a transformer are received from the engineering department they are given to the man specializing in that particular line. The draftsman then proceeds to make any new drawings required and to decide what component parts shall be used for a new sub-assembly. These decisions are based on the

draftsman's knowledge and on the information contained in the various catalogs at his disposal. In many instances it is a decision made only after consultation with the methods planning department. The planning department decides whether or not a component part can be successfully manufactured within the plant by a contributing division or within the apparatus division itself.

When the draftsman has completed his work the results pass to a section of the drafting department known as the material list section. Here lists of component parts known as material lists are typed up to cover requirements of new drawings. Master copies of old prints are taken from the material list file and duplicated. These are then combined to show a complete set of component parts required to build the apparatus and copies are mailed out to all those concerned such as the production and manufacturing departments.

4. The planning department is divided into two sections

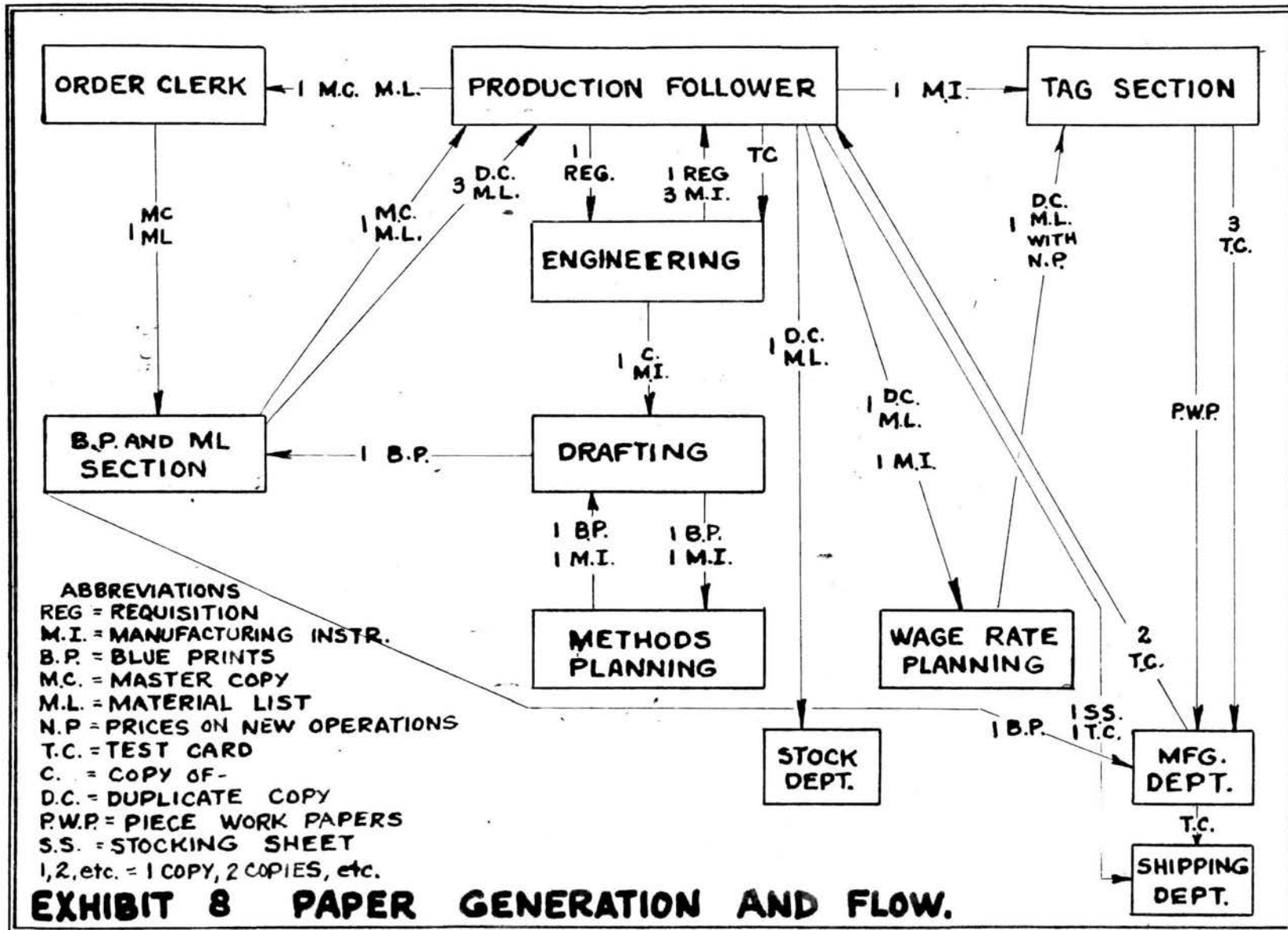
- a) Methods planning
- b) Wage rate planning

In many cases the work of one overlaps that of the other. However, upon receipt of requirements from the drafting department the planning men go to work to determine which parts will be made in the apparatus division and which in contributing divisions. This decision is based on the knowledge of

materials and machinery, which division is best set up to manufacture the required parts, and by referring to records of similar parts previously manufactured. This group must also decide on and order new tools. All this must be done according to a schedule in order to meet delivery requirements. This is known as the methods group.

Next there is the wage rate group which, again relying on knowledge of machine operation, previous jobs with similar operations and through reference to records of similar work previously performed, establishes piece work prices for each operation to be performed in the manufacture of a new part. In the case where a component part is one which has been previously manufactured, it is simply a matter of using prices previously established. In some cases the wage rate group makes a time study of a job. This latter operation is an important one because a poor time study may easily cause dissatisfaction on the part of operators and by bringing about a labor case, make it necessary to restudy an entire price structure for certain types of operations.

5. The paper flow necessary to set the manufacturing process in motion is a complicated affair. As in many other lines of business unless it is watched carefully, jobs stop and we must be ever on the watch to determine if we can eliminate any of the paper in use and still obtain the desired movement. Care must be taken that unnecessary pieces of paper do not creep into the system to add to the detail and increase the time required to process an order. The larger



the organization and the more it is spread out as evidenced in Exhibit 2, Page 14, the greater the amount of paper required and the more often duplicate sets of records must be maintained. Naturally this adds, sometimes in no small degree, to the overall cost of production and manufacture. It is not an item to be lightly regarded. We must always aim at handling the fewest possible number of papers in the shortest possible time in order to reduce the production and manufacturing cycles to the shortest time possible. This enables us to better meet competition thereby increasing the volume of output and also tends toward lower prices or increased margin or both. This viewpoint is not based on conjecture but on actual experience.

Consider Exhibit 8, Page 31, which shows the pieces of paper generated up to the point where materials are ordered. From that point on the paper generated will be considered in Chapter III under the heading of "Ordering" since it all emanates from the operation of ordering and is principally concerned with that operation.

In Exhibit 8 the "Order Clerk" and "The Tag Section" are in line with the "Production Follower" because each is an integral part of and under the jurisdiction of the production department. The "Blueprint and Material List" section is in line with the drafting department because it is a part of that department and "Methods Planning" and "Wage Rate Planning" are in line with each other because together

they comprise the planning department.

Since the requisition or order is the first piece of paper to appear, it is used as a starting point and each step in the process is listed indicating the generation and flow of the paper necessary to bring an order from the time of its initial receipt up to the point where the order clerk has ordered the materials necessary to build and all those concerned, other than expeditors (Chap. V), have been provided with all the papers necessary to build and test.

1. The Requisition - the customer's order - moves from the production department to the engineering department.
 - a) Engineers decide what apparatus will fill requirements of the requisition and issue a set of "Manufacturing Instructions" known as an M.I. These instructions indicate what the drawing number of the machine will be and whatever other requirements are necessary.

2. The next is a twofold movement - Engineering returns the requisition and three copies of the manufacturing instructions to the production follower. Three copies of the manufacturing instructions are necessary for the production follower because he requires
 - a) One for his own file
 - b) One for the wage rate planning sections in order to have prices established on new operations. This copy must be passed on by wage rate to the tag section to have piece work papers made for new operations. The piece work papers are then sent to the manufacturing department.

(Note: Piece work papers show the drawing number, operations, work stations, and prices per operation. When an operation is completed the piece work slip is punched by an inspector indicating the operator has completed the work and then goes to the foreman and from the foreman to the payroll clerk to form the basis for the weekly factory payroll.)

- c) One for the tag department to have piece work papers made up at once on those operations already having previously established prices. From the manufacturing instructions the tag section makes up three copies of a test card showing the drawing number, requisition number, serial number, and production order number of the apparatus. These copies are sent to the manufacturing department.

Secondly a copy of the manufacturing instructions is sent to the drafting department.

3. The drafting department following the instructions makes drawings for new parts and sends them to the methods planning group.
4. The methods planning group decides what tools will be required, where parts will be manufactured. (This group also orders the tools and is responsible for obtaining them in time to meet production requirements.) This information is entered on the blueprints or tracings. This is accomplished by using a code as follows: Each component part manufacturing area is represented by a symbol. These symbols are entered opposite each part in the drawing legend. E.g. 222-50-2-49 would indicate Department 222 would start a job and it would then move successively to Departments 50 and 2 for additional operations and finally to Department 49 where it would be assembled into a piece of apparatus as a component part. The planning department then returns the blueprints and manufacturing instructions to the drafting department.
5. These papers next pass into the blueprint and material list section of the drafting department but before taking

up the next step in the process it is necessary to describe a material list as we will run into the term frequently as we proceed.

The manufacturing instructions mentioned in section (a) of step 1 list the drawing number of the apparatus and the drawing numbers of the sub-assemblies which are component parts of the apparatus. A material list is necessary for each of these sub-assemblies and any sub-assemblies which are in turn component parts of the sub-assemblies on the manufacturing instructions. The material lists are lists of the component parts of the various sub-assemblies required to build the apparatus. Each time a new drawing is issued a master copy of its component parts is typed and filed in the blueprint and material list section.

Returning now to the point where the blueprints and manufacturing instructions have reached the material list section we find the following takes place.

- a) The master copies of all previously existing material lists are removed from the files and combined into one set of papers.
- b) New master copies of material lists are typed for all new drawings.
- c) These new master copies are added to those in (b) and the whole is labeled as an ML (that is a complete list of all component parts).
- d) Also copies of all new prints are sent to the manufacturing department so that they will be on hand in time for machining and assembly - all previously existing prints are already on file in the manufacturing department.

The material list is then sent to the production follower who is thus informed his requisition is ready for ordering. The production follower enters on the upper right hand corner the date he will require materials in order to assemble and meet delivery promise. A P.O. or production order number is then assigned which will identify the order easily during the ordering and building period. The master material list then passes on to the order clerk.

6. The order clerk places orders for all materials not on hand, placing a check mark (✓) opposite each item ordered and O.H. (on hand) opposite each item already in stock.
7. The master material list then moves back to the material list section of the drafting department where three copies are duplicated from the master copy.
 - a) The master copy is then refiled in the material list section.
 - b) The duplicate copies are sent to the production follower.
8. The production follower next:
 - a) Files one copy with his requisition in order that he may know all the requirements of the job and keep up to date on the progress of the parts required.
 - b) Sends one copy to the wage rate planning group to have piece work prices set on new operations on component parts.
 1. This copy is then sent to the tag section to have piece work papers issued. These piece work papers in turn are sent to the manufacturing group in the factory

to cover payments for the work performed in manufacturing the apparatus.

- c) Sends one copy to the stock department so that stock men may accumulate and deliver parts to manufacturing according to schedule set for assembling machine. Also the stock department checks the parts called for on each material list against the stock on hand and if any is missing a shortage sheet (a standard form) is issued to the production follower so that he may take the necessary action to obtain the missing parts.

9. When the apparatus has been built and tested, the test cards are stamped showing apparatus has passed test and they move on as follows:

- a) One copy is attached to the apparatus and moves with it to the shipping department.
- b) Two copies are returned to the production follower to close out his requisition and he in turn sends:
 1. One copy to the engineering department where it is filed.
 2. The second to the shipping department where it is compared with the copy on the apparatus and it is then used to close out shipping department copy of requisition.
 - a. At this time the production follower also makes out a "stocking sheet" showing the quantity, serial, and type of apparatus. This sheet is sent with the test card to the shipping department.

A study of Exhibit 8 plus the run down enumerating the generation of the various pieces of paper and the reasons for their generation readily emphasizes the complex operations necessary in order to reach the point where

materials can be ordered and expedited. It also demonstrates the care that must be taken

- a) To have the most minute detail correct.
- b) To avoid the addition of any more pieces of paper.
- c) To constantly search for worthwhile short cuts and elimination of paper.

The salaries of the clerical help required to make, handle, and file the paper is a large indirect manufacturing expense item when we stop and consider that under present union rates, the lowest salary is over forty dollars per week. This amounts, at the minimum, to more than two thousand dollars per person per year.

The origin of an order, the general organization of the production department, its relation to the engineering, drafting, and planning departments as well as the paper work system necessary to start an order on its way to completion have been covered and thus far it is evident that a great amount of work and expense is unavoidable in the fields of apparatus manufacturing such as that of steam turbines and transformers, to name only two examples, in order to set all the necessary wheels in motion. Yet this represents only part of the detail and work necessary to actually engineer and build such a piece of apparatus. Not the least important of the other phases of production work is that of ordering materials which will be the next function considered.

