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FOR
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SYSTEMS ANALYSIS

FOR

EFFECTIVE ADMINISTRATION

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PREFACE

ALL MODERN enterprises—whether profit or non-profit institutions—possess three primary common classifications of management problems:

1. Determination of the purposes of the enterprise—basic policy on what are its goals and what will be its scope of operations.
2. Determination of the best methods for organization and systematic operation by the persons and groups which will perform the functions which are required to accomplish the purposes of the enterprise.
3. Administration of the persons and groups as a team of cooperating individuals most effectively to accomplish the purposes of the enterprise using the previously determined operating patterns.

This book concerns itself with the second of these problems: the methods of translating management policy into action; of finding the most effective, simplest, and cheapest means of accomplishing every task. This systems problem is universal. It is present in every undertaking, large or small. How effectively this problem is met will frequently decide the success or failure of the undertaking. This book aims to show some of the approaches which, if properly applied, will help in the establishment of effective systems.

The general plan throughout the book has been a practical presentation of how to make successful systems analyses. First the basic principles underlying good practice are presented in connection with each aspect of the subject. Then, with illustrative examples, the application of these principles using critical questioning procedures is shown. Common pitfalls and obstacles to successful results are discussed and positive action is outlined to help assure more fortunate results.

In addition to telling how to design, evaluate, sell, and install systems and how to prepare systems reports and procedures, principles and practices in the operation of a systems department are discussed in some detail: how to organize to control the systems of the enterprise and to administer a systems program.

Throughout the book are numerous examples of how various aspects of systems and procedures analysis have been applied in leading enterprises engaged in a wide variety of fields of endeavor.

Systems Analysis for Effective Administration is thus directed to persons concerned with any phase of managing the operations of an enterprise. It is designed to interest the following types of persons: supervisors of all the various specialized activities required in every enterprise—procedural responsibilities are an essential part of these persons' operations; staff personnel engaged in various aspects of systems work, such as systems analysts, forms analysts, equipment specialists, organization analysts, procedure writers, and office planners; students in colleges and universities; and top-management personnel, who must take the initiative in starting, supporting, and directing a strong and effective systems improvement program.

I am greatly indebted to the many business organizations and executives with whom I have been associated and who have contributed immeasurably to whatever value this book may have as well as those who have permitted me to use the illustrations included in this book.

NORMAN N. BARISH

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Part I

THE SYSTEMS TOOL

1

INTRODUCTION

MANY ARE THE RISKS of doing business and many are the business failures which result from an inadequate approach to these risks. It would take many pages merely to list, let alone explain, the numerous ways and reasons businesses have failed and continue to fail. It is nevertheless possible to arrange the causes of business insolvencies in two prime groupings: failures which may be traced to the faulty, inefficient, or uncoordinated internal functioning of the enterprises; and failures which are caused by conditions external to the business, such as national economic upheavals, poorly forecasted competitive conditions, etc.

It is hard to estimate the proportion of business failures falling in each of these categories. Although an enterprise may be very poorly operated, it may not only keep its head above water but may also produce a healthy profit because of fortuitous external market conditions. Such a company, however, is in a very vulnerable position when its market conditions become less auspicious. When this company goes under during a period of contracting markets for its products, the superficial onlooker may come to the seemingly obvious conclusion that the failure is due to external forces—a declining market. Nevertheless the true cause was poor operating procedures.

A careful analysis of a large number of business failures will disclose that the fundamental causes of failure lay inside the company and within the control of its management, even though the immediate cause may have appeared to be general economic troubles in the industry or community.

It therefore behooves the management and employers of business enterprises to examine their methods and systems of conducting business. Are these methods and operating systems well coordinated for lowest cost production of the correct quality of goods and services as required by the community?

There are two possible approaches to this problem of increased operating efficiency: one is to attempt to induce people to apply more effort to work faster; the other is to simplify the procedures for performing the work so that, with the same effort, more work will be accomplished. The systems technique stresses this latter approach.

DEFINITION AND SCOPE OF SYSTEMS AND PROCEDURES ANALYSIS

Systems and procedures analysis consist of the study, analysis, and improvement of the systems which service, control, and coördinate all the operations of the enterprise. Systems analysis thus encompasses the design of planning tools for giving direction to the enterprise's activities—the development of programs for determining what should happen in the future; and the design of control tools to ensure that the plans are effected and the results evaluated. Analysis of operations which directly change the form of a product is usually known as production or methods engineering. This latter subject is outside the scope of this book.

This book is concerned with systems and procedures. The men and women who make these studies and analyses, who devise better and simpler ways for the performance of the required functions of an enterprise, are presently called by many different names. Some of the more common titles of persons who perform some aspects of systems and procedures work are: systems analyst, organizations analyst, procedure writer, forms designer, office engineer, management engineer, office equipment specialists, office planner.

WHAT ARE SYSTEMS AND PROCEDURES

Systems may be defined as the means by which the personnel of an enterprise operate to accomplish the enterprise's objectives. They provide the medium for translating managerial policies into action.

Procedures are the written and oral instructions which give "legal" sanction to a system. They are the formal instruments, frequently written or charted, which govern and prescribe the operations comprising a system.

WHAT WILL THE SYSTEMS TECHNIQUE ACCOMPLISH

Application of the systems technique can benefit the business enterprises of today in numerous ways. By coordinating all the activities of the enterprise within a workable organizational structure, they enable the business to produce and deliver its products and services on schedule as required by the customer and at the lowest possible costs. Specifically, some of the benefits which may be derived from systems and procedures analysis are:

1. Reduction in the operating time cycles to enable earlier delivery dates.
2. Lowering of inventories.
3. Reduction of errors in predicting costs and delivery dates.
4. Elimination of unnecessary functions and activities.
5. Faster working capital turnover and reduction of working capital requirements.
6. Greater operating flexibility—speedier transfer of top-management decisions into action.
7. Elimination of the conflicting systems and operations which work at cross-purposes.
8. Increase in the effectiveness of supervision by reducing the amount of time required for correcting errors, handling complaints, and taking disciplinary actions. Time spent in reading unnecessary reports or unnecessary information on reports is eliminated; time spent in getting required information is reduced.
9. Strengthening of the organization structure of the enterprise through the disclosure and elimination of practices which violate sound organizational principles. Since good systems cannot be developed on the substructure of a poor organization, systems analy-

sis will disclose such basic errors as misplaced functions, responsibility without authority, unnecessary functions, etc. and bring them to managerial attention for correction.

10. Reduction of the clerical cost of performing the coordinating, control, and service functions required in the enterprise by prescribing the best motion patterns, by proper lay-out and equipment; by standardizing and controlling the efficient design of forms, by eliminating unnecessary practices, reports, and records, and by simplifying and combining the required ones.

To illustrate just the savings in clerical cost which are made possible by systems analysis, two case histories are briefly outlined. The first, quoted from an article appearing in the *Bulletin* of the National Association of Cost Accountants, indicates how elimination of an unnecessary activity, discovered through systems analysis, increases profits.

"In one branch house an extra copy of repair invoices had been prepared for the sales department for the purpose of recording, by dealers, the sales of a certain item. This required every invoice to be first scrutinized for the parts in question and required such sales to be transcribed to a separate record. It was found that this sales record had not been used for many years and that the labor and paper cost per year to prepare it equalled the profit of some 2,000 of these items." *

Later, when discussing forms design and control, the usual system for controlling the stock of forms will be mentioned: keeping a stock card for each form with a minimum balance indicated thereon; deducting from the previous stock balance at each withdrawal to get a new balance; when the balance goes below the minimum indicated balance, placing a reorder (first examining to see if the forms design can be improved). Departmental expense charges for the use of the forms are made as the forms are withdrawn from stock.

As a simplification of this necessary function the following procedure has been successfully used: departmental expense charges are made, based on estimated usage at the time of purchase of the forms; the minimum-balance quantity of the form is physically segregated and labeled as minimum stock; no stock card is kept, but when it is necessary to withdraw from the minimum-balance quantity, part of the detachable minimum-stock label is sent to the proper group as a notice for reordering.

* Eugene R. Harrison, "Let's Look at the Records," *NACA Bulletin*, Nov. 15, 1948, p. 289.

WHY SYSTEMS ARE IMPORTANT TODAY

The earliest industrial enterprises of three centuries ago did not require systems and procedures analysis. Most enterprises of the nineteenth century managed with only limited consideration being given to these problems. Why, then, is systems analysis needed today when it was not generally needed years ago?

The small industrial enterprises of the past centuries did not require systems and procedures because the functions which modern systems coordinate, control, and service were usually all performed by one or a very limited number of persons. There was thus little necessity for formalized means of coordinating the work of the various people in the enterprise.

In the old-fashioned one-man blacksmith shop, the owner blacksmith normally performed all the direct manufacturing operations as well as the other necessary functions (this listing is not all-inclusive):

1. The sales function—by contacting his customers at his door and elsewhere.
2. The design-engineering function—by planning the form and design of his products to fulfil his customers' requirements.
3. The planning and scheduling function—by establishing delivery dates and sequences for his work.
4. The cost-estimating function—by estimating and quoting a price.
5. The production-engineering or methods function—by deciding how he was going to make the product.
6. The purchasing function—by buying his irons, hammers, anvils, raw materials, etc.
7. The direct manufacturing function—by making the product himself.
8. The shipping and delivery function—by delivering the finished product to the customer, usually at the shop door.
9. The accounting and fiscal functions—by billing his customers, collecting his accounts receivable, and keeping such financial records as he considered necessary and desirable.
10. The systems function—by deciding what organization (himself) and what routines (if any) were required for proper coordinating, controlling, and servicing of the operations of the business.

In general, very few routines, other than perhaps some financial ones, were required for the operation of this one-man business. The systems function was therefore comparatively simple and unimportant. It is listed here only to indicate that every enterprise, no matter how small, must perform this function.

As the size of the enterprises increased, however, the systems function has become more and more essential. It became more and more difficult for the boss to keep in his head all the facts he needed. More records, forms, and reports were devised to maintain control of the business operations. Responsibilities for the performance of the functions of the enterprise were divided amongst numerous groups. Within these groups, the activities were assigned to specialized personnel who performed only one small portion of the function. In the modern industrial enterprise, not only do different persons perform each of these principal functions, but each person performs only a small part of each of these functions. The problem of coordinating the work of all of these interdependent organizational units and persons has become gargantuan. The possibilities of savings and improvements through better, simpler systems have increased in proportion.

WHY BUSINESSES HAVE POOR SYSTEMS

Many businesses today use systems that should be improved to provide better coordinated, less costly operation. The internal evidences of this fact are available to all business managers who are struggling to streamline their performance to meet competitive conditions, increase profit margins, and maintain adequate control of the enterprise. The external evidences are available to outsiders from the trade reputations built up by certain companies for not keeping shipping promises; from the danger signals which are appearing in many financial statements; and from the activities of certain engineering firms which specialize in systems work.

Why do these businesses operate with poor systems despite the fact that, by and large, most of the personnel are very competent and sincere persons who are doing their work in what they consider the best manner?

The systems in many concerns have been established over long periods of time as required by the various supervisors, department heads, and top management. Many of these were probably very good at one time; some were not good even when adopted.

Some of these apparently good systems were built around the special personalities and abilities of persons in the organization. When these persons left the company or transferred to another position, the old systems were usually retained. These systems, however, do not operate too well now because they were designed to accommodate one particular set of abilities which is no longer present in the organization.

Many originally good systems have become bad ones because the character of the business operations has changed without corresponding adjustments in the systems. As a business develops, its scope and objectives shift and its systems requirements change. Conditions external to the business change and require adjustments inside the company. Unless special steps are taken to keep them up to date, the systems will deteriorate in value.

Certain activities are considered relatively unimportant when first initiated and are assigned to the departments which have available staff, even though they may not be functionally best suited for the assignments. Later, when these activities have developed to their proper scope and influence, they may remain with the original organizational group. Procedural efficiency is adversely affected.

An activity is sometimes assigned to a department because of its physical location. When the department's location is changed, the assignment of the activity should also be shifted. Failure to make this shift results in poor systems.

As a company grows and new functions are added, it is necessary to redesign the old systems and to develop carefully perfected new ones to handle the added activities. It is necessary, in addition, to have a logical over-all systems plan to assure the proper coordination of all the enterprise's procedures. Otherwise, the net effect of all the added systems—each one good when considered by itself—will be like Topsy: they just grow into one big unwieldy bulk.

In many cases, investigations of poor systems have disclosed that they started as stopgap measures to handle an emergency situation which was considered temporary. When the temporary situation, instead of disappearing, became permanent, the stopgap system was retained, despite the fact that it had been adopted with little analysis and thought.

Poor systems tend to accumulate because people cling to those things to which they are accustomed. They are generally suspicious and fearful of change. Since the characteristics of enterprises are always changing —some more slowly than others—systems are always becoming obsolete. The natural resistance of most people to change thus fosters the continued use and accumulation of poor systems.

II

THE SYSTEMS INVESTIGATION

THE TYPES AND SCOPES of systems surveys will vary over a wide range depending upon the purposes of the investigation and the size and nature of the enterprise. In some very small companies, one all-inclusive investigation might be made which would cover the over-all organizational and operational problems as well as the detailed procedural considerations. In most cases, however, an individual systems investigation would be aimed at solving one particular problem or analyzing one particular aspect of the systems of the enterprise.

SCOPE OF A COMPLETE SYSTEMS INVESTIGATION

The first phase of a complete systems investigation is the analysis of the allocation or delegation of the functions of the enterprise to the various organizational units. Has the organizational structure been established so as to provide for maximum performance of service in the manner and time desired and at the minimum total cost? Are all required functions delegated to the proper persons? Are any wasteful functions performed?

Having established the best organizational structure for the enterprise, with functions allocated so as to promote effective systems flows, the next phase would be an analysis of the lay-out to determine if the physical organization or placement of the units of the enterprise is the best possible. Is most effective use being made of all space? Are the physical relationships between the units of the organization most conducive to effective operations?

A consideration of the economy of the more detailed operating methods of the enterprise is in order after the managerial and physical lay-outs of the enterprise have been analyzed. Are the motion patterns used by the workers most economical? Are waste motions and operations performed? Can motion elements be changed, combined, or rearranged to reduce fatigue or save time?

Much of this detailed systems work is recorded on forms. It is therefore logical at this point to consider the analysis and design of these forms. Can forms be simplified to eliminate waste motions? Can they be designed for the better performance of their intended functions? Can the variety of forms be reduced by combining several forms? Can carbon copies or duplicating carbons be used to reduce transcription work?

Just as manual labor in factory operations may be reduced considerably by use of machines, so the judicious use of properly designed office equipment may reduce office and coordinating labor. How much standardization of equipment usage is desirable? What equipment is suitable for the required functions? Is it more economical than manual performance? Are the machines and personnel synchronized as well as possible?

SPECIFIC SYSTEMS INVESTIGATIONS

A large proportion of systems investigations will not call for complete surveys of all aspects of the operations of an entire enterprise. They will be designed to answer one or several questions or to solve a specific problem. The purposes of some of the more common types of systems investigations are listed below:

To determine why a certain function or group of functions is not being performed adequately and how its performance can be improved.

To determine the best over-all organizational structure.

To determine the best design and/or distribution for a form.

To determine how the operations of one or more departments in the enterprise can be improved.

To determine the best lay-out for a given department.

To determine why some one or more performances are not up to expectation and what steps should be taken to correct the situation.

To determine whether the adoption of a proposed equipment is advisable.

To determine the best organizational and/or physical locations for a function or activity.

To determine the best way of performing a clerical operation.

The scope and terms of reference of a systems investigation should always be carefully defined and observed. Although a complete systems investigation will usually involve a consideration of organizational and lay-out aspects, it is very possible to devise systems within a given organizational structure and a given lay-out. The objective of the investigation is then not to find the best system, but to find the most effective one for an existing organization and lay-out.

STEPS IN SYSTEMS SURVEY

The scope of the project having been definitely established, the analyst is ready to start on his survey. Outlined below are the principal steps in the systems investigation. Not all steps are required or advisable in all cases. (Thus all new procedures are not formally prepared in writing.) The nature of the survey and the enterprise will be determining factors.

1. Plan and schedule the investigation. A preliminary survey may be desirable to determine the factors involved in the problem and to measure the magnitude of the task.
2. Obtain the systems information, carefully checking to insure accuracy.
3. Perform one or more of the following types of required analyses:

   a. Functional assignments
   b. Systems flows
   c. Lay-outs
   d. Motion economies
   e. Forms designs
   f. Machine studies.

4. Using these analyses, determine the best solution to the systems problem.
5. Prepare a written systems report outlining the investigation and proposing the best solution.

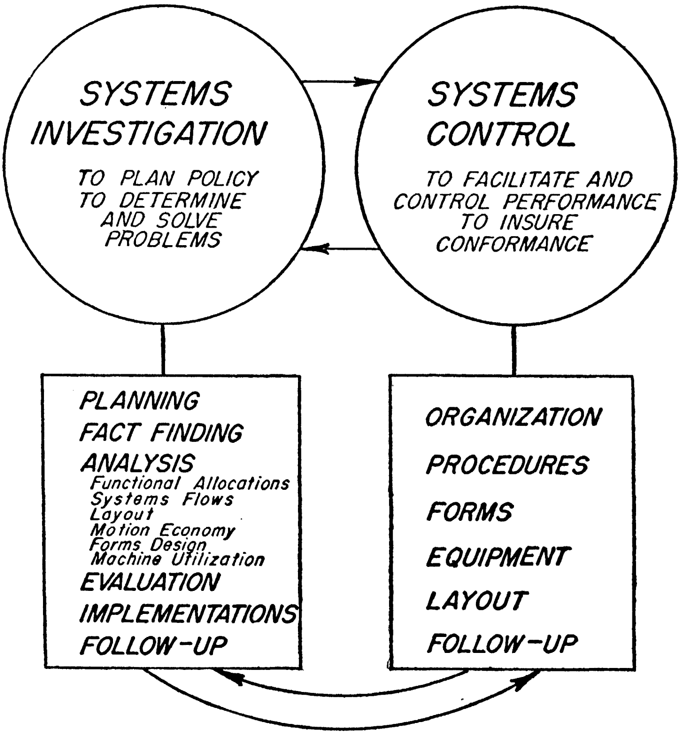


Figure 1. The systems technique—a diagrammatic representation illustrating the interrelationships of the systems investigation and control functions. The follow-up function properly belongs in both categories.

6. Sell top management and supervision on the desirability of the proposal.
7. Prepare written procedures and instructional charts and materials to explain new operations to workers.
8. Install the system, providing adequate retraining of the workers where required.
9. Follow up at periodic intervals to insure that the new system is working satisfactorily as planned.

These systems-investigation functions interact with and are assisted and complemented by the systems-control functions which are discussed in Chapter XIII. The interrelationship of the systems investigations and the systems controls is portrayed in Figure 1, which graphically summarizes the principal aspects of the systems technique.

In this book, the persons performing the various routines and analyses connected with systems work are called systems analysts. This should not imply that all the systems analyses in an enterprise should be made by systems experts. As pointed out in Chapter XIII, much of the detailed improvements in clerical procedures are more economically, more rapidly, and more readily obtainable by supervision training in the work-simplification principles and analytic techniques outlined in this book. An important function of the systems expert, then, is to train the supervisor and coordinate the supervisor's activities, which are naturally restricted to the activities of his own group.

III

PRINCIPLES OF GOOD SYSTEMS

SYSTEMS and procedures analysis was previously defined as the study, analysis, and improvement of the systems which service, control, and coordinate all the operations of the enterprise. It also was stated that many businesses operate with poor systems. What distinguishes a poor system from a good one?

The simplest and most fundamental answer to this question is that a poor system is one that does not provide the enterprise with a required service on time and at the lowest possible cost. This statement provides the cardinal basis for all systems work and, stated in a positive fashion, it will be the first of our principles of good systems.

Since the systems must operate within the framework of the organizational structure, it is impossible to divorce the organizational structure from the procedural structure of the enterprise. The organization provides the skeleton framework around which the procedures are built and, if the framework is weak, the system must also be weak. Although a good organizational structure does not guarantee good systems, a poor organizational structure may make impossible the existence of good systems. For this reason, many of the systems principles which will be presented in this chapter refer to the ways in which the functional responsibilities of the enterprise are delegated to the various organizational units.

However, for any particular company there may be several alternative organizational structures which will be almost equally good from a systems viewpoint. It is also important to remember that considerations other than the question of efficient systems—such as taxes, financing, legislation—are sometimes of great significance in determining the desirable organizational structure of a company.

The 24 general principles outlined in this chapter are guides to the establishment of systems which will promote the achievement of the objectives of the enterprise at the lowest possible cost and in accordance with the desired time schedule. For a manufacturing enterprise, the primary objective may be the production and delivery of goods to the customer in accordance with a scheduled plan of operations. For a hospital, the primary objective may be the provision of certain types of medical service to a certain community or segment of the community.

PRINCIPLE NO. 1

All the other systems principles are subservient to the cardinal rule that *a good system must provide promptly a required service at the lowest possible cost.*

The other systems principles which will be outlined in this chapter are valid only because they promote the achievement of this first principle. To satisfy this aim, a system must, first of all, promote the achievement of the objectives of the enterprise, which means, it must provide a required service. Secondly, this service must be provided when it will do the most good. Finally, the service must be performed at the lowest possible cost.

PRINCIPLE NO. 2

Other things being equal, functions should be allocated amongst the various organizational units so as to minimize the amount of required coordination, communication, and paperwork.

The greater the amount of required coordination, communication, and paperwork, the slower the operations; the greater the possibilities for mistakes; the larger the number of required checks; and the more expensive the operations.

PRINCIPLE NO. 3

To promote efficient systems, the responsibilities of each unit in the organization should be a logical and harmonious grouping of requirements for fulfilling the objectives of the enterprise.

It is therefore necessary to have a complete and definite knowledge of the objectives of the enterprise and of each of the organizational units. Each unit of the enterprise should be a logical entity. It should fulfil a definite purpose in furthering the objectives of the enterprise and each subsidiary unit should serve a logical function in furthering that purpose.

For example, the purpose of the manufacturing division is to fabricate and assemble the product as required by the sales schedule, in accordance with the engineering designs and specifications, and at minimum cost. To insure conformance with specifications, an inspection department is necessary. To provide effective control of the incoming raw materials, parts, etc., a receiving department is required. If the receiving department were given the responsibility of quality inspection of all incoming material, the principle of logical and harmonious grouping of functions would not be violated. If, however, the inspection department were given the responsibility of receiving incoming materials, the unity of purpose of the inspection department would be violated. The receiving function is a part of the material-control function and is not logically united with the insurance of conformance to specification.

PRINCIPLE NO. 4

A logical corollary to this principle of harmonious grouping is that *similar activities or functions should be placed together when other considerations permit.*

Thus, purchasing production material and purchasing office and other indirect supplies are similar activities and might be grouped together. Inspection of incoming material, parts, and components, and inspection of in-process materials, parts, and components are similar activities and, other things being equal, should be in one organizational group.

PRINCIPLE NO. 5

Especially where the element of time is important, the activities which must be performed in sequence should be located as closely together as possible, both organizationally and physically.

This principle is sometimes in conflict with the statement of Principle No. 4 that similar activities should be grouped together. Inspection of incoming materials and in-process materials are similar functions and, from a functional viewpoint, it would be logical to unite them. However, receiving and inspection are two activities which must be performed in sequence and these activities contribute to the manufacturing time cycle. Where it is important to keep the length of this time cycle to a minimum, then it may be desirable to divorce purchased-material inspection from the inspection department and place it under the material-control department which handles the receiving function.

PRINCIPLE No. 6

In addition to having a logical and harmonious grouping of functions, it is necessary that *all functions required for fulfilling the enterprise's objectives be delegated to some organizational group.*

Failure to do this may cause one of the following deleterious situations:

1. The function is not performed and the operations suffer as a result.
2. The function is assumed by a unit of the organization which is poorly suited for it. As a result, it is performed poorly and costs too much.
3. Portions of the function are assumed by different groups in the organization, resulting in incomplete performance and overlapping effort.

PRINCIPLE No. 7

It is equally important that *no function or portion of a function be performed when it does not contribute more than its cost to the enterprise.*

This principle is self-evident. It says that unnecessary functions (any one that contributes less than it costs) should be eliminated; that unnecessary equipment not be used; that the unnecessary (waste) motions of the clerk be removed; that unnecessary forms be destroyed.

PRINCIPLE No. 8

It logically follows from the previous principle that *a control system should avoid the loss of at least the amount of money it costs.*

If an auditing procedure costing $20,000 annually can be expected to avoid the petty pilfering of only $10,000 a year, then the auditing procedure is not worthwhile. If a system costing $100,000 per year will insure against a $1,000,000 loss which in all probability would not occur more than once in twenty-five years, this system is also not economically sound.

This principle, however, is not capable of easy application in many cases because it is frequently very difficult to estimate the losses which are avoided by a system. As a result, only gross violations of it will be evident in the case of many control systems. Despite its difficulty of application, this principle is nevertheless most fundamental.

PRINCIPLE No. 9

Where functions are dependent upon or service each other, they should be organizationally as close as possible. Stated another way, traveling up the organizational ladder, there should be a minimum number of vertical steps before the dependent functions come to a common superior.

It is desirable to have such functions as close as possible because in that way responsibility for coordination is concentrated, enabling better performance. For example, the purchasing and the receiving functions of the enterprise are closely dependent on each other. Figure 2 shows a typical organizational structure:

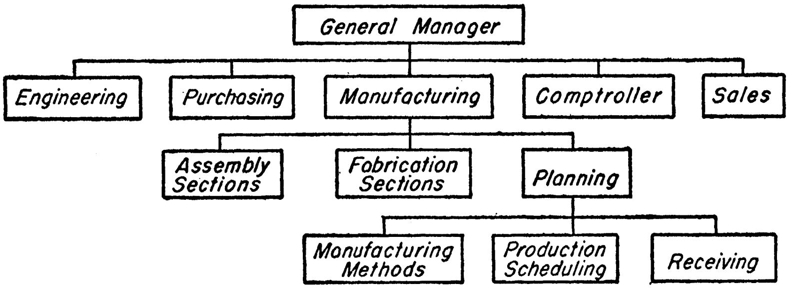


Figure 2. The receiving and purchasing functions are widely separated in this organizational structure.

There are three vertical steps on the organizational ladder before the receiving function reaches the general manager, who is the only common supervisor of the two functions. This might make coordination of the activities of the two organizational units somewhat more difficult than is desirable.

An alternative organizational arrangement is shown in Figure 3:

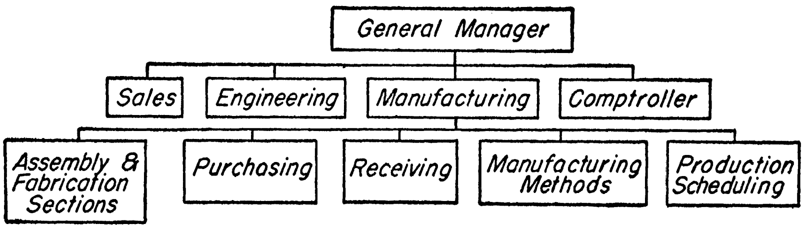


Figure 3. The receiving and purchasing functions can be more easily coordinated in this organization.

In this case, there is only one vertical step to the common supervisor of the purchasing and receiving functions. Coordination of these activities is thereby facilitated and responsibility is centralized.

PRINCIPLE NO. 10

Each organizational unit should have all the necessary authorities to carry out its responsibilities and these authorities should be placed as close as practicable to the source of action.

If any department lacks authorities which are essential to the proper performance of its function, then no system can work effectively. Thus, if the purchasing department does not have the authority to negotiate binding contracts, it cannot properly perform its purchasing responsibility.

When the authorities for action are placed high above the source of action, systems bottlenecks develop. For example, if the purchasing agents and their buyers in the purchasing department are assigned the function of negotiating purchase orders, but if every purchase order —regardless of size—must be approved and signed by the chief purchasing agent, the performance of the purchasing function will suffer. Small routine purchases will be insensibly delayed, and the chief purchasing agent will be unable to find the time to devote to the planning and policy activities which are his primary responsibility.

PRINCIPLE NO. 11

The inverse statement of this last principle is no less important. *Authorities should not be given which are not definitely required for the performance of assigned responsibilities.*

When this principle is violated and excess authorities are granted, needless activities may be adopted by the department having the unnecessary authority, thus distracting from its assigned objectives. Also, the danger of misuse of authorities is greatly increased when individuals are given authorities which are not required for the normal performance of their functions.

As an example, foremen are given the authority to reject material (issue reject tickets and determine disposition of the material) despite the fact that the inspection department has the responsibility of enforcing conformance to specifications. After a period of time, some foremen will start doing their own inspecting. This resulting duplication of inspection activities and distraction of the foreman from his primary responsibilities decreases operating effectiveness.

PRINCIPLE NO. 12

The responsibility allocations of organizational units should not overlap.

There should be no conflicts of responsibility. In general, no two organizational units should have completely common responsibilities. Failure to observe this precept results in duplication of effort, conflicts, and non-performance of some required activities.

If the assembly-floor stockrooms are assigned, among other functions, the responsibility of initiating orders for replacement parts required because of spoilage on the assembly floor and, as a check, the inventory-control department is also given this same responsibility, a number of bad results may occur:

1. The assembly stockrooms and the inventory-control department may both do slipshod jobs of reordering because each expects the other to catch any errors or omissions. The reordering activity may thus, on occasion, be forgotten entirely. The personnel of the stockrooms and the inventory-control department will, of course, attempt to shift responsibility for poor performance on each other.
2. Conflicts between the personnel of the stockrooms and inventory control will be encouraged by this overlapping of activities.
3. Both the stockrooms and inventory control will be keeping similar or duplicate records, which is very wasteful.

PRINCIPLE NO. 13

As far as possible, control functions should be allocated to organizational units which are independent of the functions to be controlled.

The degree to which this principle is observed may play a large factor in determining the effectiveness with which such control functions as accounting, quality control, auditing, systems control, etc., are performed. The further removed organizationally the control function is from the activities which it regulates, the greater the possible degree of independent control.

However, it is usually undesirable to segregate the control function too much because of the reduced effectiveness of coordination. This factor was mentioned in Principle No. 9 covering the placement of functions which depend upon, or service, each other.

It would obviously be unwise to place the quality control function in the hands of the manufacturing foreman, because one of the functions of quality control is to insure that the foreman maintains the quality standards specified by engineering. It would also be wrong to place the internal-auditing function under the plant accountant because part of this function is to check on the activities of the plant-accounting department.

PRINCIPLE No. 14

Each group of the organization should be held accountable for its performance to only one superior unit.

This is the same as saying that no person should have more than one boss. If the timekeeper reported to the production-control department as well as to the plant-accounting department, he might very well receive conflicting orders on many occasions. Different emphasis might be placed on various aspects of the timekeeping work by the two departments, resulting in confused timekeepers. Not knowing to which boss to look for final decisions would harm the morale of the timekeepers.

In some situations, it may appear desirable to have an organizational unit accountable to one superior group for administrative purposes and to another superior group for technical direction. Such arrangements may or may not work smoothly, depending to a great extent on the personalities and functions involved. These arrangements are usually unsatisfactory and should be avoided as much as possible.

PRINCIPLE No. 15

In deciding whether to centralize or decentralize the performance of service and planning functions, the economy of mass specialized operations and the elimination of duplication of functions must be compared with the reduction of communication and paperwork costs, the reduction in time cycles, the increased flexibility, and the greater unity of control and responsibility possible under decentralized operation.

What are the advantages of centralized organization such as shown in Figure 4?

In a centralized organization, there are greater possibilities of functional specialization—break-down of jobs into smaller, more repetitive, activities—because all work of the same nature is grouped together regardless of the product being produced. Economies are thus possible because of greater simplicity of jobs (easier to learn and acquire high skill) and because each supervisor can become a specialist in his own field rather than a jack-of-all-trades.

A centralized structure enables top management to control the activities of its operating divisions by means of the highly specialized and centralized staff-control functions. Since these staff-control activities

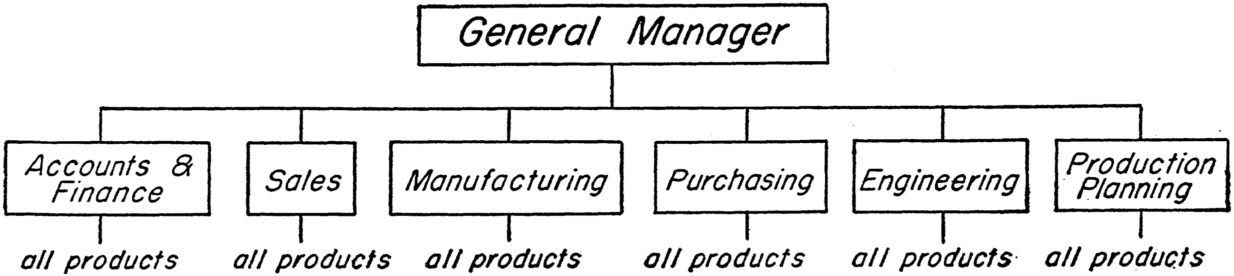


Figure 4. Chart illustrating an organization in which the various functions are centralized.

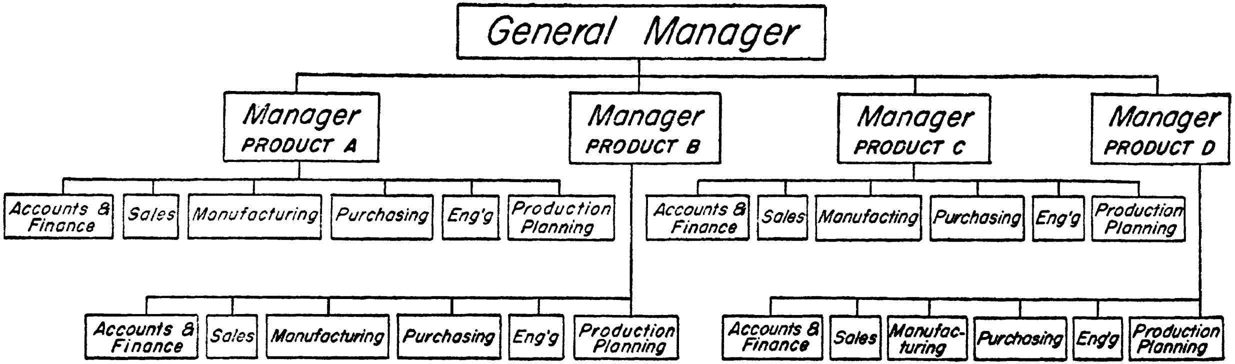


Figure 5. Chart illustrating an organization in which all functions are decentralized for each of the four product lines.

such as the accounts and finance division and the production-planning division each report to one man who reports to top management, control of the enterprise is simplified.

Because of the greater specialization of the job and the restriction of responsibilities to one phase of activity, replacement of high and low ranking personnel is simplified in a centralized organization. Salary costs for the top men are therefore a bit lower.

What advantages does a decentralized organization such as shown in Figure 5 have over the centralized kind?

Decentralization reduces the possibilities of functional specialization in favor of product specialization. Product specialization makes it easier to fix responsibility for proper performance and, as a result, creates greater incentives.

Under the centralized organization, no one person had complete responsibility for the production and sale of Product A. As a result, it is relatively difficult to fix responsibility for the good or poor performance. Since recognition of good performance is more difficult and since no one of the persons under the general manager has complete control of the situation, the incentive to insure good performance in Product A is somewhat reduced. Under the decentralized organization, the Product A manager has complete responsibility for all functions connected with Product A. If Product A fares well, then he is recognized for his good work. If it fares poorly, then the Product A manager cannot shirk responsibility since he has complete charge of all the functions connected with Product A.

Although there is duplication of functions in each product line under the decentralized organization, the total volume of paperwork is usually reduced by decentralization of a large organization. A decentralized organization, consisting essentially of relatively small units which are functionally almost independent of each other, does not require as much coordinating paperwork as the single, larger unit of the centralized organization.

The production time cycle is generally shorter in a decentralized organization because the smaller, less specialized service departments of a decentralized company can act faster than the very much larger, highly functionalized service and control departments of the centralized company.

A decentralized organization is usually more flexible than a centralized one because its less specialized units can adapt themselves to various types of operations more readily than the highly functionalized centralized structure. This is an important consideration in enterprises and industries which are continually undergoing considerable changes in their operations.

It is essential then to consider all factors when determining the desirable degree of centralization and decentralization. The optimum point varies from enterprise to enterprise and depends on the many different characteristics of the business. Decentralization of the organizational structure of an enterprise tends to increase the manageability of large enterprises. On the other hand, centralization of small enterprises tends to increase the possibilities for benefits from functional specialization. There are many variations and degrees of centralization and decentralization. To determine the best amount and variety for any particular enterprise, thorough analysis and seasoned judgment are necessary.

PRINCIPLE No. 16

In determining the most desirable form of organization, consideration should be given to the advantages and disadvantages of the three principal types of organizational structures: line, staff, and committee. No one of these ever exists in pure form but every organization is a combination of varying proportions of two or three. There is one best combination for each enterprise. The systems analyst must constantly strive towards the best combination, which is different in each case. This best combination will maximize the advantages of each type and minimize the disadvantages.

The line organization structure is the simplest, most direct kind. In this organization, there is no specialization by functions. Each supervisor is responsible for all aspects of the work of his inferiors. In its pure form, the line organization represents the ultimate in functional decentralization. A representation of a possible line organization is shown in Figure 6.

Although not practical in its pure form in most modern industrial organizations, the line form of organization possesses some definite advantages which it is desirable to salvage in a modified structure: it is simple, providing clearcut and readily defined responsibilities; control and discipline are therefore more easily maintained; action is quick and time cycles are short; and it is a very stable structure because the various units of the organization are virtually independent of each other.

The staff or functional organization in its pure form is most complicated. Each person or group in the organization performs one specialized function. The goal of the functional structure is the reduction to

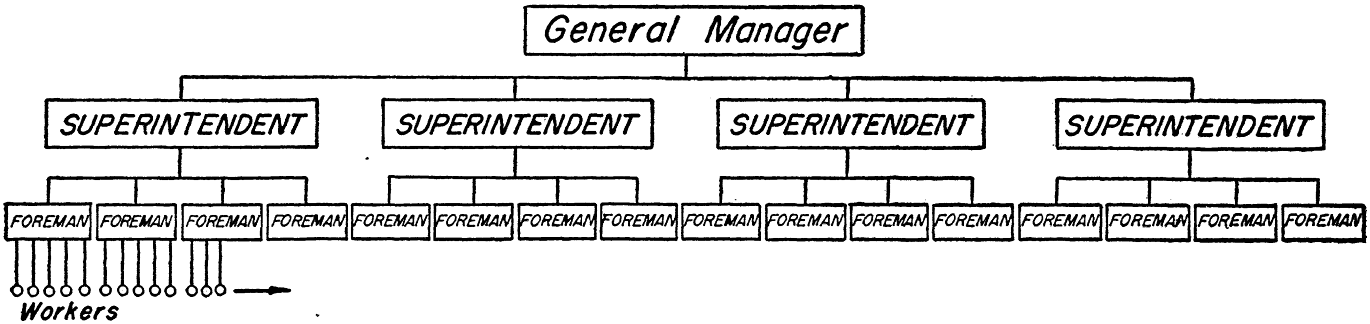


Figure 6. Chart illustrating pure line organization, in which each person performs all aspects of the work without specialized assistance.

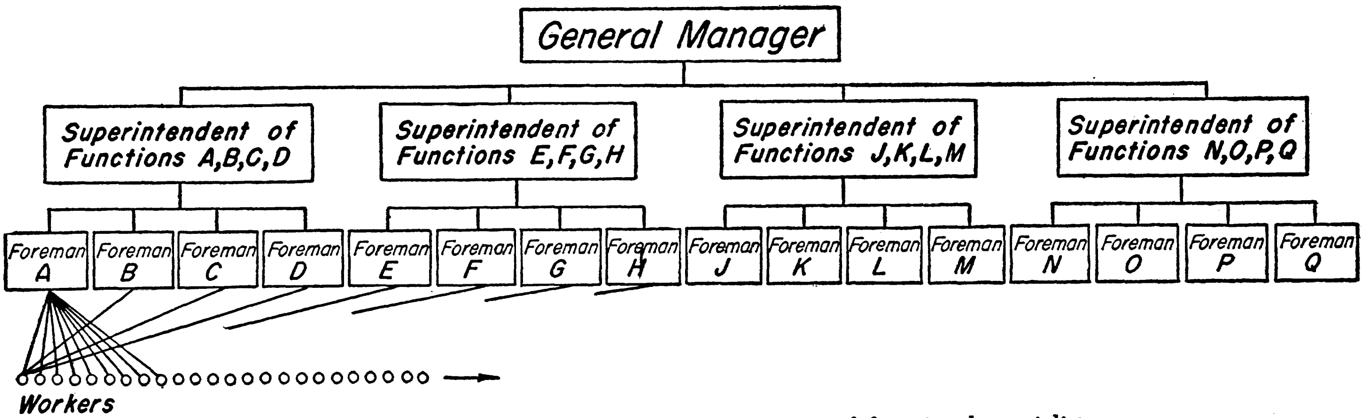


Figure 7. Chart illustrating pure staff organization of functional specialists.

a minimum of the functions performed by each person. In its pure form, the staff organization represents the ultimate in functional centralization. A diagrammatic representation is shown in Figure 7, in which 16 specialized control and service functions are performed. Each worker reports to each of the 16 specialist foremen for the different aspects of his work.

Although not practical in its pure form, this plan has the obvious and important advantage of having each supervisor an expert in his small field, enabling greater functional efficiency. The principal drawbacks of the organizational plan in its pure form are the difficulty of coordinating the work of the large number of specialists, of fixing responsibility for performance, and of maintaining discipline amongst workers or groups serving so many superiors.

Whenever the supervision of any of the organizational units is performed by a committee, some form of committee organizational structure has been created. The position of the committee may be in the line, such as the board of directors of a company, or it may be in a staff or functional unit, such as a standardization committee. Committees are valuable when expert knowledge from different groups must be pooled and when required cooperative action is to be promoted.

None of these types of organizations is practical in the pure form. Combinations of line and staff, with some committees where most desirable, is usually the most effective answer. The staff workers then serve two important functions: they provide specialist knowledge of their various fields to aid the line executive in carrying out his responsibilities; and they relieve the line executive of a plethora of details which would prevent him from working effectively. Figure 16 is an example of a line and staff organization structure.

PRINCIPLE NO. 17

A system should be as flexible as possible.

Flexibility and permanence go hand in hand. If the smallest change in personnel, policies, or product will invalidate the system, the necessity for continual revision of the system will defeat its purpose. Of course, the system must not be so general in nature as to be ineffective. The best balance must be reached between the highly generalized, flexible, permanent, but ineffective procedure and the temporary, highly efficient, specialized, but inflexible one.

The strength of a system may frequently lie in its flexibility and ability to withstand change and adapt itself to the normally changing demands of the business. Although some people confuse rigidity and strength, the relationship of the two can be seen by the following analogy with the winds of competitive enterprise: when a hurricane strikes, the flexible blade of grass survives whereas the rigid, but stronger, tree is destroyed.

Flexibility in systems may be achieved from a number of approaches. The system may be so designed that it will be effective under a wide variation of circumstances; a system performed at a high level in the organization is likely to obtain this type of flexibility by providing for discretionary judgment under prescribed conditions; a system performed at the lower levels should preferably obtain most of this flexibility by covering all possible eventualities with extensive instructions. (The possible eventualities of changing situations are more easily predicted at the lower level.) A second type of flexibility may be achieved by providing an adequate procedure for changing the system; by having stand-by systems prepared and ready to step into a required situation; by providing a systematic and frequent review of the established systems so that they can be constantly revised to meet changing conditions. The first type of flexibility is built into the design of the system. The latter type is dependent on the manner of administration of the systems control functions in the enterprise.

PRINCIPLE NO. 18

The delegation of responsibilities and the establishment of procedures should not be affected by the special abilities, personalities, or peculiarities of individual members of the organization.

The significant term in this statement is the word "special." The abilities, personalities, and specialized skills of generally available personnel must be the basis of the organization plan rather than the peculiarities of particular individuals.

There are several reasons for promoting the general application of this principle. Systems will generally be more complicated when they must be woven to meet the special organizational pattern which has been created about the individuals. Systems will be outmoded much more rapidly if this principle is violated because when personnel shifts are made, the allocation of responsibilities will have to be changed. In addition, both the organizational and procedural structures lose flexibility because of the rigid pattern imposed by the adaptation of the organization and procedures to one particular set of individuals.

It is, of course, sometimes necessary to make slight modifications in responsibility allocations to allow for certain abilities or lack of ability on the part of individuals. But such deviations, when necessary, should not be allowed to grow extensive or to affect vitally the operating pattern. Whenever they can be avoided, the business benefits.

PRINCIPLE No. 19

The length and the width of the organization structure should be kept to a minimum.

The length refers to the number of levels of management and supervision. The greater the number of levels of authority—the longer the "chain of command"—the greater the distance and the time required for information to travel up and for policy and decisions to travel down the organization. The coordination problem is thus increased. Top management is far removed from the workers and their problems. Moreover, the lower levels of the organization may feel so far removed from the controlling management of the enterprise as adversely to affect their incentives.

The width of the enterprise refers to the number of persons reporting directly to any one executive. Other things being equal, this number, known as the "span of control," should generally be smaller the higher the organizational positions. However, the nature of the business and the character of the duties are important variants. It is generally agreed by most authorities that no more than five to eight subordinates should report directely to any executive. The danger in overloading an executive with the direct supervision of too many subordinates is that he then cannot find sufficient time for his planning and policy functions. Of course, many more than eight routine workers can report to a foreman or group leader, the exact number depending on the kind of work involved.

The twin problems of the length and the width of the organizational structure cannot be completely disassociated from each other because, in some cases, to obtain a smaller "span of control" may require a longer "chain of command." Each application must be decided on its own merits, taking all pertinent facts into consideration.

PRINCIPLE No. 20

A system should be as automatic as possible.

Expediting and individual judgment should be reduced to a minimum. When the system works automatically, supervision and managerial time is saved. Also, the possibilities of errors of judgment interfering with operations are reduced considerably.

In obtaining maximum automaticity of operations as opposed to individual judgment, care must be taken to avoid the dangers involved in a highly detailed complex system of rules. Such a system may result in sluggish operations with a high degree of inflexibility.

A corollary to the automaticity principle just mentioned is that *a good system will concentrate attention on variations from standards, plans, routines, and policies.* The ideal system will thus function automatically and will bring managerial attention to any situation which requires investigation or corrective action.

The system for the accumulation of information on shipments from the manufacturing plant and the preparation of a regular report of shipments should work automatically and in the same manner every day. The reporting form and system should be so organized, moreover, that any substantial differences between actual and scheduled shipments come to the immediate attention of the responsible supervision for investigation.