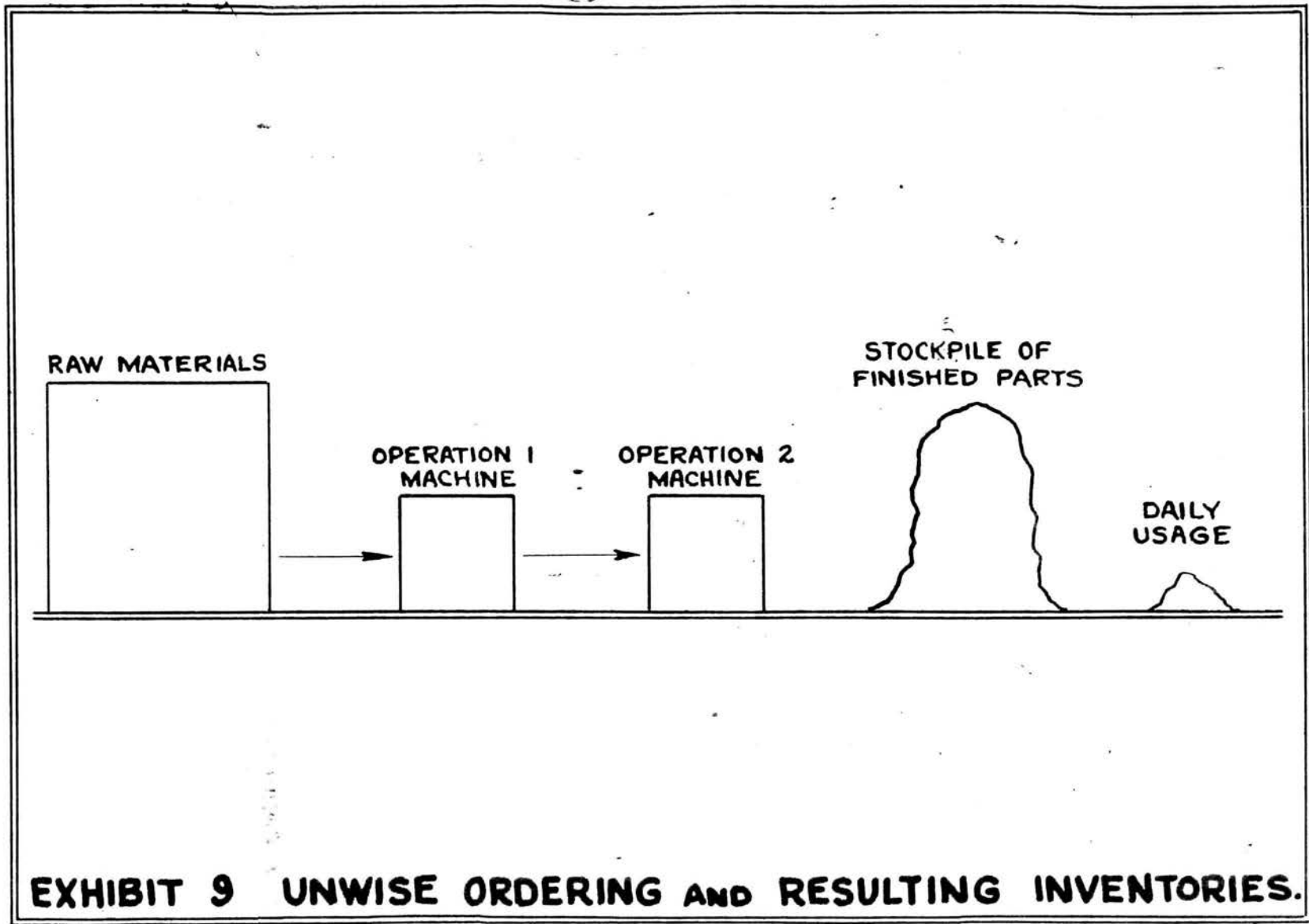


EXHIBIT 9 UNWISE ORDERING AND RESULTING INVENTORIES.

CHAPTER III

ORDERING OF MATERIALS

This chapter presents the writer's observation of some of the methods of ordering used by one of the largest national manufacturers of electrical apparatus. It must be borne in mind, however, that methods vary with local conditions. For example, the application within one company may vary from plant to plant. It is true also that the application varies between companies operating in the same field. It is felt, however, that the case observed does serve to illustrate some of the basic principles and methods used today as well as certain requisites necessary for any good ordering system.

A. Efficient and Economical Ordering.

It is necessary to bring special attention to bear regarding the ordering of materials even though it is but one of the functions of a production system, because it is an operation which has a very important bearing on the end result, namely, the profit to be obtained from the manufacture and sale of apparatus. It is possible to have all other departments function satisfactorily and yet lose either profits and orders or both if the ordering is poor. This is true because unwise ordering can increase inventories to the point where the turnover is low with the result that a large percentage of invested capital is not working and therefore not earning. See Exhibit 9, Page 39. On the other hand, failure

failure to order in sufficiently large quantities or failure to order soon enough may cause delays which increase the overall manufacturing cycle and by so doing cause a loss of business to competitors who can manufacture and ship quickly enough to satisfy customers.

The responsibility for efficient ordering rests with the production department and therein lies the greatest single responsibility of any department in relation to inventory control. This is extremely important because proper inventory control can determine whether a business is to operate at a profit or a loss. Stockpiles which do not undergo a frequent turnover not only indicate an investment which is not working but they also represent an investment upon which it is necessary to continue paying taxes without receiving any return.

A main objective is to order in such a manner as to always have enough material on hand to cover current requirements and to do so in such a way that the maximum turnover is obtained. When this is accomplished proper inventory control will of necessity be realized. Two very important factors involved in proper ordering are:

1. When to order
2. Economical ordering

Let us consider each in turn.

- a) Materials should not be ordered so far in advance that they will be on the premises waiting to be used long before they are needed.

- b) Materials shall be on hand only in time for use plus a two weeks safety factor. When placing an order, delivery should be scheduled two weeks in advance of actual need in order to take care of any delay in delivery which may occur.

This brings us to the problem of correctly determining when to order. This problem necessitates a decision as to how far in advance of the shipping date of completed apparatus the component parts of said apparatus should be ordered. There are several factors which can be arranged in a basic formula which will provide the desired answer.

No. of Weeks

Assembly time	4	
Safety factor	2	
Item must be rec'd.	<u>6</u>	in advance of shipping date
Time to obtain	18	
	<u>24</u>	in advance of shipping date

The number of weeks represented are not constant but vary with type of item. For example,

- a) Raw material from outside vendor
- b) Finished part from outside vendor ready, when received, for final assembly
- c) Internally manufactured parts

Assembly time is a factor which can be closely controlled since it takes place within one's own shop. The safety factor is included to take care of unforeseen delay in delivery which may arise. However, this element must be watched because frequently the inclination is to insure against many contingencies. If allowed to go unchecked it will inevitably lead to large inventories which are synonymous with an unhealthy condition. Although general rules can be established

and a basic formula put into operation, the actual performance of the ordering function is unfortunately not always a routine operation. One of the objectives of a good ordering system should be to make ordering a routine function. However, as in all forms of business, exceptions exist. In some types of business and in the type of manufacturing which we are discussing, the exceptions are many. Let us consider a few of them in relation to three major divisions of material.

- (a) Raw materials from outside vendors
- (b) Finished parts from outside vendors
- (c) Internally manufactured parts

When ordering types (a) and (b) we encounter the matter of "Price breaks." Here the two very important factors of maintaining low inventories and substantial reduction in cost when purchasing quantity lots must be taken into consideration. Consequently, the need for good judgment is essential when establishing a good ordering procedure. Every effort must be employed to derive the greatest benefit from both factors. Consideration given to type (c) parts ordered from contributing divisions of the company must be just as careful as that given to parts ordered from outside vendors. In the case of some items even greater consideration must be given because poor ordering may set up a far reaching chain reaction within the company which will be detrimental not only to the apparatus division doing the ordering but also to other apparatus divisions ordering materials from the same contributing divisions. To illustrate:

- a) An apparatus division engaged in the

manufacture of transformers may issue a schedule for core leg requirements which will require the contributing division to

1. Order large quantities of steel from outside vendors.
2. Increase the labor load in order to turn out the quantities required at the time scheduled.

Half way through this program the apparatus division may discover the schedule of requirements issued to the contributing division was too heavy and immediately, before any more is to be invested in an inventory which cannot be moved quickly, a cancellation of the balance of the schedule is issued.

The result is very unsatisfactory because,

- a) The contributing division is left with a static inventory of steel.
- b) The labor load must be reduced at once.

Later when apparatus requirements increase again and new orders are placed, parts cannot be obtained as quickly as needed to meet requirements because the labor load must be increased and trained before the required output can be met. Unfortunately, this example is not one which is rare and infrequent but it is one which may occur over and over so that the contributing division is ever in a process of labor fluctuation on one hand and ever in an unhealthy inventory condition on the other hand. Added to this is the fact that the fluctuation of the labor load affects the requirements of other apparatus divisions which order parts from the same contributing division. Another example of poor ordering

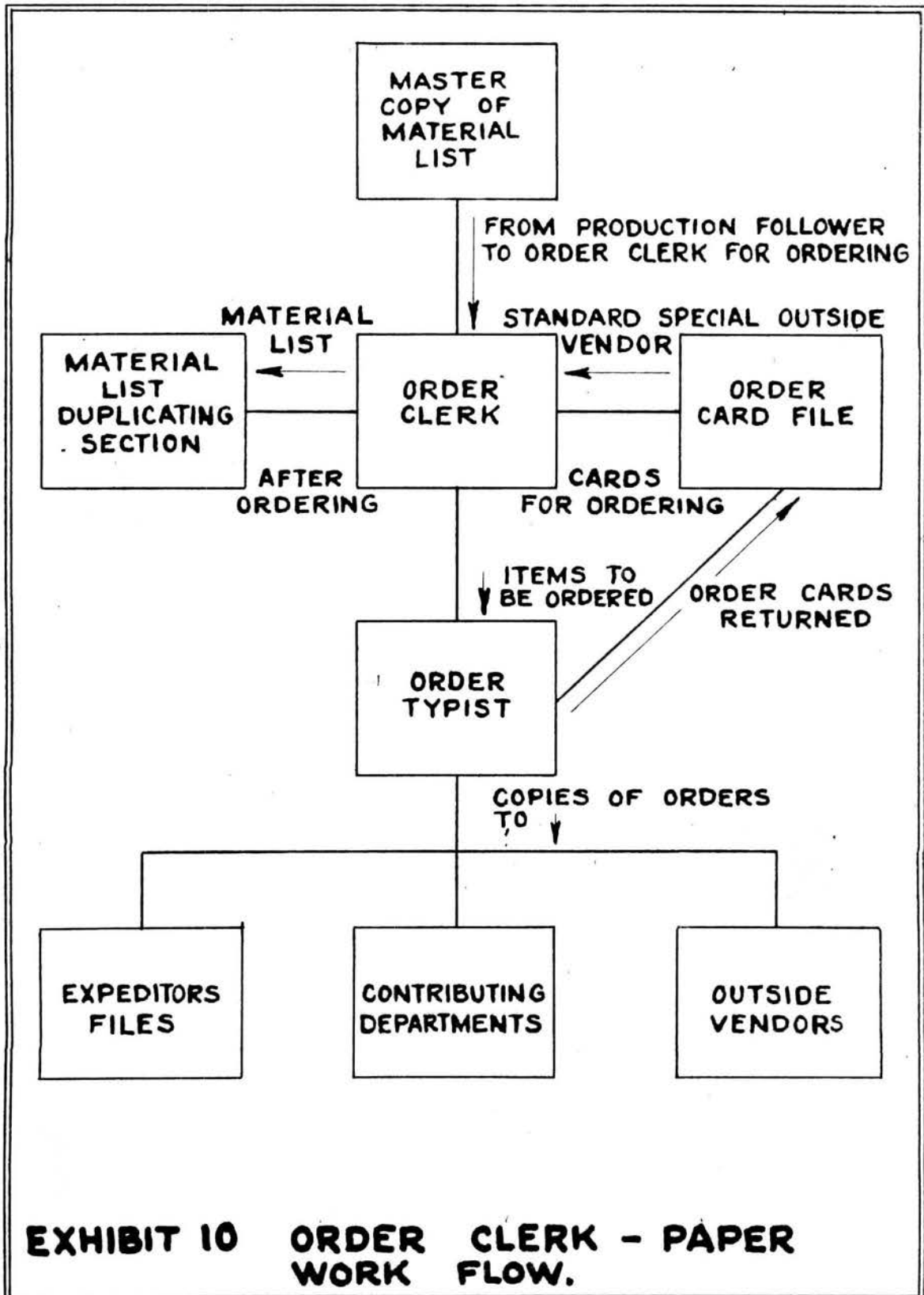
still more far reaching in its effects is that found in the case of copper wire. In this instance, the contributing division obtains the raw material (bull ring) not from an outside vendor but from a second contributing division located in another plant hundreds of miles away. Here, poor ordering affects not only the labor load within one plant but also the labor load and inventory of a second plant which contributes not only to one plant but to all the plants of the company.

1. The Order Clerk

Experience indicates that many persons have the mistaken idea that almost any individual can satisfactorily carry out the duties of an order clerk. This could be true only if the ordering function were strictly routine. Unfortunately this is not true. Consequently, an order clerk must be one who has the ability to do more than merely issue orders in a routine manner day in and day out.

Chapter II described how orders originated, special and standard items, the processing of a requisition through Engineering, Drafting, and Planning and its ultimate return to the production department and the order clerk. Let us now consider what happens when the order clerk receives a requisition for ordering of component parts of a piece of apparatus.

The requisition as represented by the material list shows each part required for final assembly. These parts are



arranged in groups called sub-assemblies. The order clerk must perform the following functions:

- a) He must check each item on the material list against its respective order card.
 1. If an item is shown on the order card as a "standard" item he records "on hand" opposite that item on the material list.
 2. If an item is shown on its respective order card as a "special" item, he must enter the date, quantity required, and the date required on the order card. The cards covering those items to be ordered are held one side until he has checked each item called for on the material list. The order cards covering standard items are given to a file clerk for refiling.

 - b) His next step is to
 1. Return master copy of material list to material list section for required number of copies to be duplicated.
 2. Send order cards covering items to be ordered to order typist who is located in purchasing section where all outside vendor items are expedited.
 - a. The order typist makes the required number of copies in a fanfold arrangement and mails internal orders to:
 - 1) Expediting group located in stock department.
 - 2) Contributing department.
- and outside vendor orders to:
- 1) Outside vendor.
 - 2) Purchasing department expediting group.

The typist stamps on each order card the date the order was typed.

If we consider these steps quickly without pausing to give the matter careful thought it would appear that the order clerk has only to follow certain established steps in order to do a good job of ordering. Such an assumption is very misleading. In the process of performing the routine duties outlined the order clerk must perform other functions which are most essential to good ordering. These additional functions are many and the principal ones he is called upon to perform are as follows:

- a) Exercise of good judgment in all phases of the ordering procedure.
- b) Order and schedule all parts in relation to their requirements relative to shipment of completed apparatus.
- c) Obtain and maintain materials in inventory at lowest possible cost.
- d) Maintain smallest possible operating inventory.
- e) Watch carefully inventory balances on hand.
- f) Be careful to note and provide for any special requisition which may come along which will place a heavy drain on standard stock inventories.
- g) Be careful to cancel, reduce or extend delivery dates when inventories begin to build up.
- h) Change minimum and maximum requirements on order cards as increases and decreases in needs take place.
- i) Change "special" items to "standard" items when order card reflects increased usage and change "standard" to "special" when order card shows decreased usage.
- j) Determine stock order quantities.

In order to properly perform these functions, the order clerk must have an accurate knowledge of what must be done in order

to come up with the correct answers. To illustrate, let us consider some of these factors and what constitutes their proper determination.