PRINCIPLE NO. 21

The delegation of functions and responsibilities to the various organizational units and the specification of procedural methods usually can be established best by reducing them to writing and distributing these writings to all concerned persons.

The advantages of establishing the functional delegations by means of organization manuals and procedural material by means of procedural manuals are manifold:

1. By requiring that organizational policy be written, it forces management to think more clearly on the subjects and to make more definite decisions. It will also tend to disclose any bad organizational practices.
2. By making organizational and procedural information available to all who require it, efficiency of operations is promoted. A person works more effectively if he knows exactly what is expected of him and how to go about performing these expected duties.
3. When functions are assigned in writing, unplanned gradual shifts in activities due to the aggressiveness or lack of aggressiveness of certain supervisors will be avoided.
4. Responsibility for poor performance can be more definitely fixed when assignments are in writing.
5. Procedural routine can be more effectively standardized and new personnel more easily trained when procedures are written.
6. By providing a compact source of information on the organization and operation of the enterprise, organization and procedure manuals, with their accompanying charts and diagrams, provide top

management with an instrument for grasping a picture of the over-all operating system as well as an ability quickly to ascertain any details that are desired.

PRINCIPLE No. 22

A good system will have a unity of purpose which it will accomplish in as simple, clear, and understandable a manner as possible.

Unity of purpose, simplicity, clarity, and understandability are the usual distinguishing features of a good system as compared to a poor one. Unity of purpose means direct achievement of objectives. Simplicity results in low operating costs. Clarity and understandability are necessary if the operating personnel are to be able to follow the system. A complex system is seldom a good system because it is very rarely workable.

PRINCIPLE No. 23

Systems must be based on verified facts and not on opinions, guesses, or false information.

For effective results, the scientific method must be used in systems work as in most other mundane pursuits. The scientific method requires the use of established and verifiable facts as the basis for hypotheses and decisions. As explained in the chapter on obtaining systems facts, the systems analyst must show exceptional zeal in insuring the accuracy of his facts because of the ease with which inaccuracies can creep into a systems investigation.

PRINCIPLE No. 24

In the design of a system, consideration should be given to the fallibilities of the personnel who will perform the routine as well as the imperfections of any machines that the personnel will be required to use.

No person and no machine is perfect in the sense of never making a mistake. Of course, some people and some machines make fewer errors than others. Most systems must be designed so that the expected errors will be automatically discovered and corrected. In some cases it may be decided, after careful study, that it is more economical to let the errors go undiscovered rather than provide in the system for their recognition. It is always important to remember, however, that people and machines have imperfections and that it is impossible to predict many of them with accuracy.

The system should therefore be adapted to the qualifications of the available workers. Although a good system should not be built around the personalities and specific aptitudes of any individual or group of individuals, it is necessary to take account of the people who will be available to operate the system. For this reason, good systems practices will vary in different countries and in different sections of the same country. Also, systems may become outmoded when the availability of workers with different skills changes to any marked degree.

In this presentation of the principles of good systems and procedures, an attempt has been made to present some of the more fundamental considerations involved in the broader aspects of systems analysis. The detailed rules for making a systems study and the methods of analyzing the systems flow, the forms design, the lay-out, the motion patterns, etc. will be presented later.

The principles outlined in this chapter do not comprise all the generalized rules which can be presented. Other, and more obvious statements can be added, many of them applicable to all kinds of work other than systems. As examples: a system should provide for maximum satisfaction of the creative and achievement instincts of the worker; all systems should be in conformance with the laws of the nation, state, and community and should not run counter to the public interest; a procedure should be in accord with top administrative policy.

No attempt has been made herein to develop a complete and adequate philosophy of scientific management. Such an undertaking would be outside the scope of this book. Rather, certain general working principles have been presented to aid the analyst in creating good systems.

Part II

METHODS OF SYSTEMS ANALYSIS

IV

PLANNING AND FACT-FINDING

THE AIM of the initial stages of most systems investigations is to obtain facts. Since the conclusions, recommendations, and subsequent actions of the systems analyst will be based on these facts, this stage of the analysis is very important. Considerable care must be taken to avoid the serious errors which can easily occur at this stage and which will render all the subsequent analyses and conclusions invalid.

It is essential that all systems data be:

1. Complete
2. Correct
3. Valid.

To be complete, no pertinent details may be omitted; to be correct, the facts must be true; to be valid, the data must be applicable to the situation being studied. Also, in the collection of systems data it is important to consider the human relations aspects which can negate the effects of an otherwise brilliant analysis.

SCOPE OF PROJECT

Systems information should be collected in an orderly manner. Before starting a project, the systems analyst should have the scope of the investigation clearly defined. He should have a complete understanding of the purpose of his assignment. This is necessary to avoid extensions of the investigation beyond the assigned field. Such extensions are generally harmful because they may cause personnel irritations; because they may be contrary to management desires; and because they may delay completion of the assigned work.

A clear and definite picture of his assignment enables the analyst to approach the problem logically. He is then able properly to organize his attack on the problem and systematize his methods of obtaining the required information. By proceeding in an orderly manner, he keeps back-tracking and waste motions to a minimum. He avoids making unnecessary contacts and avoids collecting unnecessary information or unimportant details.

SCHEDULING ACTIVITIES

Having a clear understanding of the purpose and scope of his assignment, the systems analyst should develop a detailed plan of attack. This advance planning is necessary to avoid uncoordinated movements in many directions.

The best way of coordinating the activities and eliminating illogical elements is to reduce the plan to writing and then revise it periodically as required by new findings. These written plans should include:

1. A list of the required information.
2. Possible sources of this information.
3. Systems staff requirements, such as the assistance of other analysts.
4. A time schedule of the various phases of the investigation.

To insure that all information is complete, correct, and valid, it will be desirable to check several sources of critical facts; to spot-check data on a sampling basis whenever practicable; to double-check all information which does not appear reasonable.

The information should be collected in a systematic manner: all pages of notes should be identified with date, title, and source. Records of the progress of the project should be kept on a current basis.

CRITICAL APPROACH

The systems analyst must always be silently critical and skeptical of all facts. A fact is considered suspect until it is proven true. This is very important, because a well-designed system will not be worth the paper it is written on if it is based on incorrect or incomplete facts.

The problem of correct systems data is complicated because there may be a number of different answers to the same question: how is a certain activity performed?

1. The way the supervisor thinks it is done.
2. The way the employee thinks the supervisor wants it done.
3. The way the supervisor tells the employee to do it.
4. The way the instruction manual says it should be done.
5. The way it is actually done.

People mislead not only from malicious intent: they sometimes are misinformed themselves; they sometimes do not desire to admit their ignorance and therefore guess at the answer. Written information, of course, may be incorrect because it is out of date.

The only answer to the accuracy problem is to double-check, by actual observation whenever possible.

RECORDING THE DATA

When collecting information on the various aspects of any systems problem, various means of organizing and recording these data may be employed. In many cases, forms can be successfully employed to systematize the approach and help insure complete coverage. However, if forms are used for this purpose, the analyst should not let them channel and restrict his approach so as to hamper the free use of his imaginative and analytic powers. Horizontally ruled columnar ruled paper, neatly headed, can serve equally well as any of these forms and, in addition, provide greater flexibility and possibilities for novel variations suited to the requirements of each case.

A form, such as shown in Figure 8, might be used to obtain data on the productivity of employees. A similar form might be used for obtaining data on the productivity of a machine. Data on the productivity of the employees might be summarized by a bar-chart diagram such as shown in Figure 9. A similar chart, such as shown in Figure 10, might be used graphically to portray the utilization of the various types

DAILY PRODUCTION RECORD

Employee Name Title Dept. Sect. Date

Nature of Work	Time			Quantity Produced	Equipment & Forms used
	Start	Stop	Minutes Elapsed		

Figure 8. Daily Production Record—provides data for analyzing personnel utilization, equipment utilization, productivity, and systems flows.

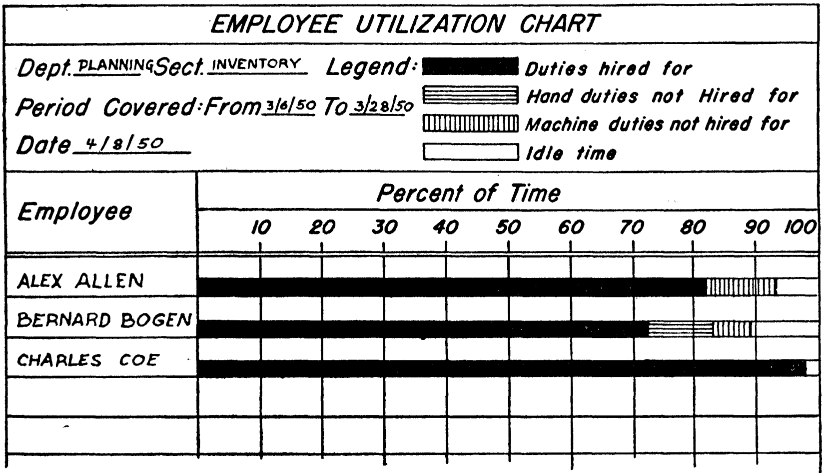


Figure 9. Employee Utilization Chart—provides a graphic portrayal of how the personnel of the section is being used.

of machines in a department. These charts point out places where further investigation and analysis should be made to determine the causes for poor or misdirected utilization of personnel and/or equipment. Another kind of presentation of this observational data is shown in Figure 11. This tabulation sheet will help direct attention to the clerical tasks that take the most time (the cost-per-unit column) and therefore offer the greatest possibilities for savings. The time-per-unit

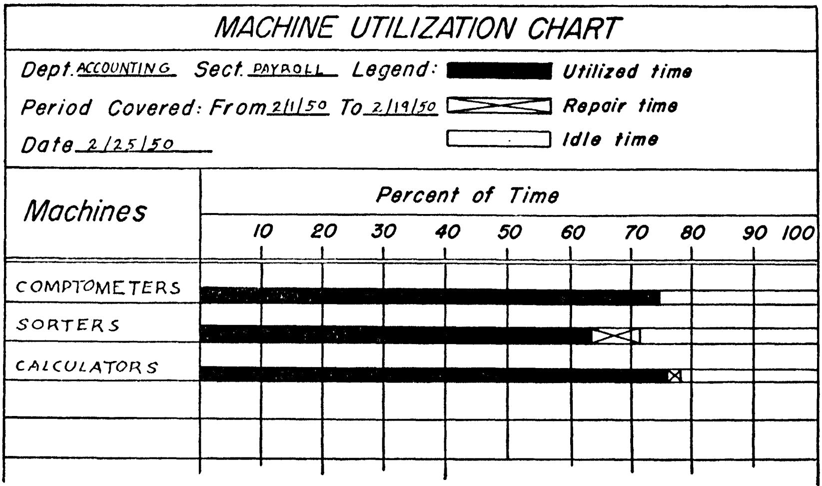


Figure 10. Machine Utilization Chart, showing effectiveness of machine scheduling.

PRODUCTION TABULATION SHEET

Employee________ Title________ Dept.________ Sect.________ Week ending________

Operation		Time (in minutes) & Production (in units)						Time per Unit	Wage Rate per Min.	Cost per Unit
		Mon.	Tues.	Wed.	Thur.	Fri.	Total			
COLLATING PUBLICITY RELEASE	Minutes									
	Units									
MATCHING SALES TICKETS	Minutes									
	Units									
POSTING GEOGRAPHICAL RECORD	Minutes									
	Units									
IDLE	Minutes									
	Units									
REST	Minutes									
	Units									
TOTAL	Minutes									
	Units									

Figure 11. Production Tabulation Sheet—provides a convenient form for analyzing the activities and determining the productivity of an employee.

column tells you something about the efficiency of performance of the operations. Comparison with others performing the same operation may reveal valuable clues about the relative effectiveness of machines, methods, and personnel. These data are also valuable in the determination of procedure costs.

In a similar manner, forms can be designed for obtaining and summarizing information on various types of equipment practices (see Chapter IX)—file usage, typewriter usage, reproduction equipment, etc. Data on the designs and usage of forms on the organizational and flow aspects of procedures, on the detailed activities of each individual in the enterprise might all be collected on specially designed forms which help insure systematic and more complete coverage.

REPORTS LIST			
Information Received From________ By________ Date______			
Report Name	Prepared By	Form No. (if any)	Other Information

Figure 12. Tabular Reports List sheet—gives listing of all reports, together with directly related information.

If a report survey is being conducted, the first step might be to obtain an inventory of all the reports prepared on a Reports List form such as Figure 12. For each report on the Reports List a sample would be obtained and a Report Data Sheet (Figure 13) would be completed to provide the data for further analysis: are all distributed copies required?; is the preparation procedure good?; does the cost of preparation exceed its usefulness?; is the report current enough?; and so on.

The analysis of reports is discussed further in Chapter VIII.

SOURCES OF SYSTEMS DATA

The sources of systems data will vary considerably, depending on the type of investigation and the past and present practices in the company. Let us consider some of the more important and normally available sources of systems facts.

REPORT DATA SHEET

Information received from ____________ By ________ Date ______

Report name ____________________________

Form no. (if any) ________ Size of sheets ______ No. of sheets ______

Why is report prepared? ____________________________

Information in report ____________________ | Sources of information

Frequency of issuance ____________ Periods covered ________

How long after fact is report issued? ____________________

How is report prepared? ____________________________

How is report duplicated? ____________________________

Estimated preparation costs Labor _____ Supplies _____ Other _____ Total _____

Distribution	7 ______	14 ______
1 ______	8 ______	15 ______
2 ______	9 ______	16 ______
3 ______	10 ______	17 ______
4 ______	11 ______	18 ______
5 ______	12 ______	19 ______
6 ______	13 ______	20 ______

Place additional data on reverse side of sheet

Figure 13. Report Data Sheet—provides information for analyzing various aspects of the reports for improvement, elimination, simplification, etc.

Organization charts and manuals may indicate no more than bare outlines of the enterprise's organization structure, or give details on the responsibilities and functions of the departments and their supervisors.

Accounting instructions may provide quite a lot of information on the existing financial controls and paperwork routines for collecting cost data. Other written operating instructions, procedures, memoranda, and bulletins may also give valuable data. In using this information, it is well to keep in mind that it sometimes represents systems which have since been discarded or which were never even completely installed.

If a systems department has been in operation many years, its project files are usually a valuable source of information. The methods department might also have information on certain problems related to its work.

Informal discussions with people who are acquainted with the problems and/or with the persons involved may be very valuable sources of orientation information. What unusual situations will be encountered or should be looked into? What personality quirks are to be expected?

The minutes of meetings of production, sales, and other executives, and of various committees may prove very valuable as indicators of operating difficulties, of the attitudes of various persons in the enterprise, of present methods of operation, and of other possible sources of more information.

If a forms file is available, it should be consulted for a knowledge of the forms and how they are used in connection with the systems. Thorough familiarity with the forms used in the procedures under consideration is very helpful because forms provide the principal means of recording and transmitting systems information.

Direct observation constitutes the most reliable source of data. The what, where, and how a thing is done can be observed and compared with the specifications in operating instructions, if any. The placement of equipment and personnel and their working methods can best be determined by direct observation.

The financial and statistical reports of the enterprise may provide useful data in many surveys. The reports of outside or internal auditing agencies frequently can be a most fruitful source of information.

In practically all cases, it will be necessary to consult the supervisory and operating personnel in the enterprise to obtain some or most of the required information. This source of systems data should be the last on the list—after all other avenues of information have been exhausted. There are good reasons for investigating all other places first:

1. The analyst will be more certain of the information he requires and the persons who can supply him with it.
2. The analyst should be as fully informed on his problem as possible before talking to persons who may be hostile and who will usually have much greater detailed knowledge than he can be expected to have. The better informed the analyst is, the more intelligently he can prepare for and conduct the interviews and the more valuable they will be. He will be better able to distinguish between fact and opinion.
3. The time of many of the persons to be interviewed is valuable and should not be wasted in educating the systems analyst more than absolutely necessary. In addition, many of these persons will properly resent having to undertake this education.

In conducting this most important and delicate aspect of the fact-gathering routine, the analyst must be thorough and skeptical, but, above all, tactful. His principal problems will be winning the trust and confidence of the personnel and distinguishing fact from fiction.

Getting along well with the supervisory and operating personnel constitutes one of the toughest and, in many respects, one of the most important jobs of the systems analyst. It is one of the toughest because of the primary hostility which is frequently felt towards systems men. (The possible reasons for this hostility and suggested ways of dealing with it are discussed later.) It is one of the most important because the best system in the world will not work without the cooperation of the supervisory and operating personnel. Mr. H. J. Ross tells the following story: *

"Not long ago I met on a train a Production Manager of a moderate sized company in the mid-west. When he broke through my modesty and learned that I was a Systems man we had a conversation that ran something like this:

" 'So you're a Systems man. Well, well, well. You know I like Systems men. They're so damn smart. They know everything. Don't they?'

" 'Well, hardly everything.'

" 'Come on, you're just being modest. Don't you know everything?'

"Well, it was obvious that something was 'sticking in his craw.' I managed to convince him that I was a reasonable creature and that furthermore I could tell from his manner that he had had an unfortunate experience and 'why not spill it.' So he did.

"His company employed a firm of consultants to survey the manu-

* H. John Ross, *Technique of Systems and Procedures*. New York, Office Research Institute, Inc., 1948.

facturing operation and provide a Production Control System which would straighten out their problems of materials flow, scheduling and overall control. The consulting firm sent two Engineers to the plant who spent about two weeks making a survey during which time they managed to antagonize about everybody in the plant including the janitor's helper.

"They then left the plant and nothing more was heard from them until they returned in about six weeks with the entire Production Control System laid out in several very impressive manuals with beautiful leather covers and gold embossing.

"They convinced a skeptical Top Management that they had the answer to the Company problem. With their experience in many similar plants, and with the facts they had, they were able to design a top-notch, a humdinger System. They had put a staff of Engineers to work, each man to a specific phase of the job, and a half dozen men had come up with the answer in the six weeks' time that they had not been in the plant. So they were told by Management to go ahead.

"They did. They called the executives together in one session and explained the plan: A question was answered with 'You'll see when we get rolling.'

"The supervisors were called together in appropriate sessions and the plans explained. Questions were answered with the same 'You'll see when we get rolling.'

"Then the plan got rolling. In a week's time the two Engineers went to Top Management and said 'Everything is rolling. It'll be a little noisy until it gets warmed up. Our contract is fulfilled. Your check, please. $35,000.'

"For a period of about four months Management struggled to get the new system warmed up but it was no go. It just wouldn't work and they finally gave up. They gave the plant orders to return to their former practices and wrote off the $35,000 fee they had paid.

"After the Production Manager was through I made my comment.

"'How could your Management believe that these Engineers could design a Production Control Plan without being right there in the plant?'

"'Well, you know, that was a strange thing. They really surprised me with a plan that wasn't too bad. It had a few weaknesses that could have been worked out in time. But on the whole it was sound.'

"'You mean . . . ?' I asked.

"'Yes, sir, I mean,' he said, 'those fellows couldn't have presented any program that would work in our organization. There was not any organized conspiracy . . . nobody ever discussed it with anyone else as far as I know. But every last person in the company below Top Management was determined that it wouldn't work, and it didn't.'

"Now I wish to impress upon you these facts. One—this is a true story. Two—it happens every day. Three—it can happen to you."

INTERVIEWING PROCEDURE

It is advisable first to confer with the top officials of the departments concerned before approaching the supervisory and operating personnel. These persons should be given a complete story on the purposes and scope of the investigation and the tentative plan of attack. Their suggestions and cooperation should be invited and any questions should be answered. If it is feasible, and the departmental officials are agreeable, direct participation of the departmental personnel is to be invited and encouraged. This is usually desirable even if, as a result, progress will be slowed down somewhat. Proposed changes will be received and installed with much greater enthusiasm by people who have participated in their development.

Having invited the suggestions, cooperation, and perhaps participation of the departmental management and having obtained clearance to consult with the department personnel, the analyst is ready for further detailed fact-finding. For success in his interviewing, the analyst may find the following recommendations helpful:

The analyst should, of course, make an appointment in advance. Dropping in on a person without advance notice does not usually constitute the best approach.

The analyst should come to the interview well prepared. Even if it is not shown to the person being interviewed, a written outline of the desired information should be prepared. Otherwise, the analyst may not get all the required information; the interview will tend to ramble; and the analyst may not appear too bright.

The analyst should take notes. They help organize the material in logical sequence and clarify his thinking. If he doesn't take notes, the analyst will not necessarily remember everything and may get some facts mixed up. Facts are more reliable when they are immediately recorded. The person being interviewed might even consider it insulting if written notes of his "words of wisdom" are not being written down, especially if he feels they cannot all be remembered. Moreover, if the analyst did not take notes and then had to call the person back to verify some facts, the reaction might not be too pleasant.

A good rule to follow in systems interviewing is: Be a good listener first and a good talker second; do the most listening and least talking that you can manage. As an analyst you learn more that way and the person you are interviewing will like you more for being a good audience.

If the analyst can conveniently learn in advance about some of the personal characteristics of the people to whom he is going to talk, he can be better prepared to cope tactfully with the interview situation. In every case, there are a number of general suggestions which can be made to a prospective systems analyst. These suggestions are intended to avoid some of the mistakes which many systems men have made while learning their profession. Many of these men who have been very successful in systems work made some of the serious errors in dealing with personnel about which the reader is presently to be warned. However, they quickly realized the error of their ways or they would not have lasted too long in their profession.

In contacting the personnel, the systems analyst would do well to understand the primary hostility with which he may be received. Some people have the misconception that a systems analyst is a disreputable efficiency expert—a smart aleck who messes things up, makes people work harder, and gets them fired. Other persons resent having a systems man intrude on their time and interrupt their work. Most people feel that they are performing their work satisfactorily and don't like anybody else snooping. Most people are naturally fearful of change. Moreover, here and there in a very large organization will be found a few people who have what they consider soft jobs or rackets which they are desirous of protecting. Most persons, other than those in the last category, can be won over by tactful handling. Misconceptions can be clarified by a friendly and sincere approach.

Your attitude should always be a sincere desire to do your job as best you can without hurting anybody else—to reduce the pressure of work, make work easier, eliminate unnecessary work. Try to talk in terms of the other man's interests. Show how what you do may prove helpful to him. Attempt to get him to share in your project. Find out what he considers wrong with the way things work at present. Even if you don't agree, show a sympathetic interest and respect for his opinion. When his ideas are good, be sure that he gets recognition for them.

Although you should be skeptical of everything, you should never allow this skepticism to be transmitted to the personnel or you will be considered a faultfinder. Never give the impression that you know a lot. Always imply that the person being interviewed knows more about the work than you, the analyst, do. The person usually knows more about the details of the work anyway. Don't find fault or criticize the way things are done. Never tell anybody he is wrong and don't criticize anybody else in the organization. It will always get around to the other person. Nobody ever won an argument in systems work. Therefore, don't argue. You lose if you lose the argument and you lose even more in the resentment of the other person if you win.

In the Appendix to this chapter is given a practical case illustration of an interview to indicate by example some of the proper techniques for securing good interview results.

Although an attempt has been made to suggest how to get along with people because of its prime importance in systems work, getting along with people cannot be reduced to a set of rules. Getting along with the personnel of the enterprise depends more on the attitude and intelligence of the analyst than observing any set of rules. A friendly and pleasant manner and an unpretentious spirit, coupled with a genuinely helpful interest in the other person, constitutes the successful combination.

WRITTEN QUESTIONNAIRE

For certain specialized systems investigations, the questionnaire method of obtaining information may be valuable. For most surveys the use of questionnaires is not to be recommended because

1. The personnel object to answering numerous, time-consuming, and tedious questionnaires.
2. It is difficult to design questionnaires which will insure obtaining exactly the information desired. Many of the answers received from elaborate questionnaires will therefore be inadequate. As a result, the interview technique will have to be used in addition to clear up doubtful points.
3. The clerical expense to the enterprise of a continued, large volume of questionnaires is rather large.
4. The questionnaire method is relatively slow because many persons put off answering the questionnaire for some time. This also necessitates considerable personal expediting of replies.

The questionnaire method is most valuable when a very small amount of information is required from a large number of persons or when a systematic study is being made of all the activities of one unit of the organization.

The systems questionnaire is in reality a temporary form and care should be taken in its design to conform to the principle of good form design outlined in Chapter VIII. The questions should be worded so that no misinterpretations are possible and no biases will be present in the replies. The introductory remarks in the cover letter should adequately explain the purposes of the questionnaire in order to avoid misunderstandings and to help solicit cooperation. It is usually a good idea to indicate a reasonable date by which return of the questionnaire is desired.

REPORTS QUESTIONNAIRE

A survey is desired on the distribution and usage of certain widely distributed reports in order to insure the inclusion of only useful information, to eliminate unnecessary recipients, to save the time of the recipients, and to reduce the costs of preparation and distribution of the reports. A questionnaire reading somewhat as follows might be transmitted to each recipient of each report.

"You are currently on the distribution list for ______________________________ ______________. As part of our program for improving the effectiveness of reports and reducing unnecessary expenses, we are surveying the distribution of various reports to insure that they contain all the required information; to eliminate unnecessary information; and to restrict the distribution to those who really require each report. We would appreciate your cooperation in this program by answering the questions listed below. Please return your answers by ______________.

1. Do you presently require this report? Yes ___ No___.
2. If you do, what information do you use?
3. How do you use this information?
4. What additional required information do you think should be included in the report?
5. How would you use this additional information?"

Before embarking on a report analysis program such as is suggested above, it would be desirable, of course, to call a brief meeting of the top executives of the affected departments to explain the purposes and scope of the survey and to solicit their suggestions and cooperation. Most reports are prepared on forms and are integral parts of established procedures. The analytic methods presented later therefore apply to their analysis.

DUTIES QUESTIONNAIRE

It has been decided to survey all the activities of the inventory-control section to ascertain what improvements can be made in operating methods. At a preliminary conference of the analyst with the section supervisor, the supervisor of the section is acquainted with the proposed plans, his part in the plans is discussed, and his ideas are solicited.

With the cooperation of the systems analyst, the section supervisor later prepares a list of all the activities of his section as well as a list of all the jobs in his section and the number of employees in each job.

DUTIES QUESTIONNAIRE		
Name ______		Date ______
Title ______	Dept. ______	Sect. ______
No.	Duty	Hrs./Wk.
1		
2		
3		
Verified by: ______	(Supervisor)	Date ______

Figure 14. Simple Duties Questionnaire—provides the basis for a valuable analysis of the activities of a department.

To obtain a detailed story on the activities of all the individuals in the section, a duties questionnaire is prepared such as shown in Figure 14. Many variations of this form may be used, depending on the exact purposes and details of the plan of analysis. In this case, the personnel of the section would be called into a conference room and the supervisor and the analyst would explain the purposes of the survey. The questionnaire would then be distributed and instructions given on how to complete it.

In the questionnaire each employee is requested to list his duties and the average amount of time he estimates he spends on each one. In many instances, the estimate of average weekly hours cannot be very accurate. This should not trouble the analyst too much. He realizes that the uses to which he will put the data, as explained in the next chapter, do not require any great accuracy. It will usually be advisable to explain this to the personnel. It might also be well, in some cases, to explain how to go about estimating average weekly hours by averaging over a period of time.

This questionnaire is designed for use in the Activity Analysis Chart discussed in the next chapter and is kept simple by asking for the minimum required information. It may sometimes be valuable to request additional information, such as:

1. Lists of all forms and reports connected with the work and the information obtained and the operations performed upon them.
2. Lists of all machines used.
3. Lists of unusual, out of the ordinary, duties that seldom occur and therefore cannot be conveniently listed among the regular duties.
4. Lists of suggestions for improving working methods.

This information is later checked and verified by the employee's immediate supervisor, who will not usually make any changes but will point out any discrepancies to the analyst. Changes should ordinarily only be made by the systems analyst. In addition, these actual duties lists should be compared with any job description specifications which may exist. However, employees should never be downgraded as a result of such a comparison, although future replacements should be made at the correct job grade. The information obtained in this manner will later be analyzed in accordance with some of the suggestions contained in the next chapter.

If more detailed and exact information were desired on the work and activities of each individual, the questionnaire approach would not be used. Instead, direct observation and independent timing of the various activities being performed would be called for.

APPENDIX

CASE ILLUSTRATION OF INTERVIEW *

(to obtain the initial consent and cooperation of an operating chief who is opposed to the idea of having a procedures study made in his unit)

THE FACTS

The person to be interviewed is a Mr. Doe, the chief clerk of a fiscal section charged with preparing important fiscal statements. Mr. Doe is a man of about forty-five years of age, has worked in this unit for some fifteen years, and has been in charge of the unit for the past ten years. Mr. Doe, though regarded as a conscientious and competent worker, is very set and narrow in his views and is very much opposed to the whole idea of procedures studies. While Mr. Doe's unit has almost uniformly given good service, it has been noted that in recent months he has failed consistently to make his statement deadlines, and several errors have crept into his statements, a thing which had previously never happened. The unit puts out various reports, three being of paramount importance: the "Statement of Disposition of Funds," the "Operations Report," and the "Budget Report." These three reports occupy the greater portion of the time of Mr. Doe and the eight clerks who comprise his operating staff.

Purpose of the Interview

The purpose of the interview is to (1) break down the resistance which Mr. Doe now has towards procedures studies, (2) to by-pass Mr. Doe with his unconscious consent, and to engage in direct discus-

* From: *Quartermaster Control Officers' Handbook*, Army Service Forces, Office of the Quartermaster General, November, 1943.

sion of these reports with his two chief assistants, a Mr. Black and a Mr. Brown, (3) if possible to get Mr. Doe's active cooperation in the conduct of a procedures study with respect to the work of his unit. Two previous attempts to make appointments for interviews have failed, but the analyst has at last succeeded in arranging an interview.

The Plan of the Interview

1. An attempt will be made early in the interview to reassure Mr. Doe that his position will not in any way be challenged by the procedures analyst.
2. An attempt will be made to engage Mr. Doe in a free discussion of the work and problems with which he is faced.
3. The analyst will try to get across to Mr. Doe the idea that all suggested improvements will be cleared directly with Mr. Doe, and that Mr. Doe will get at the very least a major share of any credit for the installation of improvements.
4. The analyst will attempt to convince Mr. Doe that his only interest is to be of real help and assistance to Mr. Doe and his unit.
5. At the proper moment, the name of Mr. Red will be introduced. Mr. Red is a close personal friend of Mr. Doe's and the analyst has just concluded a very successful study in Mr. Red's unit and now has the high regard and cooperation of Mr. Red in his work.
6. A definite attempt will be made to establish a direct line of contact with Mr. Black and Mr. Brown, with the consent of Mr. Doe.

Conduct of the Interview

ANALYST *(coming up to desk):* Good afternoon, Mr. Doe. I appreciate your giving me this time. I know how busy you are and I'll try to take up as little of your time as I can. I know it's no easy job to run an accounting job such as you have here without keeping on top of it all the time.

MR. DOE *(very tense and openly unfriendly):* Good afternoon, Mr. White, and since you bring the matter up, I don't mind telling you that the idea of having a procedures study in my unit at this time doesn't appeal to me at all. We're up to our ears in work, and I just can't see how we can afford to let you take up the time of either myself or any of my clerks by asking questions and trying to find out information. If you want my honest opinion, I think this whole idea of procedures studies is just a lot of highfalutin nonsense.

[The analyst is trying to put Mr. Doe at ease by assuring him that the analyst realizes how busy he is and by inference, indicates that the analyst realizes the importance of his position. Mr. Doe, however, reacts unfavorably. His statements indicate that he is still very opposed to procedures studies.]

ANALYST: Mr. Doe, I appreciate your frankness, and in your position I would probably feel exactly the same way. I have had that statement made to me by several of the best operating chiefs in this office, and not without reason. It does seem difficult to believe that I could be of any possible assistance to your operation, especially since you have had such a long experience in this work. I am very willing to admit that I don't know very much about accounting or accounting statements. As a matter of fact, Mr. Red down in the Statistics Section—you know Mr. Red, don't you? . . .

MR. DOE: Yes, I know Mr. Red very well; he's a personal friend of mine.

ANALYST: Well, Mr. Red said almost exactly the same thing to me when I first went into his unit, but I think you'll find that he has a somewhat different idea now. And the funny part of it is that I didn't do anything for him except to follow his directions. That was certainly an interesting job. I know that you're pretty well pressed for time, but since you are a friend of Mr. Red's, I wonder if you'd like to hear about it—it will only take me a minute or two to discuss it.

MR. DOE: Well, of course, I'd like to hear about it, but I don't know as I can spare even a few minutes now. Besides, I'll probably see Mr. Red this Friday night when we go bowling and he can tell me all about it then.

[The analyst does not attempt to counter Mr. Doe's unfavorable statement by a headlong denial. Instead he agrees with Mr. Doe, but agrees only in principle. He tells Mr. Doe that he fully appreciates his position, implies that all of the "best operating chiefs" have a similar reaction, and, therefore, there is not any criticism to be leveled at Mr. Doe for sharing their attitude. However, he softens, and to a large extent voids, Mr. Doe's objection as to any lack of knowledge on the part of the analyst by citing an identical instance. Mr. Doe admits that he is a friend of Mr. Red's. Therefore, he cannot now with any good grace deny interest in Mr. Red's problem.]

ANALYST: Well, that's probably so, but what I'd like you to know is that the major share of the credit for this idea belongs to Mr. Red, and I know that he is too modest to tell you the whole story exactly as it happened. (*Without waiting for an interruption*) You see, some people thought that Mr. Red wasn't getting his figures out fast enough for them to be completely useful but they didn't begin to realize his problem. Mr. Red got the figures out quickly enough, but when he sent them down to the central stenographic department, they just didn't get around to doing them until maybe two or three days after he sent them down, and it wasn't their fault either since they just can't get any more help. Well, there we were with Mr. Red getting the blame by thoughtless people who didn't know the whole story for something over which he had no control. You see, what they had to do in the central stenographic department was to type up handwritten draft reports on to ditto masters and then have them duplicated. We tried everything, and just when we were about to give up, Mr. Red got the idea of using a handwritten master ditto form that we could use again each month just by filling in an additional line of figures. In that way we used the same master sheet for a whole year and saved all that heading-up and recopying time. In addition to that, since we ran them off from the handwritten master ditto, we were able to get the figures out within two days after the end of the month. So you see that sometimes, especially if we get the benefit of the experience and knowledge of the operating chief, we are able to work out some little improvements that are really effective.

[The analyst is now attempting to do several things. First, he is introducing and building up Mr. Red as a "character witness." Secondly, he indicates that he will not attempt to build up a reputation at the expense of operating chiefs, since Mr. Doe knows very well that Mr. Red probably had very little to do with the improvement described. In addition, he places the burden for the effecting of improvements on the question of cooperation from the operating chief. Finally, he shows very clearly that his lack of knowledge of the particular operation does not always prevent the achievement of real benefits from the procedures study.]

MR. DOE: Well, that's very interesting, but, as you know, our problem here is very different from that of the statistics group. We don't have any duplicating problem; in fact, our principal work is getting up operating statements. We don't face any typing difficulty because we have a long-carriage typewriter right here in the office and my secretary bangs out our statements. On those statements that are duplicated, she uses a ditto master and if she can't get them run off during the day, she does it herself after hours.

ANALYST: You're very fortunate to have such a simple problem so far as duplication is concerned. And I think that your girl must certainly be interested in her work to take that trouble. It's been my experience that that's one of the best signs about a unit, to have people really interested in the work they're doing. As a matter of fact, I imagine an intelligent girl would really be interested in helping to get out statements like your "Monthly Operating Report," for example, or the "Budget Report." Does she do anything besides typing in connection with these reports?

[The analyst makes his first real gain. Mr. Doe is talking, however grudgingly, about the work of his unit.]

MR. DOE: Well, she's a good girl, but as a general rule I don't let her do anything except type these statements up. After all, we can't have untrained help fooling around with statements such as the ones we get out. Once in a while I let her run off a trial balance or something of the sort, but usually she's kept busy enough with our routine correspondence and with statement typing. That's another reason why I don't approve of this procedures study. My girl takes dictation on a regular schedule from these men throughout the day because we try to plan our work. If you come in here and start interviewing and taking up time, you're going to get us all off schedule and the only result will be that we're going to have to go into additional overtime. That's one of the things the big chiefs around here don't seem to realize. Only a year ago we had one of these procedures studies and they tried to take away two of my people. Why, the whole thing was so ridiculous I wouldn't even discuss it. I understand that you mean well, but since my operation is satisfactory—and if it wasn't I would have heard about it by this time—I don't see any reason why you should tinker with it. We worked very hard getting up the procedures we use now, and they do the job in a way that satisfies us. Not only that, but my clerks have been upset for a week because they heard that this procedures study was going to be made. I told them only the other day that they didn't have to be worried because I didn't approve of the idea and that any study of this unit that was made would be made right here at my desk.

[Mr. Doe is still opposed to the idea of procedures studies. But it will be noted that he is not nearly so forceful in his expressions as he was at the very beginning of the conversation. He is giving reasons for his opposition, reasons which have real merit and must be considered on that basis. However, his last statement poses a very difficult problem for the analyst, for in some way Mr. Doe must be given an opportunity to revoke his declaration about no survey being made without too much loss of prestige in the eyes of his subordinates.]

ANALYST: I'm sorry to hear that your employees are upset, because my job depends on how well I serve not only you but all of the people in our organization. I know that you yourself, from having done procedures work, realize that procedures work is necessary in any large organization. Furthermore, as you must know from your own experience, it is often possible for an outsider to come in and get an idea that may be beneficial to a unit. Perhaps he may not be able to develop it completely, but it can often be perfected by the operating chief and his assistants through their own knowledge and experience. I am sure that if we worked on the basis that I became a part of your unit and took no action that you did not know about beforehand, we would be able to conduct a very pleasant and perhaps a profitable study. It's very possible that nothing can be improved in your unit, and if that's the case, don't you think that your position would be strengthened with your own chiefs if some disinterested party like myself could go on record to the effect? Really, Mr. Doe, while I certainly will not press the point against your wishes, I do think that there is no possibility that you could do anything but benefit by having me work here under your direction. I feel that all the arguments you've advanced are very reasonable and deserve consideration, but you can appreciate my position in the matter.

[It will be noted that the analyst completely ignores Mr. Doe's statement that there isn't going to be any survey conducted in his unit. He again repeats the comments made about working under Mr. Doe's directions, about Mr. Doe's previous experience, about Mr. Doe's logical and reasonable approach, and puts Mr. Doe in a position where, if he disagrees with the analyst, he will be in effect stating that he is not a reasonable and logical person.]

MR. DOE: Yes, I see your point of view, but after all, I'm responsible for this operation and I just can't afford to let anything stop us from getting out the work. After all, that's our job and one of the things I want to do is get it out quickly and without any overtime. Now last week, for example, I worked down here three nights getting up a statement. That has to be considered, too. We just don't have any time to spare.

[Mr. Doe is now weakening rapidly, although he is not aware of this fact. His argument has changed completely from one of principle to one of expediency. He is no longer arguing about the basic principle of whether or not a procedures study should be made, but is instead arguing that regardless of whether it is good or not, he does not have the time to devote to it. This is a very critical phase of the interview.]

ANALYST: Mr. Doe, that is perhaps one of the best reasons why you should have a procedures study now instead of later. You're often faced with the problem of overtime work, and it's bad enough for your clerks who get paid for it, but I think it's even more unfair to you because you don't get paid for it. It may be that we won't discover any one big thing worth mentioning in a procedures study here, but we might turn up a few little things that might be sufficient to cut down on that overtime business. And while you don't have too much overtime in your unit, I know that you would prefer not to have any at all to show up for your group on the monthly overtime statement. I think it's the "Monthly Operating Statement" that calls for most of the overtime, isn't it?

[The analyst now introduces two real benefits that might accrue to Mr. Doe through a procedures study. One of these is the elimination of overtime in his unit (overtime for which Mr. Doe personally does not get paid); the other benefit is that Mr. Doe's unit will show up more favorably to the top executives so far as overtime payments are concerned. The analyst also repeats his assurance, by inference, that no attempt will be made by him to build up a striking report at the expense of Mr. Doe, by referring to "a few little things," etc. The analyst also introduces a specific question about a specific statement. If Mr. Doe answers that question, then the rest will be relatively easy.]

MR. DOE: Well, we don't have too much overtime, but most of it is when we work on this "Monthly Operating Statement." That's a rush job you know, and we can't take too long to get it out else it won't be worth anything to the people who get it.

ANALYST *(interrupting):* Yes, I can believe that. I've seen some of those statements, you know, and they certainly give a very complete picture of everything significant about our operations. It must take a lot of real work to get that statement out. And that "Disposition of Funds Statement" doesn't look like an easy job either.

[The analyst is now moving in fast. He at last succeeds in getting Mr. Doe to discuss the work of his unit, and in particular the principal products of his unit. The analyst is not going to refer directly again on his own account to the question of his conducting a procedures study. He is going to proceed on the assumption that Mr. Doe has given his tacit consent and is now going to try to work in more deeply to the point where Mr. Doe will call either Mr. Black or Mr. Brown to carry on the conversations. At that point, the procedures study will have formally begun.]

MR. DOE: Well, the "Monthly Operating Statement" and the "Disposition of Funds Statement" are about our two biggest ones. And all the divisions are pretty anxious to get them. Only yesterday, Frank Smith of Procurement called me up to find out when he'd get his copies.

ANALYST: Yes, I know he's very keen on those reports. And Mr. Blue down in the Budget Bureau told me that your "Disposition of Funds Statement" was almost as important to him as the "Budget Report."

[The analyst is still hitting hard. He indicates that he is fully aware of the importance of Mr. Doe's work to the organization, and Mr. Doe cannot do anything but accept his comments as indicating a real interest and appreciation.]

MR. DOE: Oh, sure. Mr. Blue's on my neck if we're even a day late with it. You know he helped me to make up that statement about three years ago when we first went over to the new method on funds allocation. We eliminated four other reports and replaced them with this one form. That saved a lot of work.

[Mr. Doe relaxes. It is evident that the analyst is beginning to get his confidence, principally because the analyst has stressed that the chief products of Mr. Doe's unit are fully understood and appreciated by him. Mr. Doe now wants to show that he is also progressive and can effect improvements.]

ANALYST: Yes, that must have been a fine job. I heard about it from several people. In fact, one fellow told me that if you had the time to do it, you could probably effect still further improvements in these statements, but that he wondered if you ever had any time to spare, in view of the way your work has been increasing. It's a time-consuming job, as you well know from your own experience.

[The analyst now gives Mr. Doe a logical reason as to why he has not been able to effect further improvements—namely, the fact that he has not had the time to do it. The inference is that it is this fact alone that prevents Mr. Doe from putting in further improvements.]

MR. DOE: You're right about the time question, all right. Why, only two days ago the chief came to me and told me we had to get out an interim statement on all purchases of furniture, office machines, and equipment for the past two years . . . *(Mr. Doe goes on for a few minutes on various incidents related to special rush jobs that were put on him without any warning and which required a great deal of work.)*

[Mr. Doe is still just a little bit defensive, but here is an "out," a face-saving angle that he hadn't previously thought of himself, the fact that he "hadn't had the time."]

ANALYST *(listens intently, awaiting a favorable moment to move in again towards the objective of the interview):* Well, that certainly was good performance in my opinion. With all of these reports, and with such a shortage of skilled help, it's no wonder you have to work overtime occasionally. However, I am sure that you must have some general ideas as to where improvements might be made to save overtime, and what I suggest is that you outline these ideas to me generally and I can dig into them for you. Naturally, I'll clear any ideas I may get with you, so that I won't be going off the beam with regard to any rules or regulations that I might not know about.

[The analyst again stresses one of the benefits that the study may bring to Mr. Doe. He also advances to the point where he is discussing the method by which this study will be conducted, and if Mr. Doe does not challenge him now, then the analyst has clear sailing so far as the study itself is concerned.]

MR. DOE: I'm glad to hear you say that. A lot of people think that this accounting routine is a cut and dried proposition, but you'll see that there are a lot of angles to it that don't appear on the surface.

ANALYST: I'm certain of that. I know very well that there are a lot of technical details to this kind of work, and you can be sure that I will check with you every step of the way. The one report that appears to me to be the most technical of all is that "Disposition of Funds Report." It looks like an interesting report, and I think that I'll enjoy very much finding out exactly how you make it up. I think you have Mr. Black work up all the preliminary figures for you, don't you?

MR. DOE: Yes, Black does do a lot of the detail work on that report. He does a good job, too. I know, because I trained him myself and he's had about three years' experience with it. He's worked on it almost from the very day we put it in, and he can answer many of the detailed questions on it a lot better than I could myself.

ANALYST: Well, what I would like to do, if you are agreeable, is to work with Mr. Black for a day or two to make sure I understand this statement, and then if we get into any difficulty or come up with anything that looks good we will check back with you. How would that be?

[The analyst is in! Mr. Doe is discussing the very subject matter of the study with him.]

MR. DOE: Why, I think that would be a good idea, and I think Black will be able to answer most of your questions. I'll get him over here. *(Raises voice)* Black, have you got a minute? . . . This is Mr. White, and he's going to work with you for a few days . . . etc. . . .

What the Analyst Did

1. He made an appointment for the interview.
2. He quickly indicated his recognition of the fact that Mr. Doe had an important and difficult job.
3. He built up Mr. Doe's prestige by inferring that all Mr. Doe lacked, in order to effect improvements, was the necesary time.
4. He showed a sincere appreciation of the problems facing Mr. Doe.
5. He indicated the possible benefits to Mr. Doe that might result from the study.
6. He gave a "character witness" who could testify to the success of his work.
7. He implied that he would not seek to build up a "reputation" at Mr. Doe's expense.
8. He offered to clear all ideas and possible recommendations with Mr. Doe.
9. He stated that he would consider himself a member of Mr. Doe's staff for the duration of the study.
10. He did not allow himself to be drawn into argument with Mr. Doe, regardless of the provocation. Instead of attempting to beat down the objections offered, he (a) ignored them, (b) sidetracked them, or (c) turned them to his advantage.

As was stated above, this illustration is given, not as a complete guide to interview technique, but rather to indicate in a general way the manner in which an interview can be used to further the object of a procedures study.

V

ANALYZING THE FUNCTIONAL ALLOCATIONS AND SYSTEMS FLOWS

AT THE SAME TIME as the systems analyst is gathering his facts, he will want to organize his thinking about these facts. What do they mean? Is the present procedure good? Can it be improved? Would a certain suggested alternative procedure be better?

In this chapter we want to consider some techniques for organizing systems data so that they can be more readily analyzed. These techniques are general methods which can be used for analyzing detailed systems problems as well as the more general systems flows.