- a) Ordering and scheduling of parts in relation to their requirements relative to the shipment of completed apparatus. This involves determination of requirements in terms of quantity and time. The time structure is the procurement and manufacturing cycle and each item must be scheduled to its proper place within the cycle. The scheduling cycle must be expressed in weeks or months for each type of apparatus. Each component raw material item must be assigned its proper place in the apparatus schedule. The shipping date is the base and each item is required a definite length of time in advance of completed apparatus shipping date.

Manufacturing cycles are very important and the order clerk, although supplied with information pertinent to these cycles, must be familiar with them and know how to use them correctly.

- b) Obtain and maintain an inventory at lowest possible cost.
- c) Maintain smallest possible operating inventory.

These two functions can be considered together because they are so closely related. If properly executed they lead directly to the establishment of a correct inventory flow, a main objective in all types of business.

Having established a time cycle, the order clerk must adhere to that cycle in determining when material is to be ordered and received and must use it also when deciding which minimum quantities must be on hand and on order to provide safe but not excessive coverage. This involves not only the problem of how many pounds or pieces to receive at one time but also the question of how to benefit most by ordering in economical lots. When lot quantities are ordered every endeavor must be made to have the vendor deliver in portions of the total as required by established shipping schedules of the end product. To illustrate briefly:

Quantity to be ordered = 12,000 pcs.
 Rate required = 2,000 pcs. weekly
 Schedule delivery at = 2,000 pcs. weekly

In this way a flow of inventory is established which most nearly approaches the actual output of finished apparatus and therefore, the inventory turnover is increased. This naturally brings the greatest return on the investment made.

d) Determine stock order quantities.

This problem is very important because when ordering stock items an investment is made based solely on the amount of business we anticipate will be done in the next three, six, or twelve months. It is a definite gamble. It is not the same as in the case of special parts where it is known there are requirements for all quantities ordered. This function requires most careful consideration of those factors which lend the closest control over this type of inventory such as:

Anticipated Usage
 Procurement Time
 Protective Stock
 Maximum and Minimum Order Quantities
 Design Status
 Direct and Indirect Costs

In carrying out this function, the problem of ordering economical lots is encountered. The question is whether definite quantities, worked out by formula, should be adhered to or economical lots involving larger quantities should be ordered. Basic formulas can be used to determine economical lots but their application cannot be arbitrary. The order clerk must also use good judgment.

A good order clerk therefore must be one who not merely performs routine paper work functions well but one who,

- a) Knows the objectives of the ordering function.
- b) Is aware of all factors affecting the ordering function.
- c) Clearly understands all factors involved.

- d) Follows a definite systematic plan in the performance of all functions.
- e) Exercises good judgment in all phases of the job.

Considerable stress has been placed on the topics of ordering and the order clerk because they occupy a key position in relation to the success of a business and because they are definitely the responsibility of the production department. Therefore, since they play such a vital part in the successful operation of the production department and the overall healthy condition of the business, it is necessary to supervise this work carefully. Experience has proven that unlimited ordering privileges must not be granted. Definite restrictions must be set up and enforced. All orders in excess of a certain amount must be approved by the immediate supervisor. All orders in excess of six-months requirements must be approved by the division inventory control supervisor. Unfortunately, the writer has only too often observed inventory control supervisors who were merely statistics clerks invested with a title who devote most of their time to drawing up charts and keeping stock usage records.

B. Present Trends in Ordering Systems.

The preceding paragraphs have shown the importance of the relationship between ordering and inventory control, the requisites of a good order clerk and the result, good or bad, which his work has on good inventory control. From this it follows that there is a direct effect exerted on the abil-

ity of an organization to meet delivery promises on a profitable basis. This means also the ability to surpass or to at least meet on equal footing, competitors in the same field.

However, the objectives of good ordering cannot be adequately realized regardless of the ability of the order clerk if a basically sound ordering system is lacking.

Therefore, let us next consider the two major systems observed in operation by the writer. They must be considered in a general way because each plant and each division within a plant has different problems and must operate under different local conditions. Variations in details of necessity exist. The fact that two major systems exist raises the question "Why two systems in operation?" The answer is simply that experience has finally brought home the very great importance of inventory control and as a result methods which have been in use for many years are now considered inadequate to supply the desired degree of control. The transition to new and what are believed to be improved methods is in its early stages. The new system must prove its basic worth before it is adopted for general use. The two systems are known as the present or old system and the new or peg board system. For purposes of further discussion they will be referred to as old and new systems.

1. The Old System.

In ordering, regardless of method used, each item is classified in one of two categories:

USAGE		ORDER CARD				IDENTITY- 465422		WASHER - STANDARD		
M	1950	ORDER DATE	1/21/50	3/21/50						
J	900	POINT QTY.	2200	1200				STOCK CLASS- C		
F	800	WEEKLY DATE	1/20/50	3/21/50						
M	1000	NEEDS QTY.	400	200				MODEL 1406A .		
A		ORDERING DATA-WEEKS			COST 5 - PER 1000		ROUTING - 125-16-2			
M		DATE	1/2/50	3/21/50						
Je		DELIVERY TIME	3	3						
Jy		PROT STOCK	800	400			ECONOMICAL LOT-5000			
A		ORDER TIME	1	1						
S		ORDER NO.	QTY.	DATE ISSUED	DATE WANTED	ORDER NO.	QTY.	DATE ISSUED	DATE WANTED	REMARKS
O		+ 1702	5000	4/3/50	4/24/50					3-28-50 - 1000 REJECTED
N										
D										
T _o										
T										

EXHIBIT II STANDARD - STOCK CARD.

USAGE		ORDER CARD				IDENTITY - 31052		SHAFT (SPECIAL)	
Mo	1950	ORDER	DATE						
J	0	POINT	QTY.					STOCK CLASS - B	
F	0	WEEKLY	DATE					ROUTING - 5-20-165-406	
M	0	NEEDS	QTY.						
A		ORDERING DATA (WEEKS)			COST - \$ 75. ea.		MODEL - XN2106		
M		DATE	2/11/50						
Je		DELIVERY TIME	5						
Jy		PROT. STOCK	0						
A		ORDER TIME							
S									
O		ORDER NO.	QTY.	DATE ISSUED	DATE WANTED	ORDER NO.	QTY.	DATE ISSUED	DATE WANTED
N		4492B	3	4/10/50	5/31/50				
D									
To									
Mo	19								
J									
F									
M									
A									
M									
Je									
Jy									
A									
S									
O									
N									
D									
To									

EXHIBIT 12 ORDER - CARD FOR SPECIAL ITEM.

MATERIAL - STEEL		SPECIFICATION - XYSB				COST \$ 500. PER TON					
		MODEL - B2921-2				STOCK CLASS - A					
VENDOR NO.	VENDOR	ADDRESS		WEEKLY	DATE	1/5/50	2/10/50				
1	ALL STATE STEEL CO.	LOS ANGELES, CAL.		NEED	QTY.	1,000	1,000				
2	NORTH AMERICAN PRODUCTS	PITTSBURGH, PENN.		ORDER	DATE	1/5/50	2/10/50				
3	GROMLEY STEEL INC.	BRIDGEPORT, CONN.		POINT	QTY.						
4				ORDER	DATE	1/5/50	2/10/50				
5					DEL. TIME	6	6				
6				DATA	PROTECTIVE STOCK	2	2				
7				(WEEKS)	ORDER POINT	8,000	8,000				
VENDOR NO.	DATE	QTY.	SHIPPING DATE	TYPE X	DATE	PURCHASING APPROVAL	DATE	ON HAND	ON ORDER	ASSIGNED	MONTHLY USAGE
2	1/5/50	8,000	2/16/50	C.L.	1/6/50	N.T.	1/4/50	8,000	0	6,000	
											MA 1950
											J 4,500
											F 4,000
											M
											A
											M
											Je
											Jy
											A
											S
											O
											N
											D
											TOT

EXHIBIT B3 OUTSIDE VENDOR ORDER CARD.

- a) Standard
- b) Special

Under this system each time a customer's requisition for apparatus is received, a completely new set of papers (Material List) is issued. The order clerk then proceeds to automatically order all special items and to check all standard items as on hand. Order cards are maintained only on those items classified as standard. The classification as standard is based on individual knowledge and inaccurate records of past usage and increases in rates are taken care of only in a haphazard manner. In some cases a particularly large requisition is considered and rate increases are reflected on the order cards. However, some items are always overlooked. Standard stock supplies are supposed to be controlled by the factors shown on the order card (refer to Exhibit 11, Page 53). The main control is through the determination of maximum and minimum quantities or order points. When a minimum allowable on hand quantity is reached a new order is issued to bring the stock up to the maximum allowable on hand quantity. The minimum is equivalent to time necessary to replenish stock. This includes ordering time, procurement time and a safety factor called protective stock (see Exhibit 11, Page 53). These points of information can be satisfactorily determined under the old system. The next important factor is that of order point quantity. This is equivalent to the number of weeks times the anticipated consumption rate. The element of anticipated consumption is too often based on past usage

rather than on sales estimates and backlog of unfilled orders. When the stock on hand and on order reaches the order point quantity a new order is issued. The stock on hand is determined by having the stock department take periodic physical inventories.

This briefly is a general outline of the old system. There are some variations due to local conditions and in some cases closer control has been achieved by certain changes in this system. Sometimes improved control has been obtained by giving special attention to the physical inventory aspect and by accumulating and delivering materials to manufacturing unit by unit as they are to be assembled. Self service stock for assembly is not permitted on the manufacturing floor.

2. Peg Board Explosion System.

The peg board system is the result of the search for an improved mechanical system of ordering. It is an attempt to reduce ordering of standard parts to a more routine operation. Under this system special parts continue to be ordered only when required to fill existing customer requisitions. The final objective is to control ordering to such an extent that inventories are always in a healthy condition. It naturally follows that if the desired inventory control is achieved, a smoother flow of materials and an elimination of stock delays along the manufacturing lines will follow.

Basically the system attempts to determine more

accurately standard material requirements by establishing definite production rates in terms of completed units by individual types or models and by breaking down the units into requirements for manufactured parts and purchased parts including raw materials. Following this method a developed want is established for special periods of time and each individual item is related to the sub-assembly or finished apparatus in which it is used. The term "special periods of time" is used because an explosion or determination of individual parts requirements is made periodically. In one installation observed by the writer quarterly requirements are determined and then each six weeks during the quarter an explosion is made. Also, an explosion takes place whenever a substantial change in rate of finished apparatus occurs. Study and experimentation with the system have indicated that it is best to operate on this basis. These periods can be changed to accommodate special conditions which may exist.

The "peg board" is developed from engineering documents and from this comes the prepared cata which furnishes the basis for ordering. The engineering department in conjunction with the production department determines all current basic models. A basic model is one comprised of standard parts. From these basics many specials can be built because they require only a few special parts while the majority of their components are standard. The standard parts are ordered by the peg board system and the special parts

are ordered only as required for each model using them. When the basics have been determined the following takes place:

- a) A sheet is set up for each line of apparatus listing all basic model numbers in that line (Exhibit 14 , Page 59).
- b) Next a sheet is set up for each basic model listing all component parts and showing the routing or source from which each part is obtained. Each basic sheet is assigned a number and a letter. The number indicates the line of apparatus and the letter the contributing department or source from which part is obtained (Exhibit 15, Page 60).
- c) A third sheet is set up for each contributing source. On this sheet is entered the name, drawing number and total quantity of each item required for all models for a six-week period. The apparatus line code number and contributing source code letter appear at the top of this sheet. (Exhibit 16, Page 61).

Each sheet provides sufficient space to insert requirements as they arise. Every six weeks requirements are "exploded." This means all orders or commercial requirements on hand at that time are entered and plotted, to arrive at a developed want for each standard item for a six-week period. For example, there may be a requirement for twenty units of model #5152. This model would be located on the master list of basic models and a figure 20 would be entered opposite that particular model number and under the six-week period being covered. Then the sheet on which the component parts of this particular model are listed would be consulted. This second sheet shows the number of pieces of each item required to build one unit. Therefore, each of these unit quantities would be multiplied by twenty, the number of units to be

built, and the resulting figure entered opposite its respective item. This sheet would indicate by code number the source of each item, for example, 15c (transformer part obtained from screw-machine division). The source sheet is headed 15c. Therefore, the next move would be to consult sheet 15c and enter the required quantity of this item. From this latter sheet would be determined all the parts necessary to order from a given source for the next six-week period. Orders would then be placed accordingly. If the item in question was a sub-assembly, the first breakdown would refer to another sheet showing components of the sub-assembly and this latter sheet would through routing code refer each component to its ultimate source sheet. In this way every six weeks' total requirements for all standard parts necessary to build all basic models on order for the following six-week period are determined. This method permits easy explosion of individual models into detail requirements. The ordering section compares the developed want resulting from the peg board explosion with stock on hand and on order and issues new orders to cover the resulting deficiencies.

In the treatment of the old system of ordering it was specifically mentioned that physical inventories were a part of the system since it is essential to know the quantity on hand before issuing new orders. Under the peg board system accurate inventories are essential. Inventories are obtained not by physically counting stock periodically but in

an automatic manner by use of what is known as the "bin reserve" stock system. This system operates as follows:

- a) A small white card is issued for each standard stock item. The card shows:
 - 1) Identification of item
 - a. Name
 - b. Drawing number or size
 - c. Type of apparatus on which item is used
 - 2) Bin reserve quantity. This quantity is the same as the quantity showing on the order card as necessary to cover the replenishment cycle.
- b) These cards are sent to the stock department where the quantity showing on the card is removed from the general stock area and is placed together with the card in a separate stock bin in a locked area.
- c) Whenever an item is exhausted in the general stock or assembly area the stockman removes the reserve quantity from the locked area and places this quantity in the general stock area. At the same time the stock clerk records on the card the date the reserve quantity was sent to the general area and then sends the card to the order clerk.
- d) The order clerk refers to order card for any decrease or increase in rate and issues a new order.
- e) The order clerk records date and quantity ordered on card and returns it to stock department and it is placed in open file by drawing number or other identification where it remains until new order is received. At that time reserve quantity is removed from total received and is again placed with card in locked area.

Experience has already proved that this system, operated as outlined, does provide the accurate "on hand" inventories required for a good ordering system.

Under this system the order clerk performs basically the same operations outlined under the "old or order point" system" in sub-topic one of this chapter. However, some of the work that is part of the old system has been eliminated while some new operations have been added. In the peg board set-up it is not necessary when ordering for a new requisition to check every part required against the order cards. Only the special parts must be checked for ordering. This is accomplished by the control established over standard stock by ordering to developed rates by means of the peg board explosion system and by use of the bin reserve system of physical inventory control. Standard stock in sufficient quantities should be on hand at all times excluding of course abnormal conditions encountered in obtaining stock from contributing divisions or outside vendors. The paper which must be processed in ordering for a requisition consists of the following:

- a) A complete material list just as in the old system.
- b) A "sepia" - a sepia is a sheet showing sub-assembly drawing number and indicates any part or parts which for that particular requisition are replaced by special parts. The upper half of the sheet is titled "Omit" and shows part normally called for and lower half of sheet is titled "Add" and shows the special part which replaces the part ordinarily called for in that particular assembly. In the case of a sepia, the order clerk treats the added part as a special item and orders only enough to cover the particular requisition on hand.

Two other additional operations under the peg board system are:

a) Making periodic explosions to determine needs for new period.

b) Operation of the bin reserve system.

Additional items of information to lend assistance in doing a good ordering job and in further controlling inventory are:

a) Economical lot quantities

b) Cost of item

In the case of an economical lot item the rule governing ordering only to cover developed rate plus a safety factor is suspended in order to take advantage of price breaks. However, this type of ordering is governed by restricting economical lot items to low cost items. One example would be hardware such as screws, bolts, nuts, and cotter pins. The item of cost showing on the order card acts as a guide both in the case of economical lots and all other items because all items are further classified into A, B, and C groups. Class A indicates the highest priced items and definite limits in dollars are established for this group. Each of the other classes are arranged in a similar manner in a descending scale of dollars. That is to say "B" is a lower cost group than "A" and "C" is a lower cost group than "B."

Comparison of the Two Systems

Bearing in mind primary objectives of all ordering:

- a) Purchase of materials at lowest possible cost.
- b) Maintenance of lowest possible operating inventories.
- c) Smooth, speedy and economical servicing of requisitions.

Let us compare points of difference in the two systems which points exert a definite influence upon the realization of the primary objectives.

The Old System

The Peg Board System

Classification of Items As Standard Or Special

Classification based on past usage and order clerks knowledge of stock. This method is easily open to error because many different apparatus models and consequently many thousands of items are involved. An order clerk cannot accurately know all items and all the changes which may affect their usage. Many items originally classified as special are gradually adopted for use in many different models but there is no card record to show this fact. Consequently, each time a new requisition is ordered these items are ordered in small quantities only as required. This means they cost more than if ordered in larger standard stock quantities.

Classification is based on definite information furnished by engineering data. A card record is maintained for all special as well as standard items. Repeated use of special items becomes evident and these items are reclassified as standard. This brings about a reduction in cost and helps to decrease overall manufacturing cycle because stock is on hand at all times to cover new requisitions. Also quantities ordered are based on fact with the result that a closer approach is made to the ideal healthy inventory condition desired.

Order Point Quantity

The order point quantity is based very often on usage whereas actually it should be determined by number of weeks (procurement time plus protective stock) multiplied by the anticipated rate based on sales estimates and backlog. When based on past usage very often too large or too small inventories are maintained. This method is not particularly good for apparatus business because items are considered as separate entities unrelated to the types of apparatus in

Under the peg board system, the order point quantity is actually based on sales estimates, unfilled orders and a bin reserve quantity which is based on actual facts derived from engineering data. In addition, every six weeks a new explosion or breakdown of all requirements is made and quantities on order cards are revised to fit the new needs. Under the explosion system all items are considered in relation to the apparatus in which they are used.

which they are used.

This again gives a closer control of inventory.

Physical Inventories

The order clerk continually requires the stock department to take physical inventories to be used as the on hand factor in ordering. This procedure creates an unhealthy inventory condition because the quantities reported as on hand may be already theoretically mortgaged for apparatus units in the process of being assembled and yet the order clerk applies these figures against future requirements. The result is that units become partially assembled and cannot be completed due to shortages since the same quantities have been applied to many different units.

With a bin reserve system where protective stock is always under lock and key the order clerk does not continually require physical inventories. He has to order only when the bin reserve quantity is withdrawn from locked area to be used in actual assembly. Since the reserve quantity is supposed to be large enough to cover the replenishment period, shortages do not occur under normal conditions. There are, however, some cases where shortages do occur under this system. For example, an effort may be made to turn out units ahead of schedule and as a result so many units are placed in the assembly line at one time that the reserve quantity is too small to cover the replenishment period. A second example is that of certain items which, due to their large size, cannot be placed in locked area but must be located along assembly line. Difficulty arises here because the manufacturing group are continually drawing from this stock so that a physical inventory must be taken frequently in order to control the items. The problem has been partially solved by changing the classification of these items from standard to special and ordering only as required plus a small protective quantity. Also these are the higher priced items therefore, great care must be taken in ordering. In general, the bin reserve system does reduce the number of shortages, thereby

contributing to a more even flow of inventory and finished apparatus.

Unnecessary Inventories - Lack of Inventory

Under the old method very often items are ordered and stored simply because past usage indicates they have been moving. Future needs are not properly considered based on fact and as a result an investment has been made which will not bring any immediate return. The material lays static. On the other hand past usage may have been low and as a result orders are not placed for adequate stock to cover future needs.

The explosion system periodically indicates future need over a definite period and as a result, inventories do not run too high or too low.

Schedule Items

Some of the large higher priced items such as transformer tanks and floodlight reflectors under both systems are ordered for delivery at a certain rate per week. We mention this type of item in particular because this is where the greatest inventory investment per item is contained. In this case also usage has been the basis for ordering. The results have been most discouraging. First, large amounts are tied up in inventories which do not move. Second, many of these items are manufactured from the same raw materials. As a result, while there is a large unwanted inventory of one item, there may be a shortage in the case of a second item because all the raw material has been used in manufacturing the first item.

The explosion method determines exactly how many pieces are required for a certain period and only that quantity is scheduled.

Order Card Information

Order cards do not show all factors necessary for good ordering. Too much is left to individual judgment.

Order cards show cost of each item and economical lot quantities. These points of information are based on actual fact and aid greatly in doing a good ordering job.

Relation to Expediting

Due to the fact that the tendency is to always have plenty of stock on hand, expediting has some leeway in overcoming delays in obtaining replenishing stock.

Since inventory is much more closely controlled and under the bin reserve system only enough protective stock is on hand to cover the theoretical replenishment period, expediting is a strictly pressurized job. Delays must be overcome at once and stock obtained. Otherwise, assembly lines stop and promises to customers are not maintained.

Considering the points outlined, the peg board system does have distinct advantages over the old system. Yet, it is not without disadvantages. For example,

- a) It is costly to install - in the case of a large organization, in addition to the regular staff, a special group of from eight to ten people may be necessary for a period of two to three years.
- b) This system is supposed to require fewer personnel but in one case in the electrical industry as observed by the writer, some reductions in personnel realized have been mandatory and have not resulted from the installation of the system. Also, as a result of the reductions, great pressure has been exerted on remaining personnel in order to operate. In some instances, personnel had to be replaced in order to function adequately.
- c) Ordering of small easily damaged items only "as required" has resulted in delays due to shortages. A shortage of the smallest

component part of an apparatus will delay the completion of the apparatus just as well as a shortage of the largest component. Under the old system, some of these parts are kept on hand all the time thus avoiding these delays.

- d) Wherever the system is installed it must be adapted to local conditions and this can be time consuming and costly.

In the final analysis, from the viewpoint of theory and from observation of the system in operation, indications are that it is a definite step in the right direction because it provides a more direct and a closer control of inventory and thereby increases the inventory turnover wherein lies the secret to a greater return on investment. Good ordering is essential to the success of any business. It controls inventories wherein lie the largest single investment after buildings and equipment. It can be the difference between failure and meeting competition on a profitable basis. It requires order clerks with good judgment. Upon these men rests the responsibility of doing the type of job necessary to operate successfully. The ordering procedure is a complex one and consequently every effort must be made to obtain an order system which will provide those engaged in the function of ordering with the proper tools, that is to say, the principles and the information necessary to carry out their duties in a manner which will insure proper inventory control.

The fact that large organizations are now willing to take from two to three years and to spend large sums in

the installation of new systems which they believe will provide the desired inventory controls, emphasizes the importance of the relation between good ordering and good inventory control.

CHAPTER IV

PRODUCTION FOLLOWING

In general it is the duty of the production group to see that requisitions are serviced (orders are filled) as quickly as possible without unnecessary expense and without sacrificing quality for speed. In order to perform this duty there must be a definite plan of operation and once the plan has been established it must be carefully carried out. Such a plan is actually a master schedule into which customers' requisitions are fitted in a manner which will permit completion of finished apparatus in accordance with delivery requirements of requisitions.

This type of plan must be based on good

- a) Planning
- b) Ordering
- c) Scheduling of individual parts and sub-assemblies
- d) Load control
- e) Dispatching
- f) Application of labor
- g) Use of machines
- h) Flow of materials

The production department must have definite overall cycles established for the manufacture of each type of apparatus based on individual cycles required for each step in the manufacturing process.

When new requisitions are received, they must be placed in the master schedule. The decision as to where in the master schedule new requisitions shall be placed is a function of the production section leader and the production

manager or supervisor. Once their decision has been made, they must then consult with the manufacturing, engineering, and planning departments to see if the schedule proposed by them can be carried out by these other groups. As a result of these consultations, original dates may have to be altered somewhat depending upon the current capacity and labor load in the factory. Once the final dates have been established, the production group as a whole must then set to work to develop individual schedules covering the manufacture or purchase of component parts, assembly and test. **This detailed work is performed by schedule clerks and production followers.** When these functions have been performed, a definite, detailed plan of action has been designed which will enable the fulfillment of the delivery dates showing in the master schedule.

A. Definition and Purpose of Production Following.

Although the most workable plans possible may be drawn up, the necessary execution of these plans may not be realized due to the wealth of details involved and due to unpredictable obstacles which may hold up any phase of the work. Consequently, there must be some guiding force always in close contact with the detailed functions necessary to achieve the objectives established in the master schedule. To act as this guiding force there is what is known as the production follower whose job in general is to see that the master plan is executed as designed and to thereby make sure

that the customers' requirements are met on time.

1. Duties of a Production Follower.

When a new requisition is received it is assigned to a particular production follower and from that time until the finished apparatus is completed and shipped it is the responsibility of the production follower to see that every phase of the work necessary to complete and ship the apparatus on time is carried out as scheduled. The principal individual duties are as follows:

- a. The production follower must make sure the engineering and planning departments complete their parts of the job as scheduled.
- b. He must make sure that the master material lists are issued and reach the order clerk soon enough to have the ordering functions performed in time to meet dates required for delivery of raw materials and component parts.
- c. He must also see that tools (which are ordered by planning department) are ordered and arrive on schedule.
- d. When component parts have been ordered it is necessary to have master material list pass on immediately to the material list duplicating department to have copies duplicated and issued to the stock and production departments. Here again these functions must be carried out on schedule.
- e. It is necessary also to make sure the stock department physically checks every item called for on material list, accumulates parts on hand and issues a shortage sheet for those items not on hand.
- f. Upon receipt of shortage sheet production follower must have check made to determine whether items on shortage have been ordered. If for some reason they have not been ordered, they must be ordered immediately on

WEEKS 1 to 6

WEEKLY CAPACITY
STANDARDS - 20
SPECIALS - 5

WEEKS

TYPE	1	2	3	4	5	6									MODEL
STANDARD	2		7	3	12	15									1406A
	4	9		11	1	1									1621D
	1		3	1	1	1									4532G
	10	6	2	3	2	2									1905 B
	3	1	8	2	3	1									2461 M
SPECIAL	3	1		4		1									1905 B - 3
	1		4		1	2									1756
		4		1	1	1									3233
	2		1		1	1									4532 G - 6

EXHIBIT 17 CAPACITY SCHEDULE.

WEEKS

PRODUCTION ORDER	REQUISITION	MODEL	3/17		3/17		3/21		4/7		4/14	
			QTY.	PRIMARY COIL	QTY.	SECONDARY COIL	QTY.	CORE LEGS	QTY.	TANK		FINAL ASSEMBLY
1702	AZ202	1525 B	1	693245	1	693246	3	201935	1	460359		
8561	BD3561	0125	1	819671	1	819672	3	561042	1	908151		
2316	I 215	7639	2	424621	2	424620	3	109605	1	506232		
1986	GE4069	2256	10	326542	10	326544	20	325001	10	367829		

EXHIBIT 18 MANUFACTURING SCHEDULE.

a rush basis. On the other hand, if they have been ordered on schedule and are overdue in relation to the delivery date called for on the orders, pressure must be exerted on the expediting group to obtain the materials at once.

- g. Piece work papers showing operations required, prices to be paid for operations, and dates by which operations must be completed, must be printed and given to the dispatcher in the factory in time to have various operations assigned to particular machines according to schedules. Here again the production follower must see that work is performed in accordance with schedule.

This particular function also carries the added responsibility, in the case of large quantity orders, of making sure the manufacturing group does not obtain piece work papers in advance of dates for which they are scheduled and as a result make up parts, sub-assemblies or completed apparatus, so far ahead of schedule that inventories are pyramided, many dollars in direct labor and materials are tied up, and inventory turnover reduced. Parts must be manufactured only in accordance with the schedule which shows the dates when they are required for sub-assemblies or final assembly.

- h. When final assembly, testing, and inspection have been completed on schedule it is necessary to issue the necessary shipping papers and make sure apparatus reaches shipping department on time and that shipment actually takes place as scheduled.
- i. Master schedules and all other schedules involved must be kept up to date at all times. This means that any unavoidable delays which cause a change in delivery date must be reflected in the schedules so that the correct current status is always evident on the face of the schedules.
- j. From the time the requisition is received and a delivery promise has been issued to the district office until the apparatus has been shipped, the face of the requisition must show the current status in relation to

delivery. That is to say, the original promise and any subsequent extensions must be recorded. Also any shortage sheets connected with the job must be attached to the requisition and show the up-to-date delivery promises on the short items.

- k. Whenever it is necessary to extend a delivery date a notification must be issued promptly to the district office.

Actually a production follower is a key man whose job it is to service customer requisitions. Once a job has been scheduled, it is his duty to see that the schedule is maintained. In order to accomplish this task he must be on top of the job at all times and be familiar with every development as the work progresses towards completion. He must co-ordinate all phases of the work to the end that all delivery promises are maintained. It is his duty to see that all others concerned perform their functions on schedule. This latter point is accomplished not through the use of formal authority, for he cannot issue direct orders, but through his ability to recognize possible delays and having recognized them, use his ability to devise means of overcoming these obstacles. He can accomplish a great deal by the careful use of diplomacy in his dealings with other people. The human element can contribute as much to delay as the lack of material. A knowledge of temperaments can aid greatly sometimes in solving such problems.