If an analysis were made by merely observing how things were done, quite a few improvements might be made by a superior, well-trained systems analyst. The analyst would wait for ideas to occur to him while he observed. Having a great familiarity with systems, a good memory, and a keen, fertile mind, a number of improvements may occur to him. However, many more ideas—perhaps even better ones—will occur to this same analyst when he follows a systematic method of analysis. He will then be better able to evaluate the worth of his ideas. Also, in evaluating the ideas for his own benefit, the analyst will be preparing his sales arguments which he will later require when presenting his case to management and to the personnel of the enterprise.

The methods here outlined provide not only for a systematic approach to aid in discovering the maximum possible improvements. They provide also a means for obtaining a complete picture of a complicated system which could not otherwise be grasped without relatively long and diligent study. These charts are also invaluable for demonstration and instructional purposes.

The number of different possible approaches to this problem of analyzing systems facts is infinite, and for no two problems is the best approach the same. There is no substitute for individual initiative and inventiveness. In this chapter we will attempt to explain some of the more general analytic methods which have given successful results in a large number of applications.

Analysis of systems facts involves breaking the procedure down into small basic units of uniform size. How basic these units should be—how small a unit we want—will depend on the purposes and scope of our investigation as well as the amount of available time for its completion.

The basic approach in all of these analytic techniques is:

1. Arrange the information in accordance with some graphical or tabular scheme which will make the systems arrangement clear and understandable and perhaps highlight the existence of certain possible flaws.
2. After the arrangement has been completed, critically analyze the picture thus presented in terms of the general principles previously presented as well as corollaries to these principles which will be mentioned later. The analyst must continually throw skeptical questions at himself as he carefully examines his analytic chart. Some of these questions will be suggested in the following discussions.
3. Chart the new proposal suggested by the analysis so as to highlight comparison with the existing system.

Since systems decisions must fit enterprise needs, suggested answers in the illustrative applications here are not necessarily correct for other companies. Such decisions must be tailor-made to fit.

FUNCTIONS ALLOCATIONS CHART

The Functions Allocations Chart is a simple means for graphically portraying and analyzing the allocations of functions to the various units of the organization.

The chart consists essentially of a conventional box organization chart with a listing under each box of the functions and activities of that unit. The amount of detail to be included in each listing depends upon the purposes of these investigations and how detailed the organizational break-down is to be. If the entire enterprise is being charted, a much less detailed break-down of the organizational units would be made and the break-downs of the activities would not be very minute.

A Functions Allocations Chart for a multi-plant manufacturing company employing approximately 20,000 persons is shown in Figure 15. To keep the chart to a reasonable size for inclusion in this book, the detailed break-downs of the organization and of the activities performed by each unit are given only when thought necessary for illustrating the analytic techniques and principles. In actual practice, using a large wall-size chart, the organizational structure and the activities performed by each unit of this structure should be broken down to a uniform degree of detail commensurate with the purposes of the investigation. This chart is then analyzed in accordance with some of the principles developed in the preceding chapter.

KEY QUESTIONS

The analyst analyzes each activity and group of activities separately and as a group and asks himself many questions such as the following:

1. Are all functions and activities required for most successfully attaining the desired objectives allocated to some organizational unit?
2. Are any unnecessary functions or authorities allocated?
3. Are these functions and responsibilities allocated so as to provide logical and harmonious groupings for achieving the desired objectives?
4. Are similar activities grouped close together?
5. Are functions which depend upon and service each other grouped close together?
6. Are functions which act as controls or checks on other activities placed in groups which are independent of the activities?

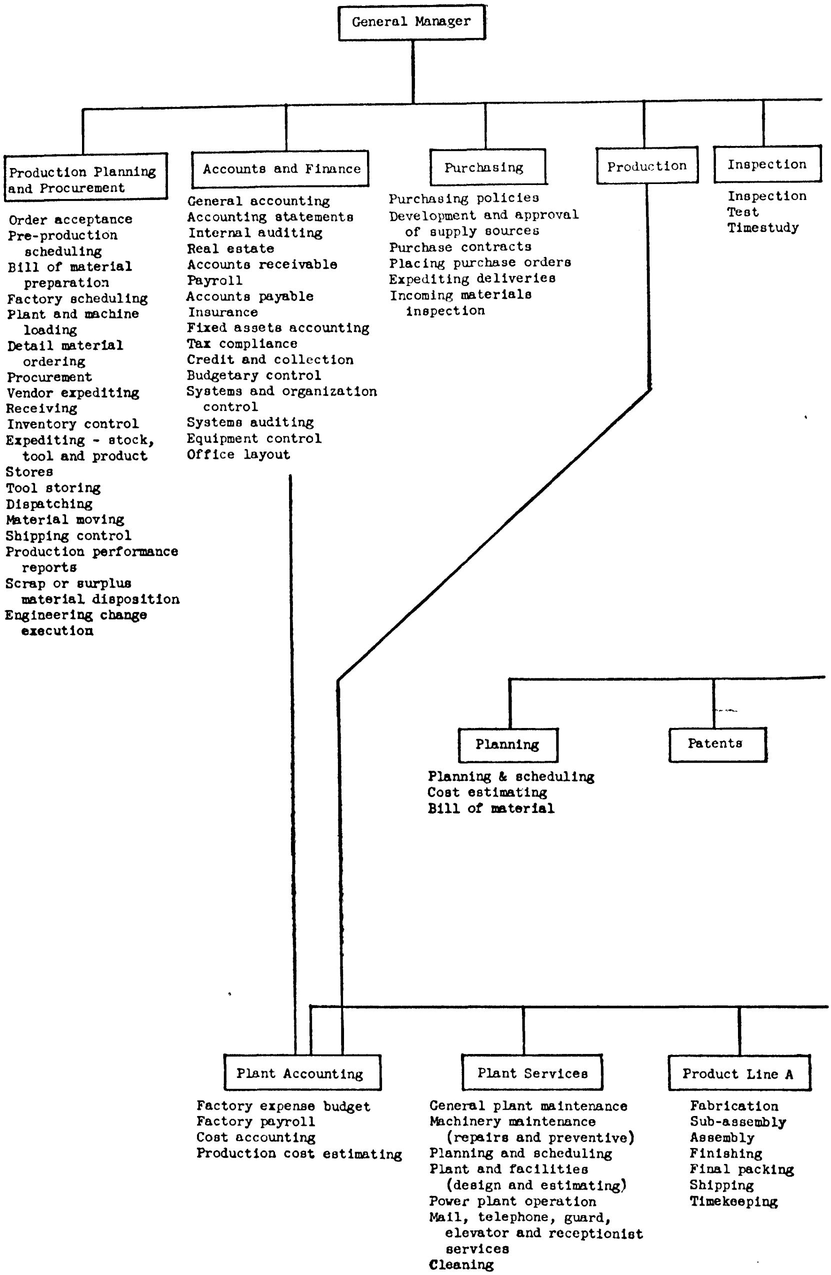
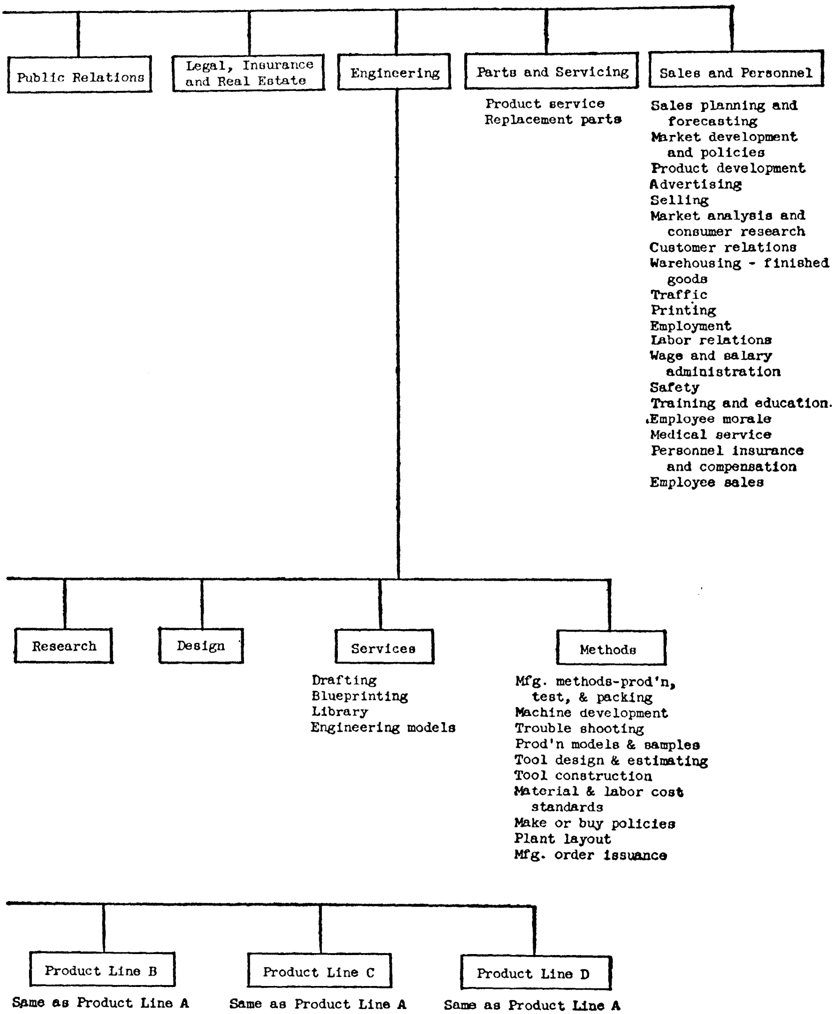


Figure 15. Functions Allocations Chart—provides summary picture of



distribution of functions among the organizational units of the enterprise.

7. Are the same responsibilities given to more than one group?
8. Have activities which must be performed in sequence been placed together, especially when the time element is important?
9. Have the advantages of centralization and decentralization been properly balanced against each other?
10. Does each group report to only one superior?
11. Have personalities entered into the organizational determinations?
12. Have the "span of control" and "chain of command" been kept to a minimum?
13. Does the organizational structure provide adequate flexibility?

ANALYSIS OF FUNCTIONS ALLOCATIONS CHART

In answering each of these questions, the analyst must utilize a knowledge of many facets of the enterprise's operations which are not here presented, as well as his accumulated knowledge and experience from years of familiarity with the operations of many enterprises. He must discuss many of these questions with operating personnel to find the correct weights and balance for applying these principles. What is important in one enterprise may not be quite so important in another.

Some of the answers to the questions asked by the analyst are given below. These answers are incomplete from two points of view: only one violation of each principle is presented; the explanation of the reasoning involved must, of necessity, be incomplete.

1. *Are all required functions allocated?*

Some aspects of the quality-control responsibility are not allocated to any group. The inspection department is charged with the job of physically testing conformance of the product with the engineering specification. However, the job of quality control includes the establishing of the most economical inspection policies which will be used to insure that customers receive a given quality of product, to correct weak links in the manufacturing process which are causing or will cause quality troubles, to reduce unnecessary variability in manufacturing process and product. Since no group has been assigned this important function, it has not been properly performed.

2. *Are any unnecessary functions allocated?*

The methods group in the engineering department is assigned the responsibility of informing the production floor of production starting dates (manufacturing order issuance). The methods group is given this function presumably because of its responsibility for determining the production method and building the tools, dies, jigs, and fixtures to conform with the prescribed method. These must obviously be completed before production can start. However, since the production-planning group establishes schedules for accomplishing this methods work as well as the starting dates and rates of production, it has been unnecessary and undesirable to have the methods group issue another schedule, even if it did not sometimes conflict with the production-planning schedule.

3. *Are these functions allocated so as to provide harmonious groupings?*

Combining time study and inspection does not constitute a harmonious grouping of functions. Time study is primarily a fact-finding and planning function. Inspection is primarily a direct labor determination of physical conformance of parts and products. They have not made a good combination in this company.

4. *Are similar activities grouped close together?*

The inspection of incoming material is assigned to the purchasing department. This was poor because the supervisors of purhasing departments are usually quite ignorant of the details of inspection practices, policies, and procedures, such knowledge not being requisite for proper performance of their procurement functions. In addition, some expensive but not completely utilized equipment and specialists are duplicated in the purchasing and inspection departments. It therefore appears desirable to have incoming material inspection performed in the inspection department where other similar inspection operations are performed.

5. *Are dependent functions close together?*

In the present organization, methods engineering is performed by the engineering department and time study engineering in the inspection department. This arrangement has not worked too well because of the close interconnection and dependency of methods and time study work.

6. *Are control functions independent of the activities controlled?*

Having the timekeepers report to the floor foremen, as in the present organization, is not advisable. The timekeeper should be as independent of shop influence as possible because of the important labor-payment control function he performs. In addition to placing the timekeepers so that they report to an independent central authority, their floor assignments in the plant should be rotated.

7. *Are there overlapping responsibilities?*

Both the production-planning department and the purchasing department have the responsibility for expediting the delivery of overdue materials. This is not only wasteful, but also hinders the proper performance of this function.

8. *Are activities which are performed in sequence placed close together?*

The determination of material and parts requirements and the inventory ordering functions are performed by the production-planning department. The next step in the production cycle, placing the purchase order on the best vendor, is performed by the centralized purchasing department which is completely independent and organizationally and physically distant from the planning department. This has made close coordination difficult and has increased the manufacturing time cycle.

9. *Has the best compromise between centralization and decentralization been reached?*

The high degree of centralization in this large enterprise has required a large amount of paperwork to coordinate the giant-sized service activities. This has resulted in sluggish operations with long time cycles, and has materially reduced the incentive and initiative of the departmental managers. Many of the enterprise's functions can be better performed if they are divided by product line. The service groups are then smaller and easier to manage. The product line managers, controlling most or all of the functions which will determine their success or failure, have a greater incentive.

10. *Does anyone report to two bosses?*

The plant accountant reports both to the production manager and to the accounts and finance department. At times this has caused some confusion and friction and should be remedied.

11. *Have personality biases affected the organization?*

Yes. Because of personality biases, the personnel function has been placed in the sales division. The personnel policies of the company have, as a result, been slanted more towards the merchandising than the engineering and manufacturing operations.

12. *Are the "span of control" and "chain of command" as small as possible?*

No. The ten persons reporting to the general manager is excessive.

The excessive "span of control" has made it impossible for the general manager to devote the proper amount of time to planning.

13. *Does the organizational arrangement promote flexibility?*
The high degree of centralization imposes handicaps on the ability of the enterprise to meet changing conditions and requirements.

Based on a more detailed analysis of the type just presented, the systems man constructed a revised Organization Allocations Chart, as shown in Figure 16. In this new chart, some of the objectionable features of the present allocations of functions have been corrected. The new organizational structure and functional allocations should represent the closest possible observance in this enterprise of the principles of good systems. However, the new chart represents a compromise, as all such charts must. The compromise is based on the individual characteristics of the enterprise, the industry, the labor market, and the geographic locale. These determine the relative importance of the various aspects of the good systems precepts.

ORGANIZATIONAL FLOW CHART

When the principal purpose of a systems survey is to study the relationships of the various phases of interdependent functions in the enterprise, the Organizational Flow Chart is an effective way to present the data for analysis and for quick comprehension of the over-all picture. The major operating steps in the performance of the function and the major organizational units performing them are graphically presented for ready analysis.

The Organizational Flow Chart consists essentially of a chart divided into vertical columns or horizontal rows labeled for each organizational unit performing one or more elements in the procedure. In its simplest form, the activities performed by each unit are indicated in each of these columns or rows by circles or squares, or elongated circles or rectangles, and these are connected in sequence by directional lines to indicate the flow of information. In general, no attempt is made in the broad charting of the procedure to identify all the details and paperwork or the distribution of all copies of the paperwork. Only principal activities are indicated.

To illustrate the construction of the Organizational Flow Chart, the system of designing and ordering packing and packaging materials in the plant of a hypothetical farm-machinery manufacturer is described below. The term "packing materials" refers to the materials required

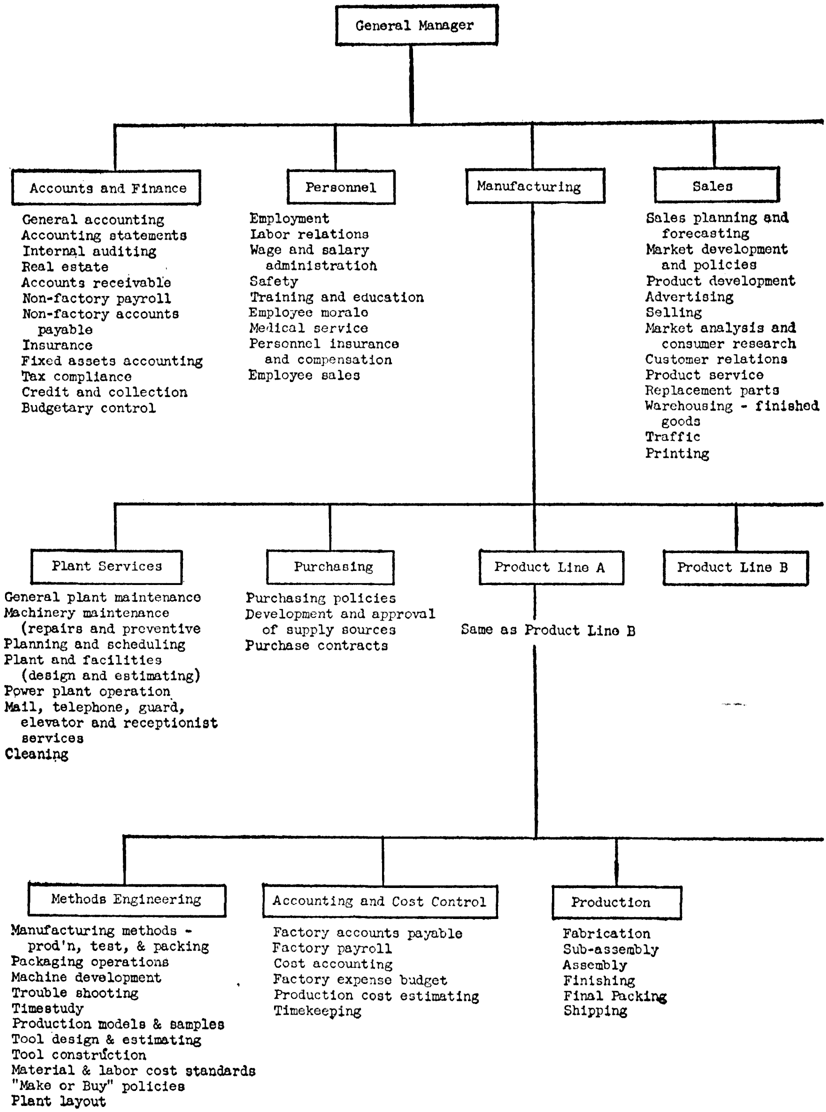
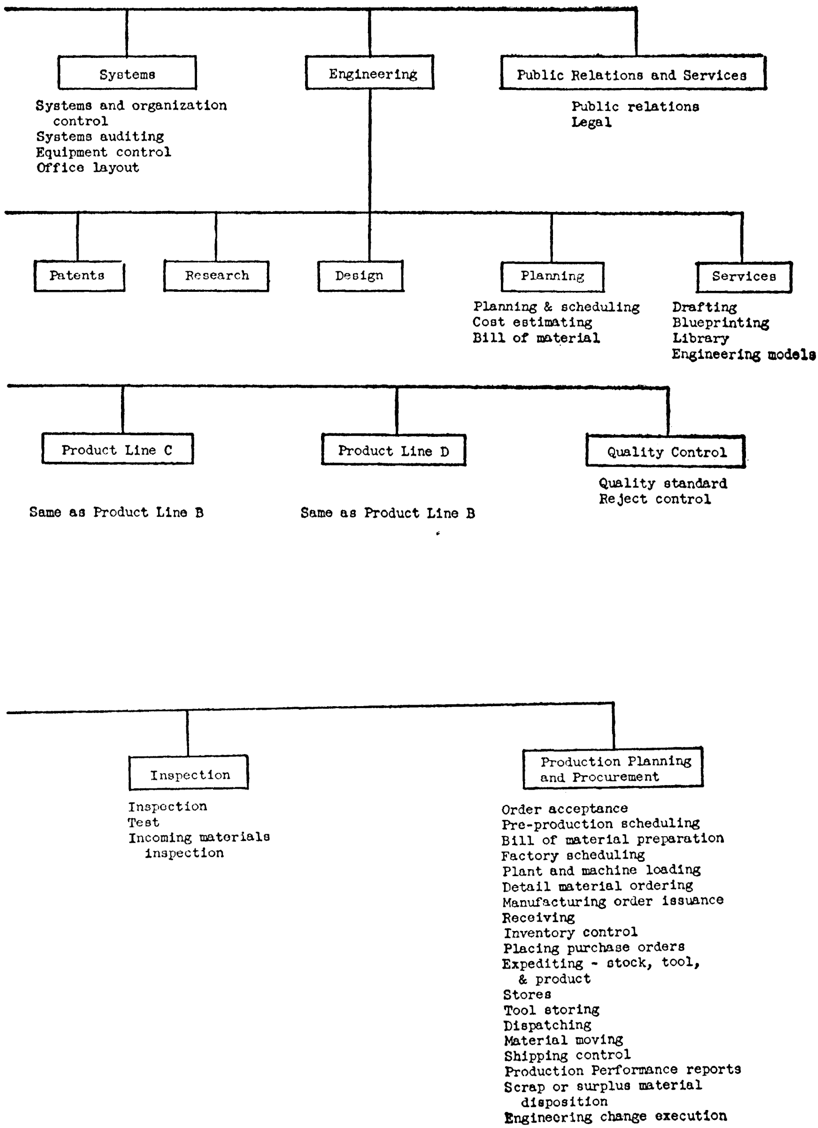


Figure 16. Proposed Functions Allocations Chart. Comparison with the exist
tions proposed in the reorganization plan.



ing situation shown in Figure 15 points up the basic redistribution of functo pack the farm equipment for shipment. The term "packaging material" is used to designate the materials for packaging spare parts and service parts.

A. The design-engineering department
   1. Designs the farm equipment
   2. Builds models
   3. Issues blueprints
   4. Prepares Bills of Material (BM) and releases to the planning department
   5. Informs the shipping department that the engineering model is completed.

B. The planning department issues a Works Order for the equipment, sending a copy to the shipping department. The shipping department is thus informed of the equipment that will be built in the plant and is put on notice to look for a model from which to design the packing that will be required for shipping the equipment.

C. Upon learning that the engineering model of a new equipment has been completed and approved, the shipping department designs the packing materials required to pack it in accordance with sales department and/or customer specifications. The shipping department then prepares a packing Bill of Material for each unit to be packed. This Bill of Material is forwarded to the inventory-control department.

D. The inventory-control department multiplies each item on the packing Bill of Material by the number of units to be shipped to obtain the quantities required.

E. The inventory-control department obtains delivery requirement information from the Production and Shipping Schedule, issued by the planning department.

F. The inventory-control department then prepares Purchase Requisitions for all required packing materials which are not available in stores and sends the Purchase Requisitions to the planning department.

G. The planning department approves the requisitions and forwards them to the purchasing department.

H. The purchasing department purchases the material.

I. The planning department prepares accumulation sheet lists in numerical sequence of all parts on the Spare Parts Kits list. A copy of this list is sent to the methods-engineering department.

J. The methods-engineering department checks the items on the accumulation sheet lists against the file of existing packaging processes. Where a process exists for packaging the part in accordance with customer requirements, no further action is taken.

K. The methods-engineering department prepares a list of those parts for which no process exists and sends it to the stores department.

L. The stores department accumulates one set of parts in accordance with the list of paragraph K above and sends the parts to the methods-engineering department.
All requested parts which are not available in the stores department are put on shortage. Cards are placed in the shortage files and a list of these short items is sent to the methods-engineering department.