Good judgment must be exercised and when a problem cannot be solved or an obstacle overcome promptly the production follower must recognize this fact immediately and

must appeal at once to his section leader and if necessary to his production manager in order to obtain the aid necessary to overcome these obstacles. When use of direct authority is needed it must be exercised by his superiors.

2. What Should Be Avoided in Performance of Duties

As shown under topic (1) the functions necessary to adequately carry out a production program are many and varied. Certain individuals are delegated to perform each function. Their one job is to carry out their particular functions properly. They are responsible only for their own duly assigned work. The production follower's job requires him to see that all their functions are properly carried out. He must not attempt to correct their failure to perform by doing their work for them. His job is to co-ordinate and see that plans are executed. This general function is so wide in scope that once he begins to actually perform the detailed work of even a single function he will be unable to carry his overall program to a successful completion. For example:

- a. He cannot help an order clerk who has fallen behind in ordering.
- b. Nor can he afford the time to search through the factory for a piece of stock which the stock department has carelessly misplaced or lost.

Also one very important point which he must guard against is permitting the manufacturing group to run his job. By this is meant they must be made to follow the schedule which the production department has supplied. Attention is given to

this point because although the production and manufacturing groups are supposed to work together toward a common goal they have different viewpoints regarding objectives. To the production department, the schedule of delivery promises is a bible and they must co-ordinate all individual operations to meet that schedule. On the other hand, the manufacturing group is far removed from the details of production work.

The main group is split up into smaller individual groups who perform one kind of work only and the workers themselves are neither acquainted with nor have the desire to be acquainted with the important relationship existing between their work and the completion of finished units. They are paid on a piece work basis and are interested primarily in:

- a. Always having plenty of work.
- b. Performing those operations which most easily bring about the largest pay envelopes at the end of the week.

In addition to the attitude of the individual workers is the fact that their foreman too often is interested in turning out a larger number of pieces or completed units rather than turning out the work which is scheduled to be performed at a given time.

The production follower must avoid permitting his schedule to be loaded beyond the capacity to manufacture. The commercial or sales department very often attempts to push new requisitions on the production group over and above the capacity available for a certain period. In such cases

the production follower must clearly state capacity is lacking and delivery dates requested cannot be made. If he does not do this but acquiesces, he will in all probability, not only fail to keep these promises but also have to extend other requisitions which will be affected by the overloading.

Before making any report on the condition of a job he must make sure his facts are correct.

To sum up briefly, a production follower plays an important part in the production picture. Upon his performance depends, to a great extent, the degree of success attained in carrying out the overall production program for it is his duty to oversee two of the principal elements necessary in filling requisitions, namely, servicing of requisitions and execution of plans.

CHAPTER V

MATERIAL HANDLING AND STORAGE

The production department enters into the material handling picture because it is the duty of this department to reduce the time of the overall cycle of manufacturing to a minimum and to see that products are completed at a minimum cost. The more these two factors are reduced, the greater is the inventory turnover and consequently the greater the return on inventory investment.

A. Importance of Proper Material Handling.

Material handling is important to production because it is the responsibility of production to provide the correct materials in the required quantities at the proper work stations at the proper time. In other words, production must provide tools and materials as required by manufacturing in order to meet the required delivery dates for completed apparatus.

The subject of material handling should receive as much attention as every other step in the production and manufacturing process. As time goes on this fact becomes more and more apparent. The trend is to reduce manual handling of stock to a minimum. Various means have been employed to accomplish this end. In the field of apparatus manufacture as observed by the writer, handling methods have undergone continual change. The problem has been a difficult one because of the variety of items required to manufacture various

types of apparatus such as steam turbines, transformers, rectifiers and floodlights to mention only a few. There is one characteristic common to all. They are made up of small and large parts ranging from small screws and nuts to large heavy turbine casings and transformer tanks. Some casings are as much as twelve feet high, six feet wide and ten to twelve feet long. The parts are very often irregular in shape and have projecting brackets. These characteristics add great difficulty to the problem of moving and storing. Therefore, different storing and moving facilities must be worked out for each. At the present time the problem of moving has been improved greatly by providing three principal types of transportation which are adaptable because the variety of items can be roughly divided into four classes by weight. These means of transportation are:

1. Overhead cranes for extremely heavy items such as turbine casings and transformer tanks. The cranes are further divided into two classes, those which require an operator riding in a cab on the crane beam and those which can be operated from the floor by a set of electric push buttons located on the end of a cable attached to the crane. In this latter case the operator walks along beside the material as it is moved. The advantage in the hand operated type is that usually it will move any load of one or two tons and enables any employee to move material when desired without having to wait for an authorized crane operator to make the move for him. Both classes of cranes are advantageous not only because they can lift heavy loads but because they can move loads quickly in any one of five directions and some types can move simultaneously in more than one direction. They all move forward, backward, to either side, and up and down. Some will

move forward or backward while at the same time positioning the load for its next work station or storage area by moving the load upward and sideways.

2. Electric fork trucks have a distinct advantage because they not only lift and transport loads up to one and one-half tons but they also lift and place loads in storage spaces ten to twelve feet above the floor. They have such advantages as:
 - a. The ability to turn in a small space.
 - b. Loads can be transported forward or backward while being raised or lowered.
 - c. The ability to move forward or backward rapidly.
 - d. They are small enough to enter a freight car, pile or unpile, and transport material in or out.

The one essential requisite, material wise, due to the nature of the trucks, is that material must be slightly raised from the floor in order that the forks which project in front of the truck may either slide underneath in order to make a lift or having made a lift, may withdraw from under the load without being bound by the weight of the load. The problem of storing material so that fork trucks can always make a lift has been solved to a great extent by storing material on wooden pallets four feet wide by four feet long. The flooring of the pallet is raised above the building floor due to the fact that it consists of two side pieces or runners made from two-by-fours or two-by-threes and has the floor boards nailed across the side pieces. As a result only the side pieces rest on the floor so that it is possible for the forks of the truck to move in between the side pieces and underneath the flooring. Another type of electric truck in use is one which lacks a lifting apparatus but can be coupled to a steel trailer or train of trailers. This type can move an entire line or train of trailers at a rapid rate.

3. Hydraulic lift hand trucks are used to advantage for short moves in stock and manufacturing areas. They enable personnel to move loads which cannot be moved by hand. Without this type of truck it is necessary to wait for a crane or fork truck operator to make a desired move. This type of truck also permits moving such loads in areas which cannot be serviced by cranes or fork trucks.
4. Electric or hand-operated conveyors are a distinct advantage where work moves in a straight line from one operation to another. In many cases a worker can perform his particular operation right on the conveyor and when he has completed that operation he can easily send the apparatus on its way to the next operator. This type of transport saves manual or other types of transport handling and thereby saves time.

In addition to the matter of efficient equipment to make moves, arrangements can be made with vendors from whom materials are purchased to have materials packed or loaded in units which can be easily handled by the equipment available. Such units can be made up not only with a view to quick and easy handling but with a view as to what quantities are used in supplying manufacturing with materials. In this way units of material are easy to handle and store and when manufacturing requires material it can be delivered in units and it will not be necessary to break open a unit and make a partial delivery.

Thus far the matter of efficient transportation has been emphasized and little has been said concerning material storage although the matter of efficient storing is also very important. Sometimes operations can be carried on

in cases where storage facilities are not of the if efficient transportation and handling methods are in use, but only at an increased cost. The matter of efficient storage will be discussed later under stock department operation, topic "B" for two reasons

1. Transportation systems are under the jurisdiction of the manufacturing group.
2. Material storage is under the jurisdiction of the stock department.

Material handling should not be considered either as unimportant or as a matter which should be given careful thought after other phases of manufacturing work have been developed and improved. This holds true because it is necessary for all operations to have required materials properly located in the proper place and at the proper time if the manufacturing process is to move smoothly and meet required production dates.

1. Relation to Overall Cost.

Thus far we have concentrated on the relation of material handling to the physical operation of the manufacturing process but actually this function has another very important bearing on a responsibility of the production department and that is to keep costs at a minimum. If freight cars are unloaded manually there is an immediate increase in the overall cost because more people are required and more time is consumed causing an increase in the weekly payroll. If pieceworkers have to stand idly by their machines or benches, cost increases because they must be paid "waiting

time." "Waiting time" is an outright loss because an expenditure must be made even though no work is performed. In addition to this, idle machines cause a loss on machine investment. Machines are purchased with a view to the possible output. If lost time is to occur frequently, the investment might as well be in a machine that produces less but also costs less. In any business, time is money and this is particularly so in apparatus manufacturing where competitors' cycles must be met and bettered if a satisfactory amount of business is to be obtained.

Therefore, the matter of speedy, efficient and economical material handling should always be given careful consideration because time is money and no matter how well a current system may appear to operate there are always opportunities for improvement.

B. The Stock Department.

The stock department is a direct responsibility of the production department because:

1. It is the duty of the production group to provide manufacturing with all the materials necessary to build.
2. The stock group is classified as an indirect expense group. That is to say the employees of the stock department do not actually manufacture. They do not perform any work on materials. In the case of manufacturing very few are engaged in indirect operations. The majority actually perform some operation in the actual building of apparatus and it is the policy of management to keep indirect labor at a minimum in the manufacturing group.

3. The policy over the years has been for manufacturing to be concerned only with actual output. Their attitude has been a disinterested one as far as paper work operations are concerned. That this attitude is carried to extremes is evidenced by the fact that operators sometimes will not even consult a blueprint because they feel they know their operations from constant repetition. As a result, they sometimes fail to follow changes which appear on the latest blueprints with the result that holes are drilled in the wrong places, coils are wound not with the latest kind of wire required but with the kind formerly required. Therefore, since it is necessary for the stock group to perform various paper work functions directly connected with the production department schedules and orders, this group comes under the supervision of the production department.

The various problems encountered in the manufacture of apparatus make it necessary to adopt detail stock operations to fit local conditions. In all cases, the responsibilities are basically the same.

1. Responsibilities of Stock Department.

As observed in the case in hand, the responsibility of this department begins when orders are placed for materials. From that time until the parts are actually delivered to manufacturing it is the duty of the stock department to take care of the parts necessary to build a piece of apparatus. The main functions of this process are to:

1. Receive materials
2. Store materials
3. Accumulate materials in unit lots
4. Deliver materials to manufacturing on time to meet required schedule dates

At first glance these general duties may appear to be very

simple ones but the actual execution entails the performance of detailed work. The organization necessary to carry out these duties cannot be a haphazard one any more than can be the organization necessary to perform any phase of the production department work. The department consists of the following personnel:

1. The stock supervisor who is responsible for all duties and personnel. It is also his responsibility to handle all labor grievances in his department. He reports directly to the production manager.
2. Stockkeepers who are responsible for their individual stock rooms or areas and the stock help working in those areas. They report directly to the stock supervisor.
3. Stock accumulators Perform actual
4. Receivers stock
5. Stock helpers operations

The department is divided into:

1. General receiving area.
2. Individual stockrooms.
 - (a) Each stockroom services separate types of apparatus.
3. Warehouse - A warehouse is part of the stock department in some cases where large inventories are on hand or where adequate and proper storage space is lacking in the factory.
4. Self-service stocks located generally in stock racks placed close and parallel to assembly lines.

Each of the main functions which are the responsibility of the department requires the performance of a great deal of detailed work. This department must receive,

store, accumulate, and deliver to manufacturing on time each of the thousands of items necessary to build. Throughout the entire process, correct identification must be preserved and a strict accounting for all quantities received must be made. In the case of special items, the stock must be marked and reserved for the special apparatus for which it was ordered. This task cannot be accomplished without maintaining various records.

If this department does not perform its functions smoothly and correctly, the entire production schedule can be slowed down because it values nothing if all required materials are on hand but cannot be located or are improperly identified. Under such conditions deliveries are not made to manufacturing on schedule.

Therefore, an efficient economical organization is necessary if the production department is to attain its objectives of:

1. Providing correct materials in correct quantities at the required time.
2. Maintaining overall cost at a minimum because the material can easily become misplaced, lose its identification, or in the case of special material, it can be assigned to the wrong job.

2. Requisites for an Efficient Organization.

a) Storage space -

The personnel of a stock department may be very efficient but the operation of the department is not satisfactory if sufficient space is not provided because materials are of necessity crammed in one on the other.

As a result they cannot be located when needed and correct inventories are impossible. These two conditions naturally cause the ordering to be incorrect and thereby seriously affect inventory control. Enough space must be provided to permit the orderly location and arrangement of materials so that

- 1) Total quantity of an item within any one area or stockroom can be located in one place.
- 2) Items can easily and quickly be marked with proper identification.
- 3) Items are easily accessible.

Enough space must be provided so that locked stockrooms can be established to care for protective stocks and special items.

b) Methods of receiving and accumulating -

These two functions are most important because they include the principal paper work functions of the department. The operation of the department can be good or bad depending upon the efficiency with which these two duties are carried out. This is true because a correct receiving record is necessary in order that expeditors may close out orders and production followers know when materials are on hand to build. In order to perform this function it is necessary to

1. Have a general receiving area to which all incoming materials are routed.
2. Divide the main area into smaller areas each one of which is plainly marked as representing a particular stockroom or stock area located at some other point in the factory.
3. Make a daily receiving record of each incoming item. This record is forwarded to the production office at the end of each day to be used by expeditors and production followers.

4. Check each incoming item and place it, according to routing shown on attached transportation tag, in the individual area representing its final destination in order that the internal transportation system will deliver it to its correct location.

Very often incoming material is incorrectly routed or the quantity called for on the transportation tag is partially missing. A good receiver must be quick to see and correct such discrepancies.

Accumulating is the term applied to the process of checking material lists showing items required to build apparatus. A stock accumulator must perform this duty accurately because upon this operation depends the ability to deliver material on hand to manufacturing on time to meet production schedules. The accumulator must perform the following steps:

- a) Check each job shown on production schedule according to the weeks in which jobs appear on schedule. This requires:
 1. Removing from material list file each material list required for jobs appearing on schedule in any given week.
 2. Carefully checking each item called for on material list.
 3. Referring to stock location file for location of each item.
 4. Physically removing required quantities from stock bins, attaching an identification tag to each item, and placing all items for any one job together in stock pans labelled with production job or order number. In the case of standard or self-service items which are located in the manufacturing area along assembly lines, the accumulator does not physically remove quantities required on material list but he must estimate accurately how much is on hand and must balance this figure against

requirements for other jobs previously delivered to manufacturing but as yet not completed. This latter step is one which can easily lead to unexpected shortages and consequent holdups if accumulator is careless.