M. Upon receipt of the parts from the stores department, in accordance with paragraph L above, the methods-engineering department specifies by Packaging Code the packing materials and process to conform with customer requirements. A Packaging Process with these specifications is issued and distributed.

N. Packaging materials are ordered on a past usage basis by the inventory-control department. Purchase Requisitions are forwarded to the purchasing department for placing the orders with the vendors.

O. The purchasing-department buyer purchases the required packaging material.

P. When the shortage parts of paragraph L above are received by the stores department, they are forwarded to the methods-engineering department.

Q. The methods-engineering department then processes these parts for spare-parts packaging.

R. When standard metal spare-parts boxes are required, the design-engineering department specifies the requirement in the "Description" column of the preliminary spare-parts list. The quantity, size, and part number of the box are omitted.

S. At least one month prior to the scheduled shipping date of the equipment, the methods-engineering department informs the design-engineering department of the quantity, size, and part number of the required spare-parts boxes.

T. Upon receipt of the information of paragraph S above from the methods-engineering department, the design-engineering department issues an engineering notice ordering the required spare-parts boxes.

U. Upon receipt of the engineering notice of paragraph T above, the planning department issues Order Cards to order:

1. The parts, materials, and labor required to manufacture the spare-parts boxes, or
2. The spare-parts boxes from vendors.

The Order Cards are handled and distributed in the standard manner.

V. Upon receipt of the Order Cards of paragraph U above, the inventory-control department prepares Purchase Requisitions for the required material, parts, or spare-parts boxes.

W. The purchasing department buys the required materials.

This procedure has been plotted in an Organizational Flow Chart, shown in Figure 17. The letters on top of each of the circles correspond with the descriptive paragraphs of the above text.

KEY QUESTIONS FOR ORGANIZATIONAL FLOW CHART

This charted procedure is analyzed by the systems analyst. He asks himself each of the following questions:

1. Could functional allocations be rearranged to reduce communication and paperwork?
2. Is there back-tracking because some groups do not have all the necessary authorities for carrying out their functions? Or because these authorities are not placed as close as possible to the persons who take the action?
3. Do all departments use all the information provided by the procedure?
4. Is the system automatic? Is expediting required?

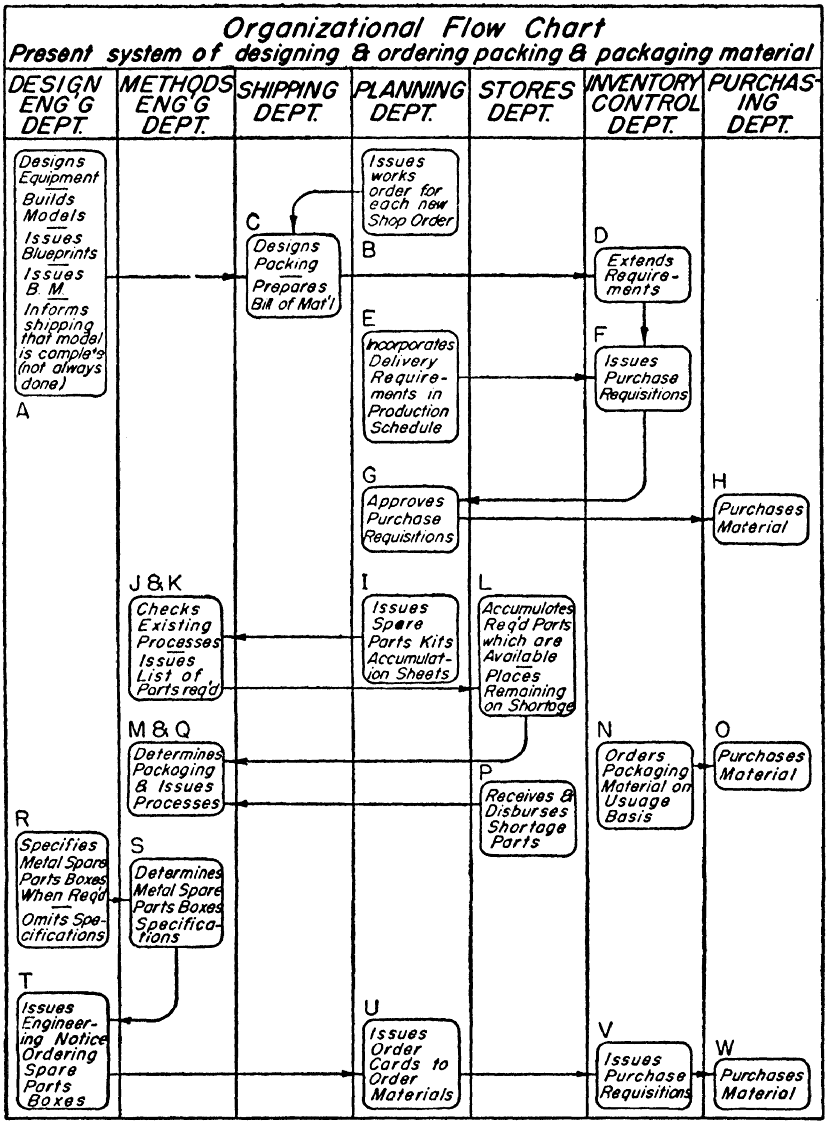
—and *analyzes each action or group of actions*—

5. Why must it be done?
6. Where should it be done for best economy?
7. When should it be done?
8. How should it be done?

ANALYSIS OF CHARTED SYSTEMS FLOW

Using these questions, the charted procedure for designing and ordering packing and packaging material is analyzed. The answers to the questions are summarized below:

1. *Could communication lines be reduced by changing responsibility assignments?*



Note: The identifying letter above each activity refers to the paragraph in which the activity is described.

Figure 17. Organizational Flow Chart—traces the flow of a rather complicated procedure and facilitates analysis of the system for possible improvements.

Yes. One example: If the design-engineering department performed the design of the packing containers as well as of the equipment, the shipping department would not be involved in the ordering cycle at all.

2. *Does back-tracking give evidence of lack of required authorities, or that authorities are placed too high in the organization?*

Yes. The Organizational Flow Chart shows back-tracking where the inventory-control department must obtain the approval of the planning department on the Purchase Requisitions which they prepare. For the proper performance of its assigned responsibilities, the inventory-control department should have the authority to place orders for materials. Requiring the written approval of the planning department on each requisition is wasteful of time and money and interferes with effective performance.

There is no evidence that authorities are not placed close enough to the personnel who take the action. If the break-down of the organizational units on the chart were finer, it might reveal back-tracking amongst the various groups in the departments because of required authorizations.

3. *Do all departments use the information they receive?*

Yes.

4. *Does the system work automatically?*

No. Expediting is required to insure the accumulation of parts in the stores department to enable the methods-engineering department to specify the packaging materials and the packaging processes. Also, since the ordering of packing and packaging materials does not follow the normal routines for production materials in the plant, more than the usual amount of personal follow-up is required.

5. *Why must each step be done?*

Ordering of packaging material on the basis of guesswork and past usage only, as specified in paragraph N, must be done because the inventory-control department is not informed of packaging requirements. If packaging requirement information were transmitted to the inventory-control department in the same manner as other material requirements, this special step of ordering on the basis of past usage could be eliminated.

6. *Where should each step be done?*

Both packing and packaging design should be performed in the design-engineering department of the plant. This will simplify procedures, shorten the ordering time cycles, and centralize responsibility for completely designing and specifying all the materials and parts required for an equipment, including shipping containers.

7. *When should each step be done?*
The design of the packing and packaging should be done at the same time or immediately after the design of the equipment and parts. This should eliminate delays which presently develop because of shortages of packing or packaging materials which have been ordered late.

8. *How should each step be done?*
The design of the packing containers should be done from the engineering models by the design-engineering department in the same manner as it is presently done by the shipping department. The design of the packaging containers should also be done from the engineering models and parts rather than from the production units, which are not available until a much later time.

Using an analysis similar to the one just presented, but going into more detail, a revised procedure is charted in Figure 18. This new procedure involves a shifting of responsibilities and is summarized below:

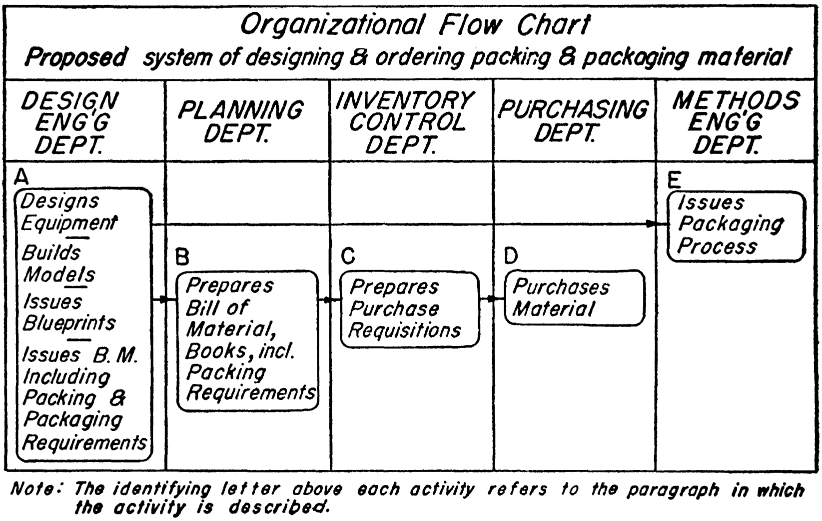


Figure 18. Proposed Organizational Flow Chart. Comparison with Figure 17 provides a very succinct and striking picture of the simpler flow provided by the proposed changes.

A. The design-engineering department
   1. Designs the equipment
   2. Builds models
   3. Designs packing and packaging
   4. Issues blueprints (The prints for the spare-part kits will have the packaging of each part in the kit specified by Packaging Code.)
   5. Prepares Bills of Material, including packing and packaging requirements, and sends to the planning department.

B. The planning department prepares and distributes the regular Bill of Material books for ordering material and parts, including packing and packaging requirements.

C. Upon receipt of the information of paragraph B above, the inventory-control department prepares Purchase Requisitions for the required items.

D. The purchasing department buys the required material.

E. Upon receipt of spare-parts prints (see paragraph A, 4 above) the methods-engineering department checks the items listed against the file of existing Packaging Processes. Where a process for packaging the part in accordance with the designated Packaging Code does not exist, a Packaging Process with these specifications is issued.

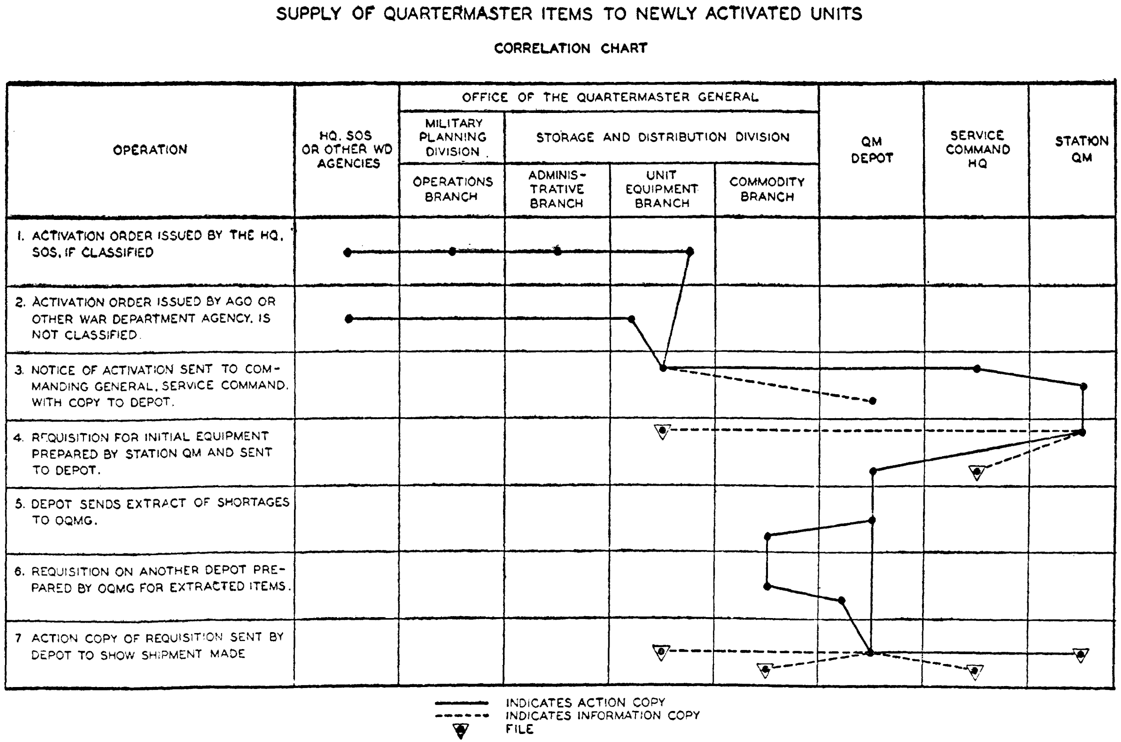
ORGANIZATION FLOW CHART VARIATIONS

A variation of the Organization Flow Chart using pictorial symbols is shown at page 260. Such a chart is especially useful for training and systems installation purposes.

Another variation of the Organizational Process Flow Chart, known as a Correlation Chart, is shown in Figure 19. This type of chart may sometimes be useful for showing how various units correlate their activities in accomplishing a given function.

ACTIVITY ANALYSIS CHART

When the analyst desires to study the entire range of the activities of an organizational group, the Activity Analysis Chart may be a very useful tool. This chart provides a means of obtaining a broad view of all the activities of the personnel in the group: what is done; where it is done; to some extent, how it is done; who does it; and approximately how much time is spent doing it. This information is arranged in the Activity Analysis Chart so as to promote logical analysis which will disclose the broad possibilities for improvements. Although there is



U.S. Army Service Forces Manual M703-3

Figure 19. Correlation Chart—similar in purpose to the Organizational Flow Chart. It shows how the various units correlate their operations for the performance of a function.

ACTIVITY	MAN HRS.	SECTION SUPERVISOR A. Appley	MH	INVENTORY ANALYST B. Brown	MH	INVENTORY ANALYST C. Court	MH
INVENTORY CONTROL RECORD AND REPORT	132					Sample check postings Prepare inventory report	15 15
REQUISITION MATERIALS	65	Review and sign	7	Determine and separate cards requiring orders Make pencil copy of requisitions Maintain requis. control register	10 20 2		
EXPEDITE SHORT ITEMS	22					Prepare and dictate expediting correspondence	1
SURPLUS UTILIZATION	27	Determine & separate cards indicating surplus material	15				
VENDOR RECORD	14						
INQUIRIES	15	Interview callers Prepare & dictate replies to inquiries	2 1	Interview callers Prepare & dictates replies to inquiries	3 1	Interview callers Prepare & dictate replies to inquiries	2 1
ADMINISTRATION	32	Conferences Budget matters Personnel matters Keep attendance records	4 1 5 2	Conferences Personnel matters - supervision, grievances, discipline, etc.	1 2	Conferences Personnel matters - supervision, grievances, discipline, etc.	1 4
MISCELLANEOUS	13	Read company policy reports, correspondence, etc.	3	Read company policy reports, correspondence, etc.	1	Read company policy reports, correspondence, etc.	1
	320		40		40		40

Fig. 20. Activity Analysis Chart—summarizes the allocations of work to

CLERK		CLERK		CLERK		SECRETARY		TYPIST-CLERK	
D. Doremor	MH	E. Earle	MH	F. Farrow	MH	G. Gordon	MH	H. Hunt	MH
Post orders File posted paper work	20 5	Post withdrawals	37	Post requirements Post deliveries	30 10				
								Type & proof purchase requisitions	26
Prepare and dictate expediting correspondence	3					Take dictation & typing of expediting correspondence. Make expediting phone calls	9 9		
Investigate to determine uses and/or disposition of surplus	12								
								Post to vendor record from purchase order	14
						Take dictation & typing of replies to inquiries	5		
						Handle administrative correspondence	12		
		Emergency messenger service	3			Open and distribute incoming mail Misc. typing	3 2		
	40		40		40		40		40

the various persons in the section in a convenient form for analysis.

nothing complicated about an Activity Analysis Chart, it can provide the basis for a revealing analysis of how effectively an organizational group is performing its assigned responsibilities.

The Activity Analysis Chart consists essentially of summary statements of the major activities of the organizational groups, together with a break-down indicating the contribution of each person to each activity.

The first step in preparing the chart is to obtain information on the duties of each person in the group and the average man-hours per week devoted to each duty. This is conveniently done by means of a questionnaire, such as was discussed in Chapter IV. At the same time, the analyst should start determining the major activities of the group. All information sources should be utilized in attempting to make the list complete and accurate. The supervisor of the group can prepare the original list. Direct observation may reveal activities which were forgotten by the supervisor. An organizational manual, if available, may disclose some omitted activities to be added to the list. When the duties questionnaires have been received, additional forgotten activities may be brought to light.

The construction of the Activity Analysis Chart is illustrated in Figure 20 by the sample analysis of an inventory-control group. The principal categories of activities are indicated in the first left-hand column in roughly descending order of importance. Each column to the right is then labeled with the name of the persons in the group. Each duty of every person is entered in the row of the activity to which it contributes. Alongside each duty are entered the average weekly man-hours spent on the duty. The hours spent by each person on each duty contributing to the activity are then added horizontally to get the total man-hours devoted by the group to that activity.

Although it is frequently undesirable to place salaries on the Activity Analysis Chart, it is usually very helpful for the analyst to know all the salaries, or at least the approximate range of the salary of each person. Otherwise, it may be more difficult properly to evaluate the utilization of skills under the existing and/or proposed procedures.

Key questions for the Activity Analysis Chart

The analysis of the Activity Analysis Chart can be divided into three phases:

I. Analysis of the activities as entities—questioning each and all of the activities listed in the left-hand column of the chart.

II. Analysis of the duties for the performance of each activity: how is the activity broken down into elements or duties and how are these duties distributed? The group of duties in each horizontal activity row is considered separately.

III. Analysis of the duties of each individual: what is the job assignment of each person? The group of duties listed in each individual's column are studied separately.

Analysis of the activities as entities

1. What function or functions is the unit responsible for?
2. Are all the activities necessary for the successful accomplishment of function or functions?
3. Are there any activities or functions which are unrelated to the primary responsibility and which should be performed elsewhere? Can any of the activities be performed more efficiently elsewhere?
4. Are any additional activities required for the successful accomplishment of assigned responsibilities?
5. Which activities are of major importance? Do these activities receive the major proportion of the man-hours of the group? Which activities are of lesser relative importance? Is too large a proportion of the total time spent on them?
6. Are any of the activities duplicated elsewhere in the enterprise? Is it advisable to eliminate the duplication?

Analysis of the duties for performance of each activity

1. What duties are necessary to accomplish the activity? Are all of these assigned to some person?
2. Are any unnecessary duties or duplication of duties assigned?
3. Do the most important duties connected with the activity take the most time?
4. If all of the duties connected with the activity are assigned to one or a few persons, would it be preferable to spread the duties amongst more persons? Should they be assigned to each person on a sequential (assembly-line) basis or should each person be assigned the same parallel duties? If the duties connected with the activity are spread over a large number of people, would it be preferable to concentrate responsibility in one or two persons?
5. Is the long-run amount saved by checking duties greater than their cost?

6. Do the highly skilled employees perfrom the high-skill duties connected with each activity?

Analysis of the duties of each individual

1. Does the group of duties assigned the individual constitute a logical job grouping? Are there too many miscellaneous, unrelated duties which reduce worker efficiency?
2. Are the special skills of the employee used to the fullest extent? During what proportion of the total work time does the person use his special skills?
3. Is the work load distributed evenly? Do some employees have too large a proportion of the important and the deadline work which imposes strain?

SAMPLE ANALYSIS OF THE INVENTORY-CONTROL ACTIVITIES AS ENTITIES

1. *What functions is the unit responsible for?*

The inventory-control section is responsible for maintaining the proper levels of inventories in stores and for insuring that required material is available for delivery to the fabrication and assembly floors in accordance with schedule.

2. *Are all activities necessary to accomplish this?*

The vendor-record activity of the inventory-control section is not required to accomplish proper inventory control. It is valuable to have a record on one card of all the orders that have been placed on each vendor for the past ten years to answer inquiries and perhaps aid a little in expediting. However, it does not promote the objectives of the section in a substantial enough way to justify its cost.

3. *Could any activities be performed better elsewhere?*

The investigation of possible uses of surplus materials could better be performed in the design- and methods-engineering groups. The question of substitution of materials and parts is essentially an engineering and methods problem requiring a knowledge of the technical considerations as well as of future plans. When reviewing the inventory-control cards to separate those items requiring orders, the inventory clerks can prepare surplus notice forms which can then be circulated to the various groups concerned in making decisions on possible future utilization. (The amount of time for this duty is so small that it is not listed on the proposed Activity Analysis Chart prepared later.)

4. *Are any additional activities necessary?*
When parts are slightly damaged, or rejected for remediable defects, they are eligible for rework to make them usable if future requirements warrant. The inventory-control section maintains the record of requirements. The record of reject parts which might be reworked is kept in the storerooms in a haphazard manner. After checking with the inventory-control section, orders for rework are prepared by the storeroom, with a copy going to the inventory-control section for their records. Setting up a reject rework activity in the inventory-control section will centralize responsibility for this activity at the source of the knowledge of future requirements.

5. *Do major activities receive the major proportion of the man-hours?*
The inventory-control record, requisitioning of materials, and expediting of short items constitute the activities of major importance. They use up only 69 percent of the total man-hours of the section. Too large a proportion of the time of the section is spent on relatively unimportant activities such as interviewing callers, preparing inventory reports, investigating uses for surplus, and other miscellaneous activities. The major activities of requisitioning and expediting have suffered as a result.

6. *Should any activities which are duplicated elsewhere be eliminated?*
The information in the inventory reports prepared by the inventory-control section is also contained in satisfactory form in the more detailed reports issued by the plant-accounting department. Almost all the recipients of the Inventory-Control Report also receive the Plant-Accounting Report. The Inventory-Control Report should be eliminated.

SAMPLE ANALYSIS OF THE DUTIES FOR THE PERFORMANCE OF EACH ACTIVITY

1. *Are all required duties assigned?*
Without a record of the floor shortages (materials which have disappeared and cannot be accounted for) the inventory-control record is incomplete. Floor shortages must be replaced. Unless they are entered as requirements, the total requirements will be understated. Posting of floor shortages is thus a necessary duty of the inventory-control record activity which has not been assigned and performed.

2. *Are any duties duplicated?*
The personnel matters duty of the administration activity—general

supervision, grievances, discipline, etc.—are handled by both the section supervisor and the two inventory analysts. This is not the kind of duty that can be shared very well. It is preferable from the point of view of both economy and effectiveness not to have this duty repeated in three places.

3. *Do the most important duties consume the most time?*

The review-and-sign duty of the material-requisitioning activity appears to consume too small an amount of time in proportion to its importance in comparison with the time spent in the preparation of the requisitions. This is the most important control which the section supervisor directly exercises on the inventory-control function.

4. *Would it be preferable to redistribute the duties amongst more or fewer persons or in a different pattern?*

The separating of cards for materials requiring new purchase orders, the preparation of the pencil copy of requisitions, and the maintenance of the requisition control register are all performed by the inventory analyst. On the average, these duties take up practically all of his time. When there is a sudden rush and high volume of work in the requisitioning activity for a short period, it is impossible for the inventory analyst to adjust his duties to meet this short-range peak requirement. If some of these duties could be placed properly elsewhere, the inventory analyst could take on duties related to other activities. Then, on those occasions when the material-requisitioning activity required more than the average amount of time, he could take the time from a duty connected with a less immediately urgent activity.