5. Placing a check mark on material list opposite each item on hand and an "x" opposite each item which is short.
6. Making out a shortage sheet showing all items short with the production order number and submitting it to the production office so that shortage may be ordered and obtained on a rush basis.
7. Maintaining a card file by drawing number of each item short. Each card also shows the production order number of the job on which shortage exists.
8. Receiving all materials coming into that particular stockroom and checking them against shortage file. Applying shortage items to proper jobs when received and placing all other items in regular stock bins in their respective locations.
9. Maintaining a stock location file of all items by drawing number.
10. Delivering accumulations for individual jobs to manufacturing.

Briefly, once material has been moved from the general receiving area to the individual stockroom the accumulator takes over and controls the physical and paper work operations which govern the delivery of material to manufacturing on schedule.

c) Equipment -

Even though a stock department has ample storage space and has efficient methods of receiving and accumulating stock it will not operate at maximum efficiency if proper equipment is not available.

This is true because items become mixed up and misplaced and even though on hand cannot be located when needed. Also any effort to straighten out such a situation invariably results in larger space requirements because materials must be spread out in order to have them easily accessible. Invariably too, any house cleaning has only a temporary effect. Items get misplaced all over again after a while.

1. To operate at maximum efficiency stock racks are provided which make the most use of the space available. Such racks, in the case of apparatus manufacturing, are made of steel to insure long life in view of the fact that they are used to store heavy materials. The racks are selected with a view to size, shape, quantities and types of material to be stored in them. For example, bin type racks are for smaller items and pipe racks upon which may be stored entire pallet loads of material are used for heavy or bulky materials. The latter type are of particular advantage because they permit electric fork trucks to handle all material quickly. This type rack utilizes space in a maximum degree because with the aid of fork trucks, material can be located ten to twelve feet above the floor.
2. Hydraulic hand trucks are used to move moderately heavy loads in and around local stock areas and to transport when electric fork trucks are not immediately available.
3. Filing cabinets are provided in order that records may be maintained in an orderly and neat manner so as to eliminate undue delay in searching for misplaced papers and so as to keep the essential stock location file in good order

Unfortunately electric fork trucks are not under the supervision of the stock department even though the responsibility for movement of materials rests with the department. This very often creates a difficult problem for the

stock department because transportation is directly under the supervision of manufacturing and when a move or a lift is required the trucks are always busy with some other task. The matter of obtaining necessary lifts often necessitates repeated requests for service before a move is finally made and consequently this process is time consuming and slows down the physical work of the department. Proper equipment is as necessary to efficient operation as any other factor in the make up of a stock department. Without such facilities work is slowed down because it takes longer to accomplish the tasks assigned, and a resulting increase in indirect expense is incurred.

3. Paper Work.

As demonstrated thus far, the type of stockkeeping needed for the manufacture of apparatus requires not only the physical handling and storage of materials but it also requires the maintenance of various records and the processing of various pieces of paper for the production office. Possession of sufficient space and good equipment along will not suffice. Along with these requisites, accurate records must be maintained. In general, the paper work required of an apparatus stock organization is as follows:

a) Receiving records -

These records are most important for without them efficiency is at a minimum. Lack of correct information as to stock on hand, knowledge of its exact location, identity and quantity, results in a slow down of the manufacturing process and an unhealthy

inventory situation. More man hours are required to service manufacturing, thereby increasing expense. Also the production group fail to start jobs when stock is available, expeditors do not close out orders, and order clerks either order too heavily or too lightly to cover requirements. In addition receipts must be matched with invoices received from outside vendors. Otherwise, there would be no way of telling whether material has been received and vendor is entitled to payment. Therefore, an accurate daily receiving sheet must be prepared and furnished to the production group.

b) Stock location cards -

Each individual stock area or stockroom must maintain a file by drawing number or other proper identification of all items in that area, so that stock can be quickly obtained and checked. Otherwise, as in the case of receiving records, more man hours and greater expense are incurred.

c) Material lists -

These papers arranged in sets, each set representing a definite job in the production schedule, show the exact stock requirements for each piece of apparatus to be built. They must be checked carefully item by item and records made opposite each item as to whether on hand or not. When items are short they must be recorded as on hand at a later date when they are actually received. They are necessary to:

1. Inform stock group what must be supplied to manufacturing.
2. Determine which items are short and therefore preventing completion of apparatus on time.

d) Shortage cards on file -

When a material list has been checked, a separate card must be made out for each item short and placed by drawing number in the shortage file to enable the accumulator to apply these items, as soon as they are

received, to the jobs which require them. This provides for the delivery of jobs to manufacturing just as soon as all stock is on hand.

e) Shortage sheets -

As soon as material list has been checked, a shortage sheet must be made out in triplicate for that particular job. The original copy and one duplicate are sent to production office so that short items may be ordered if previously overlooked or if already ordered, pressure may be applied to obtain them at once. One copy sent to the office is thus used for the benefit of the order clerk and the expeditor while the other copy goes to the proper production follower to reschedule the job and issue an extension to the customer if necessary. The copy retained in the stockroom must be kept up to date day by day by crossing off each item as it is received. When the last item has thus been disposed of, the stockman knows without checking the entire material list, that the job is ready for delivery to manufacturing.

It can be seen then that a stock organization must perform accurate detailed paper work in order that the overall operation may progress smoothly. The degree of efficiency achieved in this phase of stock work exerts a definite influence on ability to meet commitments and on the overall indirect expense of the division.

C. Expediting of Materials.

This function is performed by a branch of the stock department located in the production office. In contrast to the other members of the stock group who are day workers this group is a salary group. They are the "white collar" workers of the department along with a very few stock record clerks. This function is a very important one in a set up which operates to definite production schedules

which depend on having necessary materials on hand in time to meet customer commitment dates.

Once an order has been issued by the order clerk two copies of the order are placed in the expeditor's file. From that time on it is the responsibility of the expeditors to make sure each item is received on or slightly in advance of the wanted date shown on the order. The general detailed duties of an expeditor are to:

1. Log one copy of each new order so that it will be checked with the suppliers at least two days in advance of wanted date. The logging is accomplished by dividing file into thirty-one sections, each section representing a definite day of the month. The second copy of the order is filed by drawing number if a standard item and by production order number and drawing number if a special item. This second copy must always show the date under which the first copy is logged. This is necessary in order to apply daily receipts with a minimum of effort and in order to obtain status of any item or job quickly.
2. Check daily receiving sheets and apply receipts to open orders.
3. Maintain a record of current status of order relative to delivery, extensions, and quantities received.
4. Issue a written extension to the production follower each time a delivery is extended.
5. Exert all possible pressure to obtain items appearing on shortage sheets furnished by the stock accumulators in the various stockrooms. Particular pressure is necessary in this case because the appearance of a shortage sheet indicates that a certain job scheduled for building within a week's time still lacks some of the required items.

Such are the general functions of an expeditor. A female clerk performs the routine filing and application of receipts to the orders in the open file. Actually, in addition to these general functions, the expeditor performs many other duties such as:

1. Locating a shipment lost or misrouted in traveling from one building to another.
2. Reporting manufacturing difficulties of suppliers which require decisions and drawing changes by the expeditor's own engineering or planning group and seeing to it that the required information gets back to suppliers promptly.
3. Obtaining substitute materials on a rush basis when materials called for cannot be obtained in time to meet delivery dates.
4. Actually transporting small quantities of rush materials from supplier to his own division because normal transportation system does not move quickly enough to meet his needs.

However, his paramount duty is to keep in constant contact with suppliers, know the current status of each order and exert sufficient pressure to obtain what is needed when it is needed. The expeditor must go to the top command if necessary when those handling suppliers detailed work do not give the desired results and he must apply to his immediate supervisor or production manager when his own efforts cannot overcome difficulties preventing the delivery of materials on specified wanted dates. He must be quick to realize when such aid is necessary and prompt to apply for the help necessary to gain his objectives.

This phase of the stock department work exerts a definite influence upon the overall performance of the production department and is just as important in this respect as each of the other main functions of the production group because without required materials on hand at proper times, schedules cannot be maintained and completed apparatus is manufactured in a hit or miss fashion entirely out of line with delivery promises given to customers. Often in years past, material handling and stock work in general have been given too little consideration by management. Stock areas were not carefully planned, equipment was not provided, and efficient paper work systems were not developed. Stock personnel as the lowest paid group were considered as "lumpers" concerned only in moving materials around. Each stock group had perhaps one man who remembered where various materials were stored and recognized various items as components by sight and as belonging to a certain type of apparatus. Everything depended on one individual and if he was absent for a day, output suffered. In contrast to such a haphazard type of organization, there exists today an organization which is recognized as a necessary integral part of the production group. It is so recognized because:

1. Expansion of output created material handling problems which could not be overcome by using the old methods.
2. Development of detailed accounting systems which reflect all expenditures which are components of the total cost of manufacture brought to light the heavy outlay necessary

to handle stock by these old methods.

3. Expansion of output brought increase in paper work making it necessary to definitely systematize the relation between stock work and production department work.

As a result, management realized competition could not be met on equal terms and worthwhile profit realized if manufacturing delays, unhealthy inventory conditions, and slowdowns due to poor stock location systems, poor storage methods, receiving methods, and slow movement of material were to continue. Added to this was the consciousness of the great amount of unnecessary indirect expense contained in the overall cost of manufacturing due to these same factors. From this realization have come improved systems which enable efficient operation on a larger scale with fewer personnel.

It is not to be supposed, however, that the possibilities for improvement have been exhausted. Each division and each stock system within a division must contend with problems created by the nature of the type of production planning, schedules, ordering methods, apparatus manufactured, sources of materials, and even types of buildings in which they are housed. In addition to these problems, it is interesting to note that employees with long terms of service who operated previously under haphazard methods create a problem because they are not inclined to follow definite rules. They consider written records are something to avoid. In the case of older members of manufacturing groups, the

inclination is to take any material they can lay their hands on if it will help them complete some operation regardless of the fact that it is supposed to be reserved for a definite job which is scheduled for completion prior to the job they are so eager to complete. They look with disfavor on locked stockrooms which prevent their having free access to all stocks.

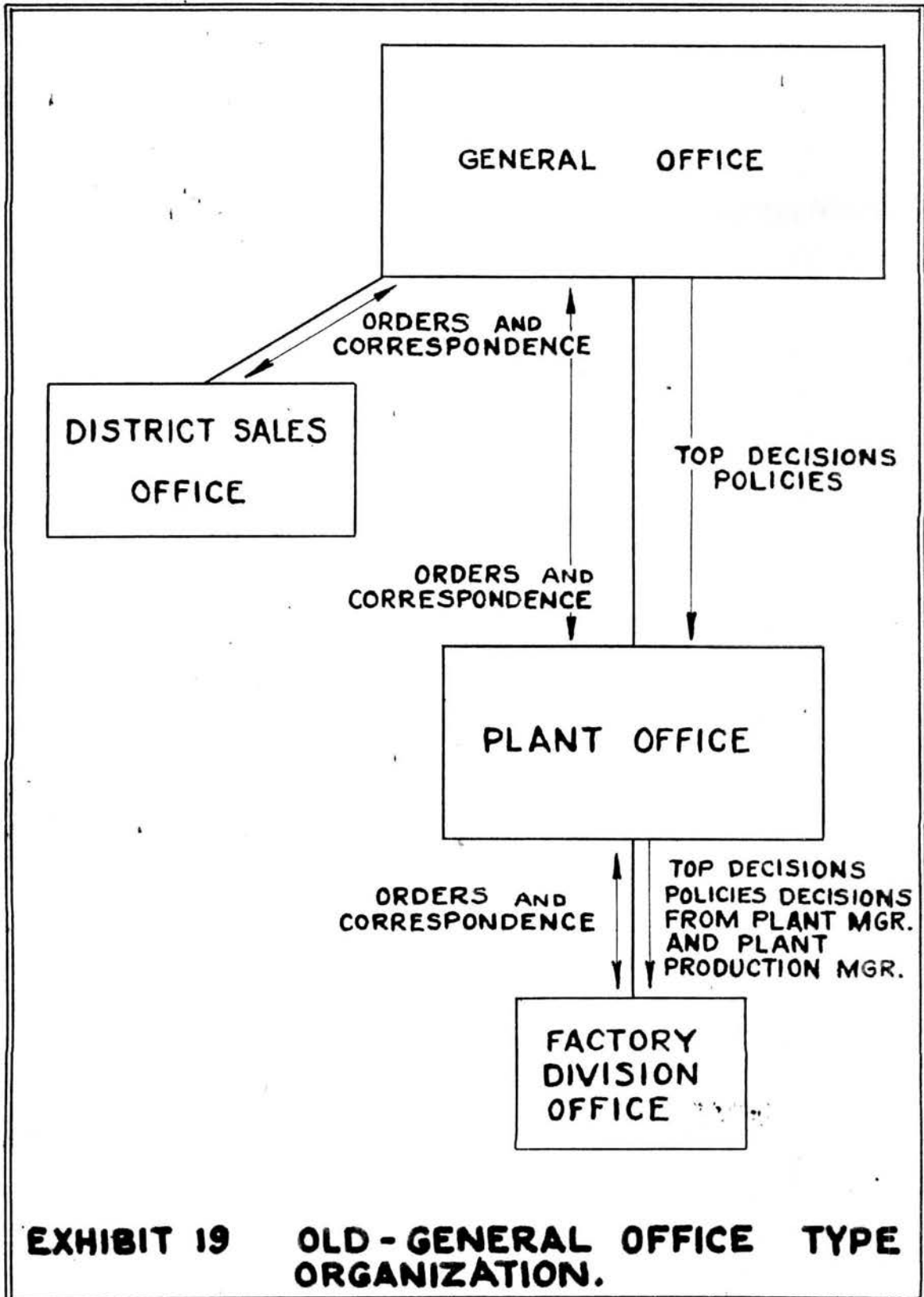
Management has realized the importance of this work and has done much to make improvements but as in other cases where it might be said an extreme was reached by neglecting to make improvements, the trend in some cases at present is to go to the other extreme:

1. By locating more and more items along assembly lines regardless of the peculiar nature of the items.
2. Expecting stock help to keep accurate inventories of items to which manufacturing groups have access at all times with every opportunity to mix similar appearing but entirely different items in same bins in the process of using them.
3. By reducing the number of personnel not only in accordance with the number warranted by improved methods, but in excess of the warranted figure to the end that this type of work becomes more and more pressurized. Sometimes systems are installed and an arbitrary figure used for the number of personnel to be used in the operation of the system. This figure is based on theoretical judgment without enough consideration of local conditions.

The trend toward this second extreme under the present program of improvement can create production difficulties just as in the old systems. In some cases observed by the writer performance was such that some of the personnel removed had

to be replaced in order to resume smooth operation.

Therefore in any improvement a middle course must be sought in the matter of cutting expenses because the best of equipment and systems cannot operate efficiently by themselves.



CHAPTER VI

PRESENT TRENDS IN PRODUCTION ORGANIZATION

In the case observed by the writer, until comparatively recently the overall organization was operated in a centralized manner with all orders passing through and all top decisions coming from the general or home office as shown in Exhibit 19, Page 105. In turn, all orders had to be processed through the individual plant general offices before reaching an individual division within a plant where production schedules are made up and manufacture of apparatus takes place. The groups through which all business had to pass before reaching the division where manufacturing takes place were:

a) General Office

1. Company production manager.
2. Commercial or sales department for sales estimates and authorization to build standard apparatus for future sale.
3. Managers of various apparatus lines for top decisions.

b) Plant General Office

1. Plant Manager's office for decisions and policies.
2. Plant Production Manager's office for decisions and policies.
3. Order and Stores section for all outside vendor orders and business.

The general office was located in many cases at a great distance from both the district sales offices and the plant organizations.

Top management in the person of board of directors,

company president, and his various assistants, decided that in addition to keeping pace with competitors, technological improvements, and development of more straightline factory manufacturing methods there was a great need for improvement in the organization as a whole. There was an awakening not only to this need for improvement but investigation produced facts indicating there existed in this field many opportunities for betterment which could bring a definite improvement in overall company operation.

The fact that the company had operated so long with the type of organization shown in Exhibit 19, Page 105, exemplifies a pattern followed in many and varied fields of endeavor. Changes very often take place slowly and habits are very difficult to break. More and more is heard daily of progressive movements. The history of manufacturing and of business in general bears silent witness to the fact that progressive steps must be taken from time to time if survival is to continue. In the case of a very large company backed by huge reserves, improvements in one field may make up temporarily for disadvantages in another field but in the long run each phase of the work must be improved.

Therefore, knowing that improvement was required, opportunity for improvement was present and employing the well-known fact that to simplify is to improve, a new organizational plan of operation was put into effect. The new plan of operation was intended to improve all phases of the

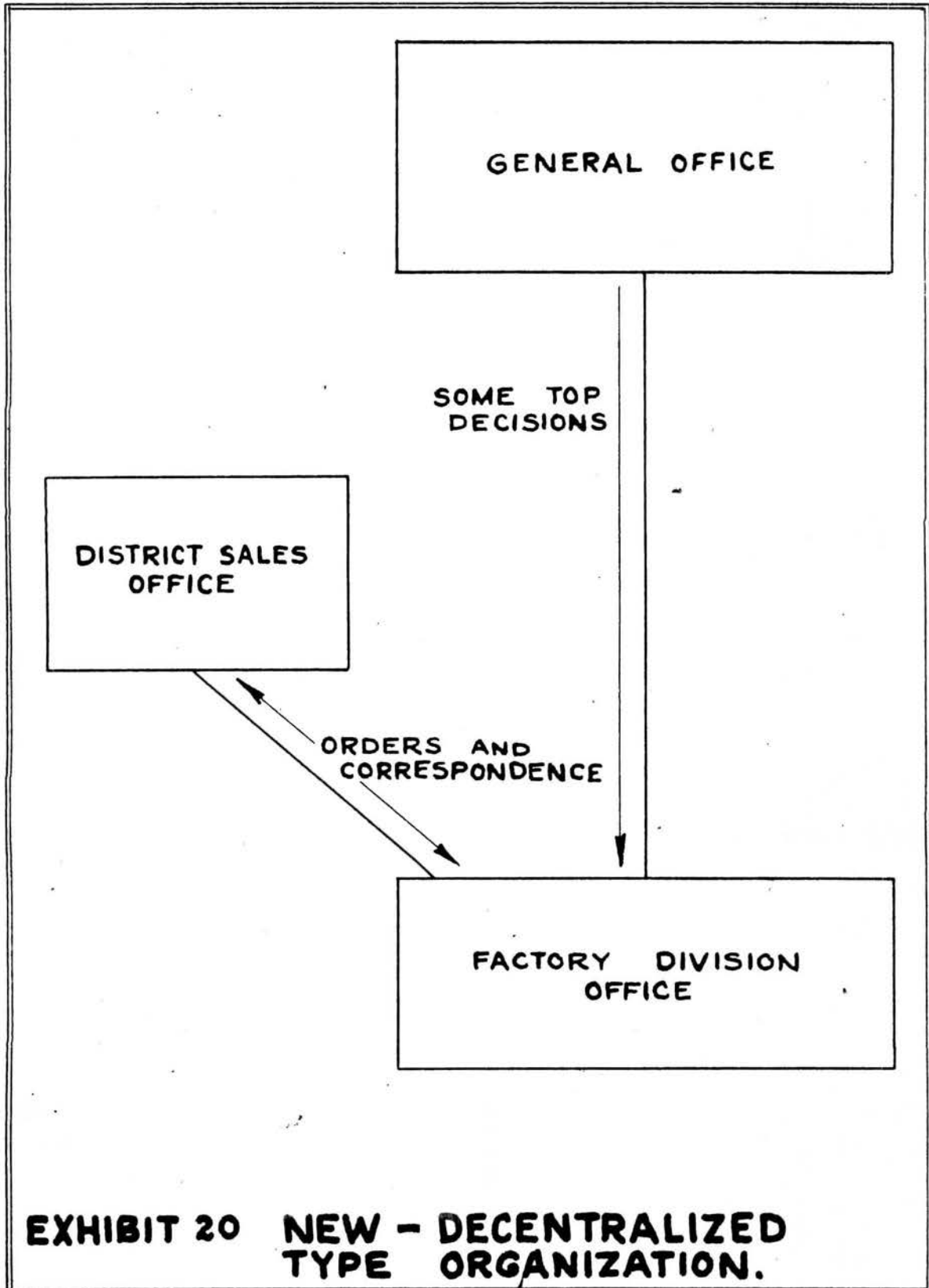


EXHIBIT 20 NEW - DECENTRALIZED TYPE ORGANIZATION.

business. It is considered here only in relation to the effect on production functions.

A. Plant and Management Decentralization.

Under this new plan, operations have been simplified and personnel reduced by unification of personnel under one roof instead of having various functional groups located in widely separated spots and also by reduction in the number of groups and functions necessary to carry out the details of the business. (See Exhibit 20, Page 108)

This has been accomplished by:

1. Locating the manager of a particular line of apparatus in the apparatus division office.
2. Locating the commercial or sales group in the division office.
3. Eliminating the production group in the general office with the exception of the production manager who now supervises general policies only, for all apparatus lines.
4. Removing division production group from jurisdiction of plant general office production manager.
5. Eliminating order and stores group in plant general office.
6. Locating of accounting group in the division office.

The carrying out of these six points has transformed each apparatus division within a plant from a dependent unit to one which can operate on its own in a manner very similar to that of a small independent company. However, it is not entirely divorced from the general office which con-

tinues to control appropriations, profit, loss and major decisions of the type commonly made by boards of directors, president and vice presidents. The Division manager reports directly to the president and vice president and on some matters to other high ranking officials in charge of various general policies for the entire company.

1. Purpose.

The decision to decentralize operations was made due to a realization that improvement was necessary and that opportunity for improvement existed. It was felt that the installation of a decentralized system would permit attainment of a major objective, namely, faster and better servicing of customers' requisitions, with an accompanying reduction in cost of operation so as to better meet competition.

2. Effects.

A glance at Exhibits 19 and 20, Pages 105 and 108, quickly reveals that two major groups have been removed from the picture. It is no longer necessary to process orders and obtain decisions through a home office and a plant office. All facilities required to service customers' requisitions are located in one place. Production supervisors, or production managers as they are called under the new system, do not have to carry their problems to a plant production group who in turn must apply to the home office for final word as to what should or should not be done. Each division has an apparatus manager right on the scene of action who can give

decisions quickly.

The commercial group also is close at hand so that they are not only available to handle customer problems quickly but also they can obtain a better understanding of production and manufacturing problems which will aid them in deciding what and how quickly various types of apparatus can be built. They can deal directly with the production manager, the production section leader or the production follower if necessary.

Previously, manufacturing and production groups always were separated and each received its instructions from different company officials. As a result oftentimes points of disagreement arose which had a harmful effect on co-operation between the two groups, and upon the morale of the individuals comprising the groups. Under the new plan both the production manager and the manufacturing manager are responsible to one head, the division manager, with the production manager immediately responsible to the manager of manufacturing. This has developed a much better sense of team play and co-operation.

The accounting department is also present where it can quickly have a finger on the pulse of the business and investigate any unsatisfactory trends in profits or expenditure and as in the case of the commercial department, the accounting department can obtain a better understanding of actual divisional problems.

The division manager no longer must operate through the medium of an echelon of executives and depend on their judgments colored by varied interests and opinions. He now depends on a comparatively small staff of assistants and can obtain true facts quickly because he has these few always within call and can observe actual operations at close range.

The paper work has been considerably reduced because of the elimination of the home office and plant office groups. The necessity for maintaining many sets of duplicate records has been eliminated.

Elimination of production groups in the home and plant offices and the elimination of the order and stores group in the plant office facilitates the processing of orders and reduces the dependency of one group on another. In the case of ordering of materials from outside vendors the apparatus division can order directly from vendors according to the needs and policies of the division without interference and restrictions from a general group in the plant office. In the case of the production groups the same factors have been eliminated.

One of the primary objectives of a production department is to give customers good service. Under the decentralization plan increased opportunity to improve service has been provided. All the groups and functions upon which production depends to handle other phases of the business

have been concentrated in the same building with production. In the process of decentralization the reduction of unnecessary personnel and paper work has provided a means of reducing overall expense because in determining the total cost of a piece of apparatus the expenses of all groups in the entire organization are allocated to that apparatus on a percentage basis. By the unification of all departments in one location, the time necessary to process an order has been reduced. Decisions can be obtained in minutes or hours where they formerly required days, weeks, or even months.

Therefore, this definite step in the direction of simplification is bring about not only smoother, faster operation but at the same time is contributing to another very important objective of production, namely, reduction of costs. As time goes on this trend will lead to still greater gains because the top men operating the business are on the actual manufacturing scene where they can, through daily contact with all phases of the business, take advantage of further opportunity for improvement.

CHAPTER VII

RELATION OF SUPERVISION TO PRODUCTION ORGANIZATION

In any line of business a good guiding hand is required if satisfactory results are to be achieved. In the case of production with its essential requisite of servicing customers' wants with speed and economy in the face of all sorts of difficulties and with the wealth of detailed work necessary in the execution of production functions, a good leader is more than ever necessary in order that the department may function with a maximum of efficiency. Such a man is known as the production supervisor and under the new system of decentralized operation this title has been changed to that of production manager. The man holding this position not only acts as a guide for the operation of the department but he is the master planner in respect to all production functions. He is the one responsible for the execution of all functions to the end that customers are satisfied and economy and profit are realized. To accomplish this task a production supervisor must be an individual whose abilities can meet the many requirements of the job.

A. The Production Supervisor.

The production supervisor is the key link in the production chain. Primarily, he must have the ability to plan, delegate authority, and supervise execution. He must possess, in addition to his knowledge of production, certain personal qualities of character. Without them his knowledge will not enable him to derive a maximum of efficiency from

his department. Some of the important qualities necessary to do a good job are to:

1. Know all aspects of production work and its relation to manufacturing, accounting, and all other factors which influence production or are influenced by production performance.
2. Believe in the importance of production work.
3. Like his work.
4. Be able to explain work to others quickly and in a manner easily understood by them.
5. Be familiar with all that goes on within his department and to obtain this information directly and not second hand.
6. Inspire confidence in his staff and employees in general without becoming familiar with them.
7. Respect all as human beings having equal rights regardless of who or what they may be in their personal life.
8. Avoid entangling associations with employees.
9. Keep his own confidence except when situation demands otherwise.
10. Be neat in appearance.
11. Speak only when occasion warrants and only when something of value can be said.
12. Be a good listener able to quickly digest facts and put aside the irrelevant.
13. Understand people, knowing common likes and dislikes.
14. Always get to a point quickly both in speech and action.
15. Recognize obstacles quickly and proceed to remove them immediately avoiding entanglements in details.
16. Be interested in success of employees, giving them every possible chance for same if deserved.

17. Be forthright, truthful and fair in all his actions.
18. Quickly admit lack of knowledge and proceed at once to correct source for correct answer.
19. Be unafraid of superiors and all others.
20. Be firm when necessary.
21. Be emotionally steady, never giving evidence of anger nor excessive enthusiasm.
22. Get results, not by use of direct orders based on his authority but by suggestion.
23. Give his superiors the correct facts the first time.
24. Have the members of his department perform the work and never personally do the work or become involved in details.
25. Have feelings impervious to hurt while always being considerate of the feelings of others.
26. Be assured in manner because he knows his job and is confident of handling it satisfactorily.
27. Always fight for what he believes is right.
28. Always exercise good judgment.

These, as specified, are only some of the requisites for a good supervisor. There are many more characteristics but these points will suffice to demonstrate the latitude of the subject. In general, they are requirements which are just as applicable in any line of business as they are in production work. They do, perhaps from the viewpoint of dealing with people, have a particular application because in production work time is of the essence with the result that it is a pressurized type of work and efficient

management of people working under pressure is a difficult problem at best.

B. The Section Supervisor.

This supervisor, who is commonly known as the section leader, is responsible for production work connected with one or more types of apparatus but never for all types manufactured by a division. He is directly answerable to the production supervisor and his chief task is to see that the production work covering certain types of apparatus is efficiently carried out. This job carries with it the responsibility for the personnel in his section. He is their guide and instructor besides being their "boss." He must seek to achieve the same performance with regard to his section as the production supervisor does with regard to the department as a whole. Although his field is a narrower one than that of the production supervisor, the same requisites as listed under topic "A" are not only applicable but necessary if a satisfactory job is to be done.

C. Supervision and the Selection of Personnel.

This field of supervisory work alone is a very important one because upon it can very easily depend the amount of efficiency with which a department operates. A department burdened with individuals who have neither the desire nor interest to do a good job cannot hope to avoid a consequent poor output of apparatus. This naturally means a loss in profits. Sometimes in such a situation production

is realized but only because the number of personnel is increased to push the work through to completion. This procedure simply provides a crutch for a sick organization and increases costs whereas steps should be taken to remedy the unhealthy condition. Too much emphasis cannot be placed on this subject.