The present assignment of duties to the clerks performing the inventory-control record activity concentrates in each clerk one or two of the sequences of events which occur on each record card—requirements, orders, receipts; disbursements. This possesses the advantage that each clerk becomes an expert in posting the events assigned to him. This advantage is not of great significance, however, because the clerks can become experts in the posting of all four events with little extra training and exertion. It is more advantageous to assign the same duties in parallel to all three clerks working on this activity, giving each one a separate group of storerooms and items. Periodic variations in the activity of the four events do not cause as great a burden on one person. Job monotony is reduced by some variations in the type of posting.

The interviewing of callers, answering of phone queries, and dictating of replies to inquiries can be handled more effectively if concentrated in one person. It is difficult to find a logical basis for dividing the responsibility, thus causing confusion in answering inquiries. In addition, these inquiry duties are disrupting to the normal routine of the day's operations and may hold up more essential duties. The supervisor is best able to control them and to see that they do not interfere too greatly with more essential activities. The handling of all inquiries also will aid the supervisor to keep tabs on all the activities of his section.

5. *Do the checking duties cost more than they are worth?*

The expenditure of 15 hours a week of the inventory analyst's time to check the postings of the clerks is not worthwhile. The number of discovered errors which would not have been revealed when the cards were reviewed and separated for ordering purposes is exceedingly small. In addition, the checking duty tends to promote a feeling of laxness on the part of the clerks—an attitude of "mistakes are all right because the checker will find them."

6. *Does the higher skilled person do the higher skilled part of the activity?*

In the surplus-utilization activity the investigating and determination of disposition duty, which requires a high degree of judgment and skill, is performed by the clerk. The section supervisor, however, determines which items are to be considered surplus by analyzing the inventory-control record cards. This duty does not require very high skill and can be made quite routine by establishing standards as to when material is to be considered surplus.

SAMPLE ANALYSIS OF THE DUTIES OF EACH INDIVIDUAL

1. *Does the job grouping of each person constitute a logical entity?*

The duties of Donald Doremor, clerk, do not constitute a logical job grouping. His duties are pretty much a mixture of relatively unrelated tasks. This is poor for his sense of accomplishment, morale, and effectiveness.

2. *Are each person's special skills used to the fullest?*

The section supervisor spends almost half his time determining surplus material from inventory cards and keeping attendance records. These could be handled very well or better by a clerk.

Inventory analyst Bernard Brown spends more than one quarter of his time separating cards requiring orders and maintaining a requisi-

ACTIVITY		SECTION SUPERVISOR		INVENTORY ANALYST		CLERK	
	MAN-HRS.	A. Appley	M.H.	B. Brown	M.H.	D. Doremor	M.H.
INVENTORY CONTROL RECORD	114					Post deliveries & withdrawals Post requirements Post orders Post floor rejects, shortages	15 10 8 4
REQUISITION MATERIALS	75	Review & sign	12	Prepare pencil copy of requisitions	26	Separate cards requiring orders	3
EXPEDITE SHORT ITEMS	33	Handle very critical cases	6	Prepare expediting correspondence Make expediting phone calls	6 3		
REJECT REWORK	8	Review & sign	1	Prepare pencil of rework orders	3		
INQUIRIES	13	Interview callers Prepare and dictate replies to inquiries	6 2				
ADMINISTRATION	25	Conferences Budgetary matters Personnel matters supervision, grievances, discipline	4 1 5	Conferences	1		
MISCELLANEOUS	12	Read company policy reports, correspondence Review & improve section operating procedures	2 1	Read company policy reports, correspondence, etc.	1		
	280		40		40		40

Figure 21. Activity Analysis Chart—shows reallocation of activities

CLERK		CLERK		SECRETARY		TYPIST-CLERK	
E. Earle	M.H.	F. Farrow	M.H.	G. Gordon	M.H.	H. Hunt	M.H.
Post deliveries & withdrawals Post requirements Post orders Post floor rejects, shortages	17 10 6 4	Post deliveries & withdrawals Post requirements Post orders Post floor rejects, shortages	15 10 6 4			File posted paperwork	5
Separate cards requiring orders	3	Separate cards requiring orders	3			Type & proof purchase requisitions Maintain requisitions control register	26 2
				Take dictation & typing of expediting correspondence	18		
		Maintain rework stock record	2			Type & proof rework orders Maintain rework order control register	$1\frac{3}{4}$ $\frac{1}{4}$
				Take dictation & typing of replies to inquiries	5		
				Handle administrative correspondence Keep attendance records	12 2		
				Open & distribute incoming mail	3	Emergency messenger service Miscellaneous typing	3 2
	40		40		40		40

of the personnel shown in Figure 20, made after careful analysis.

tion control register. Both of these duties could be performed by a clerk.

3. *Is the work load roughly balanced?*

Inventory analyst Charles Court appears to have few duties which might impose great strain.

Based on a more detailed consideration of the type of analysis just presented, a new Activity Analysis Chart, shown in Figure 21, was constructed to show how the inventory-control section's activities could be organized more effectively.

The Activity Analysis Chart provides a technique for making an analysis of the broader aspects of the activities of an organizational group as well as some of the more detailed considerations. It is important to remember, however, that it does not constitute the sole or most effective tool for analyzing all the detailed systems problems of an organizational unit. For example, it does not necessarily describe or provide for the analysis of how the activities are performed. Many other useful analytic tools are presented in this and other chapters to cover these additional needs.

DEPARTMENT ANALYSIS CHART

A variation of the Activity Analysis Chart is the Department Activity Analysis Chart, such as shown in Figure 22, essentially an Activity

DEPARTMENT ANALYSIS CHART Department XYZ													
Activity		Section 1		Section 2		Section 3		Section 4		Section 5		Section 6	
	man hrs		man hrs		man hrs		man hrs		man hrs		man hrs		man hrs
Activity A													
Activity B													
Activity C													
Activity D													
Activity E													

Figure 22. Department Analysis Chart—shows sections, departments, divisions, etc.: similar to the activity analysis chart.

Analysis Chart which considers the activities of the groups making up an organizational unit rather than the individuals in an organizational unit. This chart can be considered a less detailed consolidation of the Activity Analysis Charts for each section. Department Activity Analysis Charts can be similarly consolidated to produce a Department Activity Analysis Chart for the next higher organizational unit.

The method of analysis of the Department Analysis Chart is directly analogous to the analysis of the Activity Analysis Chart. Similar questions are asked to discover sources of improvement.

PROCESS CHART

To study the details of a relatively simple activity or a small portion of an activity which is performed within one organizational unit, the Process Chart is a very convenient and useful device. It records the detailed systems data in readily understandable manner so that they may be analyzed to eliminate unnecessary steps or to change the order in which they are done to reduce effort, fatigue, and time.

The Process Chart, applied to systems work, is essentially a detailed, chronological record of the successive steps in a procedure. In its simplest form, the Process Chart consists of a two-column chart, one column of description and a second column to the left of the first, symbolizing the described step for ease of understanding the sequence of steps. The simplest charts use just four symbols:

◯ Operation
o Transportation
□ Inspection
▽ Storage

An operation is performed when something is added, subtracted, changed, or created. An action is not classified as an operation if it involves solely the movement of an object from one place to another or if only a check or verification but no change in the record or object or situation is made.

A transportation occurs whenever an object, form, letter, or idea is moved from one place to another.

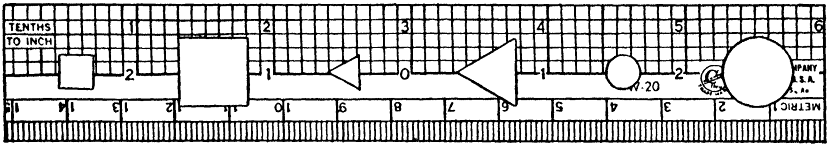
An inspection occurs whenever an object, form, letter, or idea is checked or verified, but without making any change.

A storage results whenever an object, form, letter, or idea is not being operated upon, transported, or inspected. Storages fall into two types of situations:

1. Storages which delay the next step in the process—holding up the next operation, transportation, or inspection.
2. Storages which involve protection of the object until the operation, transportation, or inspection is ready to be performed.

It is not always possible clearly to distinguish between these two types of storages.

For ease in drawing the process chart symbols, a celluloid ruler with symbol cut-outs, such as is shown in Figure 23, may be used.



Courtesy C-Thru Ruler Company

Figure 23. Metric rule and stencil cut-out template for drawing process chart symbols.

CONSTRUCTING THE PROCESS CHART

The first step in constructing a process chart is to define carefully the activity being charted. Where does it begin and where does it end? After deciding on and defining the scope of the activity, stay within it. Cover no ground outside the defined scope.

Then, determine each step of the activity in sequence. Omit no elements in the activity. If in doubt whether a minor step should be included, include it. Describe each step so that it is clearly identifiable.

For the transportation steps, determine the distance in feet. For the storage steps, determine the time so spent.

It is desired to analyze the issuance of a purchase order in a certain company. Each step in this activity is therefore determined and written down by the analyst:

Pencil order prepared by buyer
In outgoing box (20 min.)
To Register desk (950 ft.)
In incoming box (15 min.)
Checked for completeness and accuracy of extensions
P.O. number stamped on
In outgoing box (20 min.)
To typing pool control desk (175 ft.)
In incoming box of control desk (45 min.)
Checked for completeness and accuracy of extensions

P.O. number entered in control book and typist number placed on pencil order
In outgoing box (20 min.)
To sorting table (50 ft.)
Sorted numerically
To typist (25 ft.)
In incoming box (50 min.)
P.O. typed
Pencil and typed order in outgoing box (15 min.)
To proofreader's desk (150 ft.)
In incoming box (25 min.)
Proofread
In outgoing box (20 min.)
To control desk (130 ft.)
In incoming box (15 min.)
Checked for completeness and accuracy of extensions
Control book entry
In outgoing box (45 min.)
To purchasing agent (1,100 ft.)
In incoming box (100 min.)
Reviewed and signed
In outgoing box (20 min.)
To buyer (100 ft.)
In incoming box (45 min.)
Reviewed
In outgoing box (20 min.)

It is now desired to chart these steps in a simple manner which will graphically promote clarity and ease of analysis. We also want to be able to summarize the process: how many feet of transportation; how many minutes of storage; how many operation, transportation, storage, and inspection steps?

A convenient form for doing this is shown in Figure 24, in which this process is charted. The separate columns for the time and distance information facilitate addition. The preprinted symbols on the chart, which are connected by broken lines, save time in making the chart and facilitate the counting of the number of steps in each category. The total number of steps in each of the four categories should obviously add up to the total number of steps in the process.

This procedure illustrates several characteristics of most processes and procedures which it is helpful to keep in mind.

1. Most operations or series of operations have a storage before and after.

2. If each of the series of operations is not performed in immediate succession on the same form, document, object, or machine, there will usually be a storage step between the operations.
3. When operations are performed in succession by different persons, there will usually be a transportation between the successive operations.

The process chart just prepared shows 6 operations, 8 transportations, 6 inspections, and 15 storages. The transportations total 2,680 feet and the storages take up 475 minutes.

KEY QUESTIONS

How can this procedure be improved? To aid the analyst in making a systematic analysis, he should ask himself the following questions:

1. Are the check and control steps worthwhile or would taking a calculated risk be cheaper in the long run?
2. Is the system as automatic as possible?
3. Are there repeated steps or cycles of steps which suggest duplication or overlapping activities?

Examining each step and each group of steps individually and in orderly succession to avoid a haphazard approach:

4. *Why* must the step or group of steps be done? Is it necessary?
5. *What* would happen if it were eliminated?
6. *Who* should do the step or group of steps? Could some other person or unit do it easier—less work, time, transportation, or storage? Could it be assigned to a person of lower skill?
7. *How* should it be done? Are the forms, equipment, and work methods correct?
8. *When* should the step or group of steps be done? Should it be done earlier or later in the process?
9. *Where* should it be done? Would a changed location reduce transportation?

SAMPLE PROCESS CHART ANALYSIS

Let us apply these questions to the purchase order procedure just charted. Numbering the answers the same as the questions just asked, the systems analyst notes the following answers:

1. *Are the checks or controls necessary?*

On discussing the situation, the analyst and purchasing agent come to the conclusion that although it was very nice to have a control record of the orders going into and out of the purchase order typing pool, the control was not really worth the expense. It could be dispensed with, even though it might be missed on rare occasions.

2. *Is the system automatic?*

Yes. Judgment decisions are reduced to a minimum. The question of the buyer's procedure in choosing a vendor and price is a separate system.

3. *Are there repeated steps or cycles of steps which suggest duplication or overlapping activities?*

The registration of every purchase order at both the register and control desks suggests unnecessary duplication. Also, the checking of each order for completeness and accuracy of extensions by four different persons suggests unnecessary repetition of a required control activity.

4. *Why must each step be done? Why must the orders be sorted into numerical order before being typed?*

The analyst and supervisor could not find out why the routine had been started.

5. *What would happen if the step were eliminated?*

Nothing.

6. *Who should check for completeness and for accuracy of extensions on purchase orders?*

It was decided that the proofreader was the logical person to check on the completeness and accuracy of the order as prepared by the buyer. The proofreader was considered the logical person even though this activity is performed after the order has been typed because:

   a. The buyer is expected to be accurate in most cases and very few errors will be uncovered requiring retyping.
   b. It saves the extra two transportations and two storage steps which would be necessary if the independent check were made prior to typing.

7. *How should it be done?*

By using continuous interleaved carbon fanfold purchase order forms which have been prenumbered in series by the printer, the necessity for registering and numbering each order is eliminated. Automatic regis-

PROCESS CHART

Procedure Charted: Purchase Order Preparation
Unit & Division: Purchasing Dept.
☒ **Present** ☐ **Proposed** **Charted by:** N. N. B. **Date:** 1/6/50

Distance in feet	Time in min.	O T I S	Description of Step
		○ ∘ □ ▽	Pencil order prepared by buyer
	20	○ ∘ □ ▽	In outgoing box
950		○ ∘ □ ▽	To register desk
	15	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Checked for completeness & accuracy of extensions
		○ ∘ □ ▽	P. O. number stamped on
	20	○ ∘ □ ▽	In outgoing box
175		○ ∘ □ ▽	To typing pool control desk
	45	○ ∘ □ ▽	In incoming box of control desk
		○ ∘ □ ▽	Checked for completeness & accuracy of extensions
		○ ∘ □ ▽	P.O. # ent'd in control book & typist # placed on pencil order
	20	○ ∘ □ ▽	In outgoing box
50		○ ∘ □ ▽	To sorting table
		○ ∘ □ ▽	Sorted numerically
25		○ ∘ □ ▽	To typist
	50	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	P.O. typed
	15	○ ∘ □ ▽	Pencil and typed order in outgoing box
150		○ ∘ □ ▽	To proofreader's desk
	25	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Proofread
	20	○ ∘ □ ▽	In outgoing box
130		○ ∘ □ ▽	To control desk
	15	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Checked for completeness & accuracy of extensions
		○ ∘ □ ▽	Control book entry
	45	○ ∘ □ ▽	In outgoing box
1100		○ ∘ □ ▽	To purchasing agent
	100	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Reviewed and signed
	20	○ ∘ □ ▽	In outgoing box
100		○ ∘ □ ▽	To buyer
	45	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Reviewed
	20	○ ∘ □ ▽	In outgoing box
2680	475		

Figure 24. Process Chart—gives a step-by-step presentation of the procedure for preparing purchase orders.

PROCESS CHART

Procedure Charted: Purchase Order Preparation

Unit & Division: Purchasing Dept.

☐ Present
☒ Proposed

Charted by: N. N. B. Date: 1/6/50

Distance in feet	Time in min.	O T I S	Description of Step
		○ ∘ □ ▽	Pencil order prepared by buyer
	20	○ ∘ □ ▽	In outgoing box
220		○ ∘ □ ▽	To typing pool supervisor
	15	○ ∘ □ ▽	In incoming box
25		○ ∘ □ ▽	To typist
	50	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	P.O. typed
	15	○ ∘ □ ▽	Pencil & typed order in outgoing box
50		○ ∘ □ ▽	To proofreader's desk
	25	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Proofread & checked for completeness & accuracy of extension
	20	○ ∘ □ ▽	In outgoing box
190		○ ∘ □ ▽	To buyer
	45	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Reviewed and initialed
	20	○ ∘ □ ▽	In outgoing box
100		○ ∘ □ ▽	To purchasing agent
	100	○ ∘ □ ▽	In incoming box
		○ ∘ □ ▽	Reviewed and signed
	20	○ ∘ □ ▽	In outgoing box
		○ ∘ □ ▽	
		○ ∘ □ ▽	
		○ ∘ □ ▽	
		○ ∘ □ ▽	
		○ ∘ □ ▽	
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		○ ∘ □ ▽	
		○ ∘ □ ▽	
		○ ∘ □ ▽	
		○ ∘ □ ▽	
585	330		

Figure 25. Proposed Process Chart—shows advantages of the new purchase order preparation procedure evolved from analysis of the method shown in Figure 24.

tration is achieved because no number can be used twice and one extra copy of the order can serve in place of the information provided by the register.

8. *When should it be done?*

In the present procedure, the purchasing agent signs the purchase order before it has been reviewed by the buyer. This is inadvisable because the purchasing agent does not have the initialed approval of the buyer and the purchase order becomes a valid contract upon the agent's signature. There is always the danger of an incorrect order being released without the review of the buyer.

9. *Where should it be done?*

By relocating the typing pool nearer the buyers, the distance for the required transportations could be cut to less than a quarter of what it is under the present lay-out.

As a result of this careful consideration of the purchase order procedure, a new proposed procedure was developed and a new Process Chart prepared. It is shown in Figure 25. It is seen that the total number of steps has been reduced from 35 to 20: operations from 6 to 2; transportations from 8 to 5; inspections from 6 to 3; and storages from 15 to 10. The distance travelled has been cut from 2,680 to 585 ft. and the storage times from 475 to 330 minutes.

ELABORATIONS OF THE PROCESS CHART

Using the simple basis of the process chart just developed, elaborate process charts of great complexity have been designed and used by some people for systems analysis. Although some complexities may be valuable for certain applications, the writer has found that, by and large, the systems man will do well to apply to his own investigations the rule: a simple system is usually the best system. Overcomplexity can be very confusing.

The two principal avenues of elaboration of process charts are:

1. The addition to the form of extra columns and spaces for additional information.
2. The use of many different symbols for visually indicating and classifying the types of operations.

The use of one or two symbols in addition to the four standard ones just described is sometimes useful when certain unusual types of steps occur with great frequency in a procedure. In such cases, of course, the symbols used should be carefully described in the legend on the chart.

System

Procedure Study Sheet

Date______

Prepared For (Company Location, Sponsor)			Job Assignment No.
Form	**Form No.**	**Title of Copy**	**Copy No.**

Origin of Record	Move
Adding To Record	Inspection
Handling Operation	Hold, Delay, File Or Storage

Question Each Step	
What is done?	WHY?
Where is it done?	WHY?
When is it done?	WHY?
Who does it?	WHY?
How is it done?	WHY?

Indicate Type of Improvement For Each	
Can it be eliminated?	If so, indicate by______E
Can it be combined or changed in sequence for better operation?	If combine, mark______C If change in sequence, mark______CS
Can it be simplified?	If so, mark______S

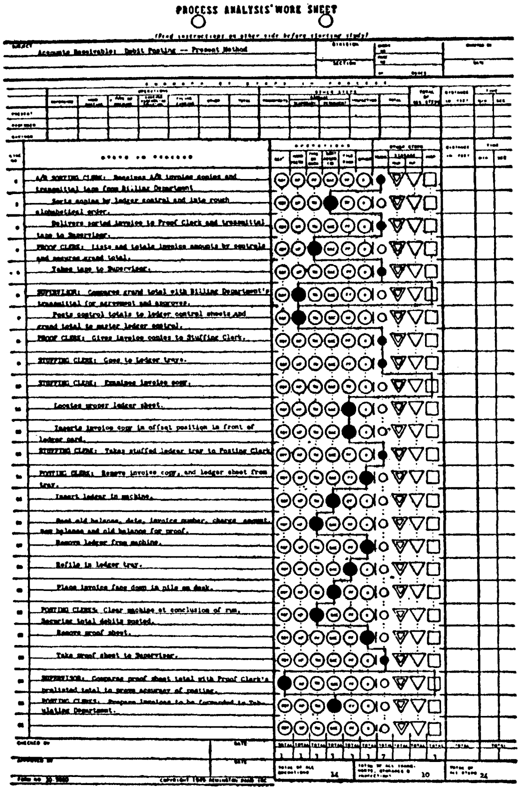
Step	Symbol	Description	No. of Oper.	Wage Bkt.	Output or Dist. Moved	Notes --- Questions --- Improvement

One of the Paperwork Simplification tools of The Standard Register Company, Dayton, Ohio

Completed by______

Courtesy Standard Register Company of Dayton, Ohio

Figure 26. Process Chart Form—gives more information and additional symbols.

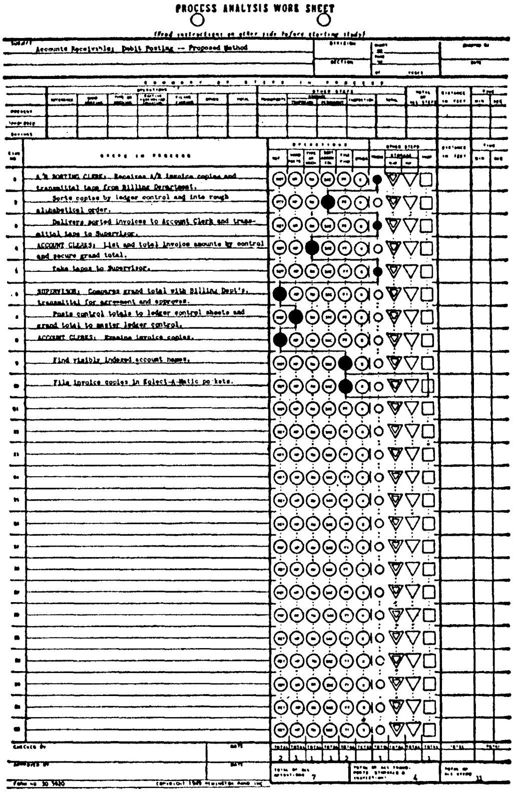


Courtesy Remington

Figure 27. Process Analysis Chart—shows debit-posting operation requiring
Proofing and stuffing work is eliminated under the new method, which offers

In Figure 26 is shown a more elaborate chart form which contains key questions to promote simplification of ideas. Figure 27 illustrates another example of an elaboration of the first kind which might prove useful. The use of many different symbols in charting is illustrated in the organizational process chart application shown later in Figure 32. The symbols for the legend in this chart were drawn from the more complete list of symbols shown in Figure 28. These elaborations of the simple process chart may prove valuable to the analyst. By virtue of the added rigors required of him in preparing the chart, they may force him to a better understanding and analysis of the system he is studying.