In the case observed by the writer, those concerned in the hiring of help are the general personnel office, the production supervisor and the section leader or supervisor. The general office may maintain personnel records for all employees in the plant and from this pool employees are selected when openings occur for promotion. At the present time the problem of hiring new help off the street is a minor one because under terms of the union contract all employees laid off for the lack of work must be recalled before new help is hired. The pool thus created is sufficiently large to provide most help needed for some time to come.

Whenever an opening occurs the personnel office is notified by the production supervisor in whose division the opening exists. The personnel office notifies the next person on the list who is eligible both by seniority and experience to report to the production supervisor for an interview. The candidate is interviewed by both the production supervisor and the leader of the section where the opening exists. The decision to accept or reject the applicant is the result of the two interviews. In addition to the interviews, the

applicant's previous record, supplied by the personnel office, is considered. This also is a factor influencing the final decision.

When interviewing an applicant the supervisor speaks and acts in a friendly manner and attempts to put the person to be interviewed at his ease so that he will talk freely stating what he thinks of the job offered and why he feels he is qualified to fill that job. The supervisor listens carefully to what the applicant has to say because very often something valuable can be learned indirectly from the statements made. The following items of information are furnished by the interviewer because they are the most important factors concerning the job from the applicant's viewpoint. They concern his welfare.

1. Compensation.
2. Degree of security. Is it a temporary or a permanent job or is it uncertain which it will be in the future.
3. Opportunities for advancement.
4. Job conditions - are they poor or disagreeable?
5. What sort of performance will be expected on the part of the applicant if he is selected for the job?
6. Indicates before close of interview whether applicant will be considered further for the job and if possible gives a yes or no answer as to whether he will be given the job.

Nothing should be held back or camouflaged when presenting these points. All pertinent information should be presented truthfully and throughout the interview the supervisor should

Speak with conviction and assurance on every point. The applicant should be invited to present any questions which he may have and they should be answered clearly, directly, and immediately. Unless all aspects of the situation have been presented clearly and fairly at the time of the interview an employee may be added to the organization who will later become a disturbing influence because he did not clearly understand all the facts before he accepted the job.

These basic requirements have been presented in their relation to the production supervisor but as mentioned previously the section leader also takes part in the selection of personnel. Very often he will be the one who actually explains the job conditions and takes the employee into the office and gives him the main details of the job. During this process the same conditions apply as in the case of the production supervisor.

Whatever statements are made regarding compensation at the time of the interview must be lived up to when the employee begins work. The rate of compensation cannot be stated as one amount when hiring and later reduced to a lower amount when employee begins his duties.

There is in existence today one factor which limits the usefulness of a supervisor's ability to select good personnel. The rules contained in the union contract with the company place greatest emphasis on seniority as a qualification for advancement. As a result some individuals must be

accepted, although the supervisor may know from verbal reports that the applicant would not be suitable because he lacks definite written records to prove the unsuitability of the applicant. In this type of case the applicant must be given the job on the basis of seniority. If he is rejected the union can make a labor case out of the situation and carry this point as long as management lacks written proof that the applicant is unsuitable for the job.

The duties of both production supervisor and section leader also call for their handling of labor grievances. This is a field which requires diplomacy in order to settle grievances to the satisfaction of both labor and management. Here too, the supervisor or section leader must be sure of the facts and honest in their presentation. By so doing he can win the respect of labor because they know that his decisions will always be fair ones. This goes a long way toward preventing dissatisfaction and the resultant poor performance which follows dissatisfaction. Labor representatives are more inclined to listen to reason and sometimes settle minor grievances with the employees involved without bringing the case to supervision. This is especially true in cases where labor representatives know the employee is at fault or is unreasonable in his demands.

However it is not to be implied from this statement that all cases are settled at the supervisor's level. To the contrary, there are times when the supervisor's solution

to a case is not satisfactory to labor and as a result labor exercises its prerogative to appeal the case first to the local plant official company labor board and if not satisfied there the case is then appealed to the labor board representing the company as a whole.

All in all, the supervisor must be adept in hiring, supervising of help and in handling of employee grievances if his department is to function smoothly. This field is just as important to overall satisfactory operation as each of the other functions of the department. The best planned systems are of little avail without people competent to make them operate or where employees are dissatisfied.

D. Supervision and Education.

As observed by the writer, education within the industry has been slowly developing over a period of years. Today it has reached the point where management realizes the more an employee knows about his job and its relation to the business as a whole, the better is the performance of that employee. Whereas in years past, an employee was told as little as possible, he is now informed of developments as they take place in relation to his own job and his own security. This latter development is not universal. As a matter of fact there is a long way to go in this direction but steps have been taken which indicate further development of this field is to come.

Specifically, certain definite programs have been

established in the industry which the writer observed. For example:

1. Individuals who show they have ability and an inclination toward production work are chosen on a basis of merit to attend a production school for a prescribed length of time. During that period they are trained in all phases of production work not only by theory as presented in the classroom but by actual experience on each type of job. They are assigned to one production job after another in order to gain essential experience. When they have successfully completed the course they are assigned sometimes to a supervisor's job of some kind and very often only to a minor production job where they remain until opportunity for advancement arises. Very often section leaders and production managers are selected from this group.
2. Meetings are held for production supervisors approximately every two weeks. These meetings are to keep supervisors abreast of developments on points pertaining to their work, company policies, and matters of interest to employees both in respect to their work and their personal life. For example, these meetings cover both production work and matters relating to pensions and disability compensation.
3. Production supervisors hold a meeting with their section leaders passing on to them the information they received at the production supervisors' meeting.
4. The section leaders in turn hold a meeting with the members of their sections and pass on the information of interest to their employees. This latter practice is one which is still in the formative stage. Due to pressure of work these meetings are somewhat irregular but management advocates the practice and the future may see a more definite program.
5. Classes are also held for all supervisors, section leaders and factory foremen on subjects pertaining to other phases of the business. For example, a course in accounting may be given to show the relation of this department to the business in general and to their work

in particular. This brings about a better understanding of each other's problems and the mutual dependence of one department on another.

6. Local radio programs have been established under the supervision of a public relations director to bring about better community relations.
7. Company scholarships have been established for which children of employees can apply in order to obtain a college education.

The steps taken thus far in the educational field indicate definite recognition of the basic value of education and of the fact that it is not enough to have employees know only what is necessary to perform their daily work.

Good supervision is essential to any successful business enterprise. It is the guide which keeps the organization running smoothly and it is the directing force which can spell success or failure. The duties and problems of supervision are many and require outstanding abilities and characteristics. All of the qualities which may be named as requisites for good leaders naturally do not exist in any one member of supervision but - knowing what they are - better results can be obtained if they are carefully considered when selecting individuals to become members of this group.

The best of supervisors have a many-sided problem to deal with and need tools with which to carry out their work. Education is becoming more and more recognized as a means to that end.

CHAPTER VIII

CONCLUSION

Thus far we have considered the various main functions of an apparatus production department in an attempt to show the principal operations of each function in order to demonstrate the importance of that function in its relation to the production department as a whole and to bring home the fact that each function is properly executed only through the performance of many and varied detailed tasks. Each individual function must be carefully tied in with each of the other functions in the system. In some cases these functions reach out beyond the limits of the department itself and touch engineering, planning, and drafting departments. If any one function fails to operate according to schedule, then the production system as a whole bogs down as naturally does the actual output of completed apparatus. Such a result means customers are dissatisfied with broken delivery promises and dissatisfied customers today do not make good and regular customers tomorrow.

An example of this might be the failure of the production follower to see that the necessary engineering, drafting, or planning was done on time to permit early enough ordering, receiving, and stock accumulating to meet the schedule for delivery of parts to manufacturing for actual building. So, too, poor or inadequate ordering, production schedules, and stock handling can quickly cause a break in

scheduled production which is injurious to the overall plans of the department.

Therefore, the old saying "A chain is no stronger than its weakest link" is very true in the case of production work.

Satisfactory production operation requires smooth, unified and co-ordinated action in every phase of the work.

Production is designed primarily to service the needs of customers with a view to quality and speed. In so doing, orders must not only be filled quickly enough and good enough to satisfy the customer but cost must be maintained at as low a point as possible. Inventories must be maintained large enough to accommodate fulfillment of new orders but also low enough so that capital investment is not represented by large unmoving stock piles. The greater the turnover of materials the faster and greater the return on investment. On the other hand, inventories must not be maintained at such a low point that new orders cannot be filled within advertised manufacturing cycles. In the process of how much and when to order, sights must be trained on buying at the lowest possible cost without sacrificing quality. Advantage must be taken of economical lots.

This department also acts as a guardian of all materials on hand through the medium of its stock branch. In the case of this branch thought must be always given to most economical methods of handling and storing materials.

Consequently each function performed by the production department exerts a definite influence on the degree of success attained in servicing customers. The combined operations of the department also add to or detract from the general success of the business because they play an important part in the control of important economical factors which directly affect profit and loss.

In contrast to years ago when material handling with its accompanying stock problems was performed by difficult time consuming labor, today there are various types of cranes, electric trucks and suitable racks provided to perform a greater amount of work with less manual labor in less time and at a lower cost.

New paper work systems have been installed which so far give the impression that definite economical improvement is close at hand.

The importance now attached to good supervision and to the benefits to be derived from an expanded educational program indicates there now exists a realization that these are factors which have received too little attention in the past and that they exert a valuable influence on the end results of a business enterprise.

In general, the trend has been towards improvement and at present the movement has been accelerated to a greater degree than at any time in the past. Progress has definitely been made and prospects for greater progress in the

future are good.

The method of operation in use at present has been the outgrowth of experience, expanded production and general business changes. It is satisfactory in that competition can be met with a certain degree of success and profits realized. This indicates that competition has the same or similar difficulties and the system does operate, under present conditions, in a manner which helps to bring a return on investments. It does not mean that the present method of operation is the best which can be developed to fit manufacturing conditions and requirements. As previously stated, the new consciousness to the possibilities for improvement as evidenced by general trends, of which the decentralization program is a good example, clearly indicates that the present method of operation can and will be improved. One possibility for improvement lies in a further simplification of the existing paper work systems. A second important step can be accomplished if a manufacturing field such as that of apparatus can increase the number of standard models manufactured and decrease the number of specials which very often are unpredictable as to ultimate cost until they have been actually manufactured. Servicing of such requisitions increases the amount of paper work and the number of personnel necessary to operate. Sometimes such apparatus may be actually manufactured at a loss. However, it is not to be inferred from this statement that profits are

not realized from the manufacture of special apparatus. There will always be customers who cannot avoid special requirements but it is believed there is further opportunity to reduce the number of cases where special apparatus must be supplied. Careful study of all models which have been manufactured would at least reveal cases where many component parts listed as special actually are used in a number of different models.

In the matter of personnel management with all its problems much can be done to aid supervision and personnel alike with a resulting beneficial effect on output.

A production department considered through the medium of its main functions is revealed as a department which must, through good planning and proper execution of plans, supply manufacturing with the necessary tools and materials to construct and ship apparatus satisfactory to the customer in cost, quality and delivery. At the same time it must smoothly operate a very detailed process in an economical manner so as to make definite contributions to profit, the ultimate goal of all business.

BIBLIOGRAPHY

- Alford, L. P. - Production Handbook published by The Ronald Press Company, New York, 1947.
- Alford, L. P. - Laws of Management Applied to Manufacturing published by The Ronald Press Company, New York, 1928.
- Alford, L. P. - Management's Handbook published by The Ronald Press Company, New York, 1924.
- Anderson, Arthur G., Merten Joseph Mandeville, and John Mueller Anderson - Industrial Management published by The Ronald Press Company, New York, 1943.
- Bethel, Lawrence L., Walter L. Tann, Franklin S. Atwater, Edward E. Rung - Production Control published by McGraw-Hill Book Company, Inc., New York, 1948.
- Boston Chamber of Commerce - Practical Experience in Industrial Planning - Material Control published by Bureau of Commercial and Industrial Affairs, Boston, 1925.
- Connelly, John Robert - Technique of Production Processes published by Mc-Graw Hill Book Company, Inc., New York, 1943.
- Cornell, William B. - Organization and Management in Industry and Business published by The Ronald Press Company, New York, 1936.
- Craig and Charters - Personal Leadership in Industry published by McGraw-Hill Book Company, New York, 1925.
- Davis, Ralph Currier - Industrial Organization and Management published by Harper and Brothers, New York, 1940.
- Diemer, Hugo - How to Set up Production Control for Greater Profits published by McGraw-Hill Book Company, Inc., New York, 1930.
- Geschelin, Joseph, and John Younger - Work Routing, Scheduling and Dispatching in Production published by The Ronald Press Company, New York, 1947.

- Hallock, John W. - Production Planning published by The Ronald Press Company, New York, 1929.
- Hempel, Edward H. - Top Management Planning published by Harper and Brothers, New York, 1945.
- Knowles, Asa S., and Robert D. Thomson - Production Control published by The Macmillan Company, New York, 1943.
- Koepke, Charles A. - Plant Production Control - published by John Wiley and Sons, Inc., New York, 1949.
- Koshkin, Simeon J. - Modern Material Handling published by John Wiley and Sons, Inc., New York, 1932.
- Lansburgh, Richard H., and William R. Spriegel - Industrial Management published by John Wiley and Sons, Inc., New York, 1940.
- Mitchell, William N. - Organization and Management of Production published by McGraw-Hill Book Company, Inc., New York, 1939.
- Muther, Richard - Production-Line Technique published by McGraw-Hill Book Company, Inc., New York, 1944.
- Raymond, Fairfield E. - Quantity and Economy in Manufacture published by McGraw-Hill Book Company, New York, 1931.
- Simons, A. M. - Production Management published by American Technical Society, Chicago, 1940.
- Sinclair, Prior - Budgeting published by The Ronald Press Company, New York, 1934.
- Stocker, Harry E. - Materials Handling published by Prentice-Hall, Inc., New York, 1943.
- The Industrial Truck Statistical Association - Material-Handling Handbook, Chicago, 1940.
- American Management Association Production Series 143-155 - Practical Methods of Speeding Production published by American Management Association, New York, 1945.
- American Management Association Production Series 171-180 - Planning for Low Cost Production published

by American Management Association, New York, 1947.

American Management Association Production Series 184 -
Organization Teamwork in Production published by American Management Association, New York, 1949.

American Management Association Production Series 191 -
The Production Department's Responsibility For Profits published by American Management Association, New York, 1950.

Factory Management and Maintenance, Vol. 107, No. 9 -
Efficient Storage Saves \$50,000 a Year published by McGraw-Hill Publishing Company, Inc., New York, 1949.