The procedure being process-charted might involve routines which start as a single sequence but later branch out into two or more



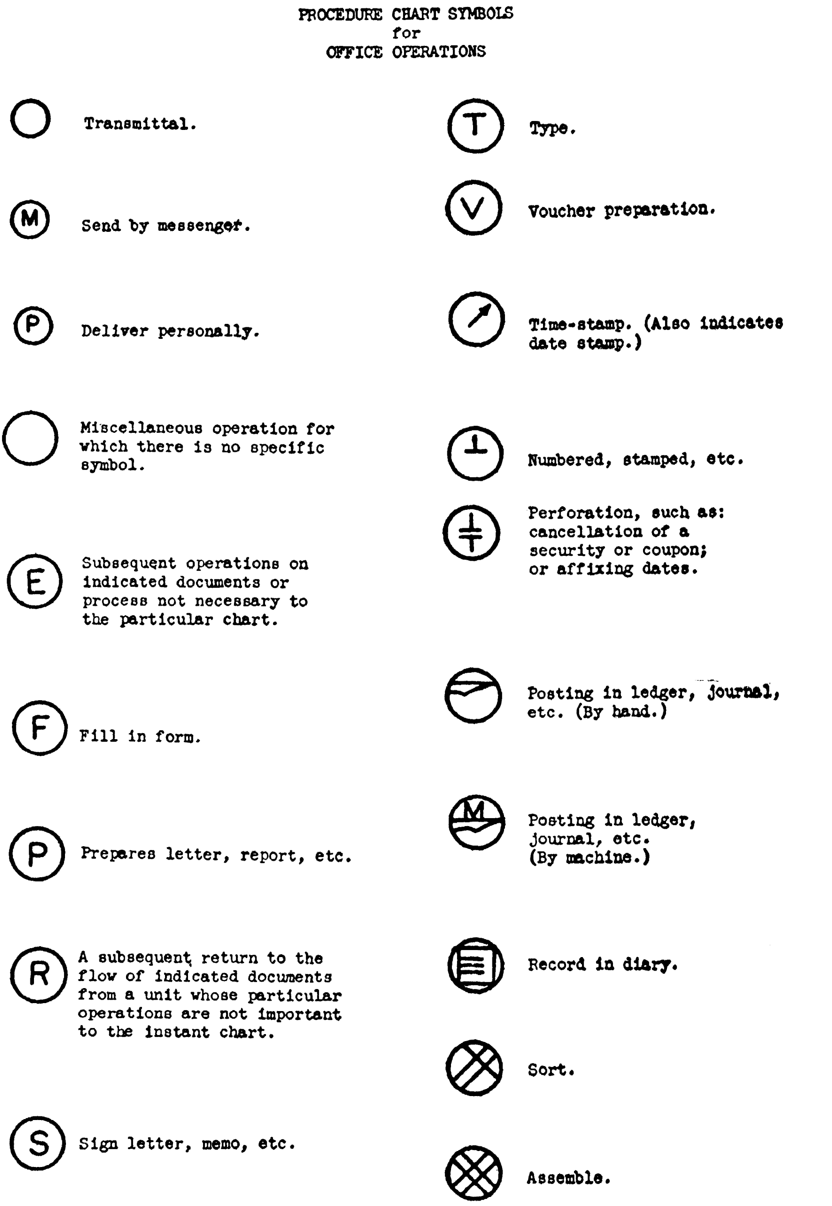
Rand, Inc.

25 steps. The same operation is then shown charted in only 10 steps.
a minimum of clerical drudgery.

sequences which are performed at the same time. Figure 29 shows one method of process-charting such a procedure. Sometimes two or more sequences of steps start out separately and are later united in the performance of the function. These procedures are handled similarly, the two or more branches coming together, instead of the branching out process shown here. Such a procedure is charted pictorially without benefit of the process chart symbols in the chart of a punched-card payroll procedure on page 262.

STANDARDS FOR CONSTRUCTION OF PROCESS CHARTS

A special committee of the American Society of Mechanical Engineers has developed standards for the construction of operation and flow



PROCEDURE CHART SYMBOLS
for
OFFICE OPERATIONS

Transmittal.

Send by messenger.

Deliver personally.

Miscellaneous operation for which there is no specific symbol.

Subsequent operations on indicated documents or process not necessary to the particular chart.

Fill in form.

Prepares letter, report, etc.

A subsequent return to the flow of indicated documents from a unit whose particular operations are not important to the instant chart.

Sign letter, memo, etc.

Type.

Voucher preparation.

Time-stamp. (Also indicates date stamp.)

Numbered, stamped, etc.

Perforation, such as: cancellation of a security or coupon; or affixing dates.

Posting in ledger, journal, etc. (By hand.)

Posting in ledger, journal, etc. (By machine.)

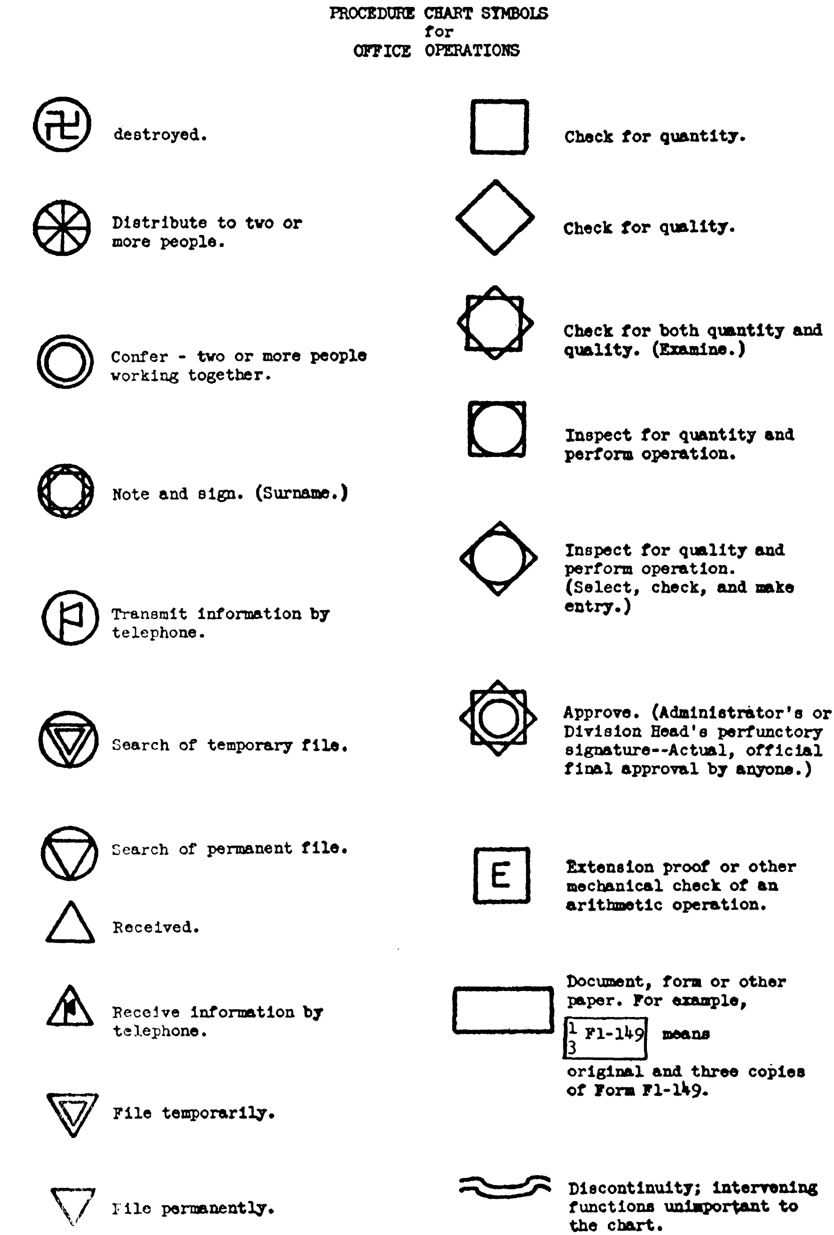
Record in diary.

Sort.

Assemble.

From Administrative Planning Series Number III,

Figure 28. These thirty-nine procedure chart symbols provide a detailed



Office of the Secretary of War

categorization of the kinds of operations found in office procedures.

PROCESS CHART- INDUCTION PAPERS

ADJUTANT GENERAL'S OFFICE-ENLISTED BRANCH

RECORD EXAMINING SUB-SECTION

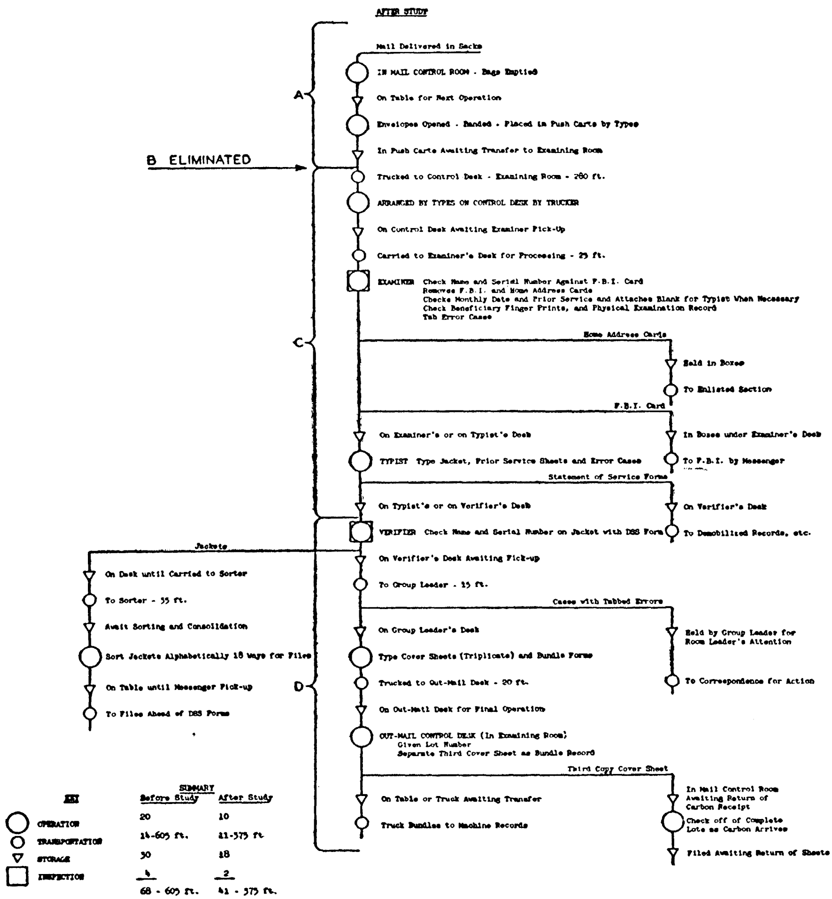


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Figure 29. Process Chart of an Induction Papers procedure—illustrates a neat method of process-charting a routine which branches out.

process charts. This committee standardized on five classifications of activities: operation, transportation, inspection, delay, and storage. In Figure 30 is shown a process chart of a requisition for supplies procedure, which has been constructed in accordance with these standards.

PROCESS CHART

Name of Part or Product Requisition For Supplies - Rush Job

Chart Begins at Machine Shop Foreman's Desk, Ends on Typist's Desk in Pur. Dept. | Chart No.

Order No. Lot Size Dept. | Sheet 1

Charted by C.H.H. Date Charted 7-28-45 Bldg. M. E. Lab | of 1 Sheets

Travel in ft.	Time in min.	Symbol	Operations	Remarks
		1	Written longhand by foreman	
		1	On foreman's desk (awaiting messenger)	
1000		1	By messenger to secretary of head of department	
		2	On secretary's desk (awaiting typing)	
		2	Typed	
15		2	By messenger to head of department	
		3	On head of department's desk (awaiting approval)	
		O-3 INS-1	Examined, approved and coded (signed and code stamped)	
		4	On head of department's desk (awaiting messenger)	
2000		3	To Purchasing Department	
		5	On purchasing agent's desk (awaiting approval)	
		2	Examined and approved	
		6	On purchasing agent's desk (awaiting messenger)	
25		4	To typist's desk	
		7	On typist's desk (awaiting typing of purchase order)	

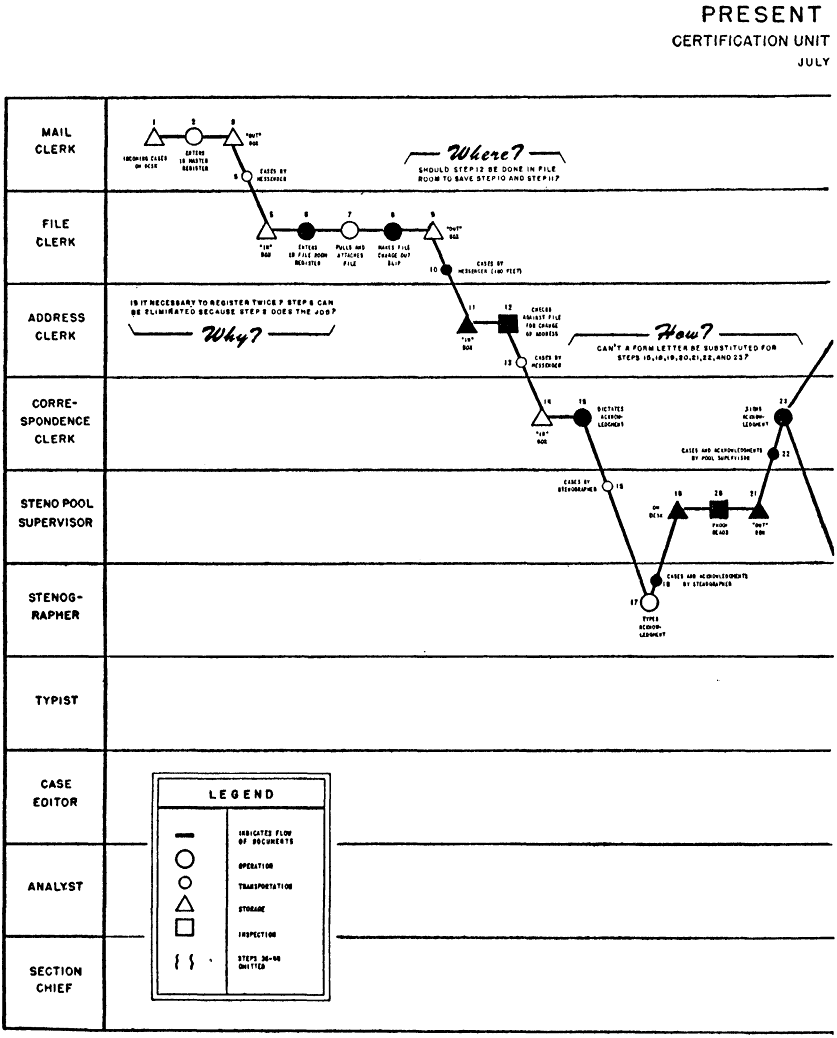
ASME Standard "Operation and Flow Process Charts"

Figure 30. Process Chart of a requisition for supplies.

ORGANIZATIONAL PROCESS FLOW CHART

The Organizational Flow Chart portrays the departmental relationships of various phases of interdependent activities. The Process Chart is a detailed chronological record of the successive steps in the performance of an activity or function, these steps being categorized by type. The Organizational Process Flow Chart is a combination of these two graphic systems: columns or rows labeled for the organizational unit or persons performing the activities of the procedure; the steps graphically portrayed by the process chart symbols.

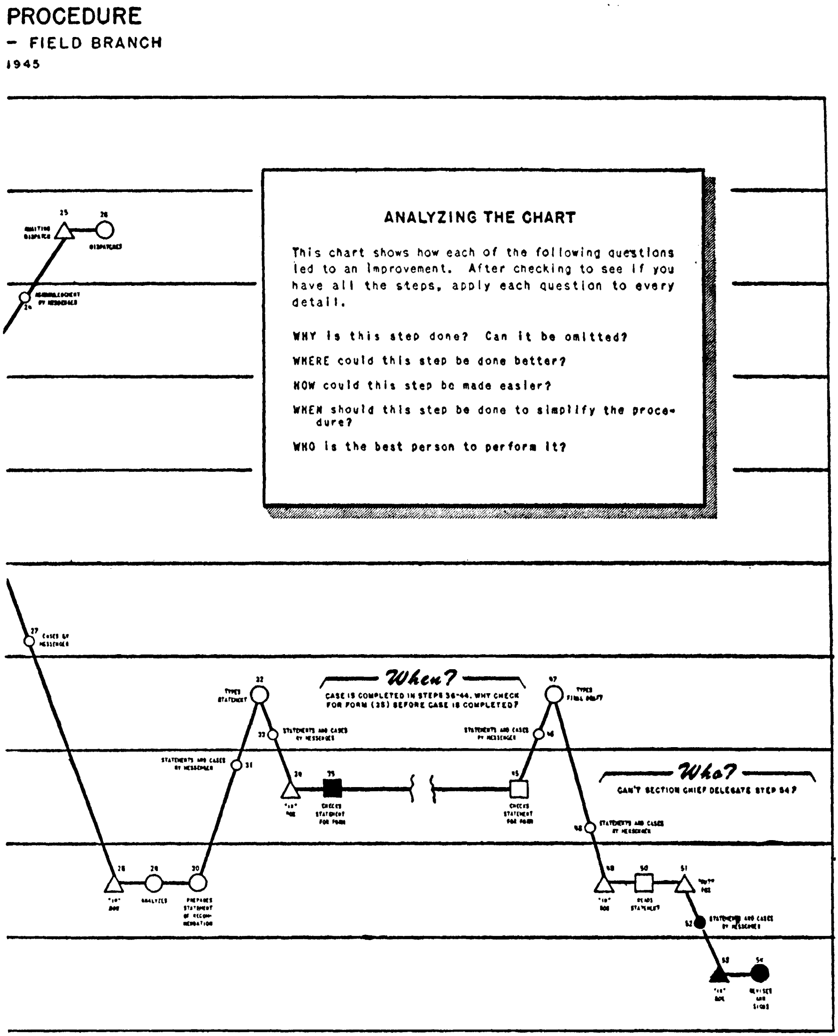
The Organizational Process Flow Chart is especially valuable for the



U.S. Bureau of the Budget Management

Figure 31. Organizational Process Flow Chart—presents effectively the analysis of the detailed steps of relatively complicated procedures in which the activities are performed by a number of organizational units or persons.

Two examples of this type of chart are shown. In Figure 31 we see an analysis of a certification procedure. In this case, the organizational units are represented by the labeled rows. The symbols used are the

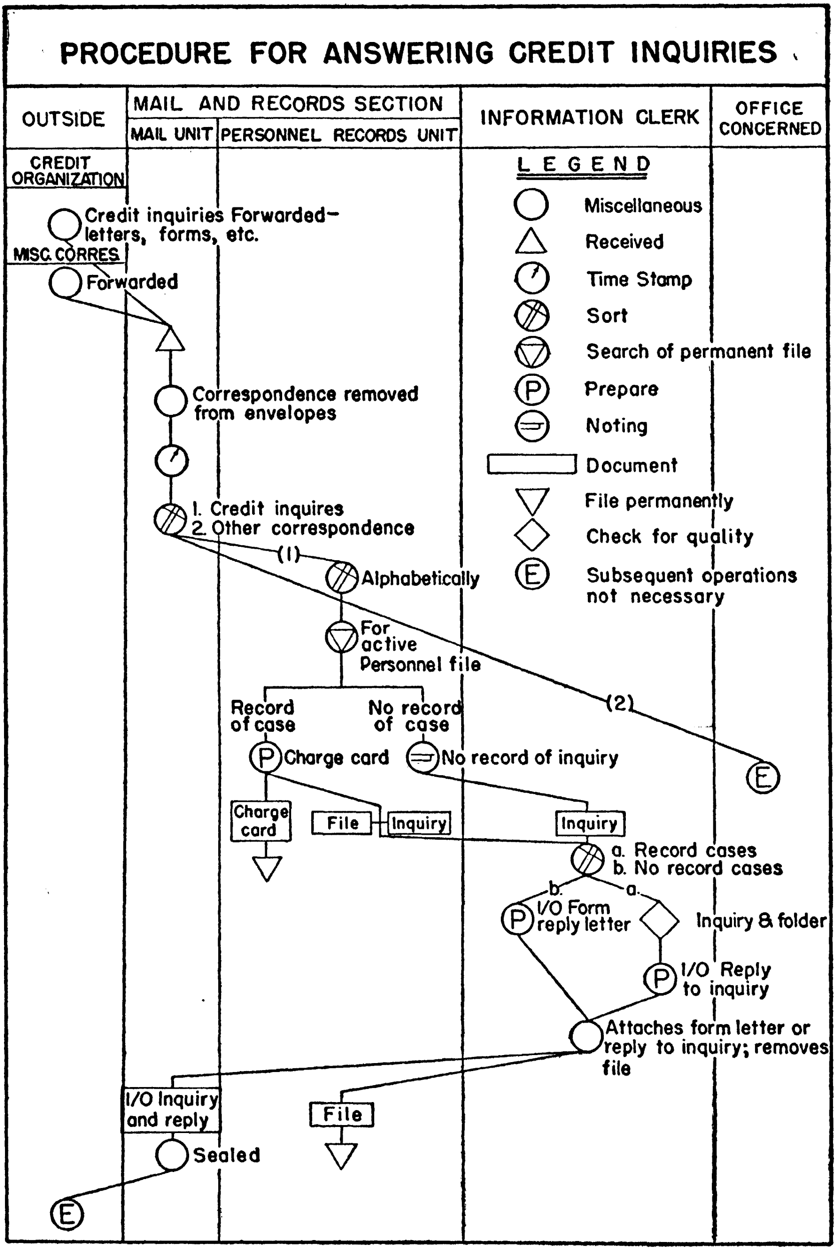


Bulletin "Process Charting"

proceduce of the Certification Unit and poses pertinent questions.

standard ones presented in our discussion of the process chart.

The questions to be used in the analysis of this type of chart are similar to those presented for both the Organizational Flow Chart and the Process Chart of which this chart is a combination. The where, why, how, when, and who questions are illustrated right on the chart of Figure 31.



From Administrative Planning Series Number III, Office of the Secretary of War

Figure 32. Organizational Process Flow Chart of a procedure for answering credit inquiries, utilizing an elaborate legend.

In Figure 32 is shown a second example of the Organizational Process Flow Chart. In this chart, the organizational units are represented by columns. The symbolic system is quite a bit more complex, using symbols chosen from Figure 28 on page 98. This type of more detailed symbolic analysis is very valuable on some occasions. However, the writer has found that the simpler chart using four to six standard symbols is more valuable for most purposes because of its greater understandability.

FORMS DISTRIBUTION CHART

The Forms Distribution Chart is a specialized Organizational Flow Chart for portraying and analyzing the distribution of the several copies of a form. As in the Organizational Flow Chart, the column headings indicate the organizational units receiving and/or transmitting copies.

This type of chart is valuable for quick, easy portrayal of how each copy of a form or report is distributed and for cursory analysis of possible improvements in the distribution. However, because it achieves its simplicity by eliminating explanation of the details, it can seldom be used as the sole means for a complete analysis to promote the greatest possible improvements.

QUESTIONING PROCEDURE

For portraying a relatively simple distribution pattern, a chart such as shown in Figure 33 is very useful. To analyze the distribution plotted on this chart, the following questions are suggested:

1. Why is each copy needed?
2. Are other copies needed?
3. How many copies are filed by the various groups? Are all these files essential?
4. Can one copy be circulated to eliminate the requirement for one or more other copies?
5. Do any groups get duplicate copies? Are they both required?
6. Do the clearest copies go to the right groups?
7. Does back-tracking of copies indicate overcomplicated or useless paperwork movements?

These questions are not aimed at analyzing the design of the form or at a completely comprehensive consideration of its uses. Only the more obvious aspects of its distribution are being analyzed.

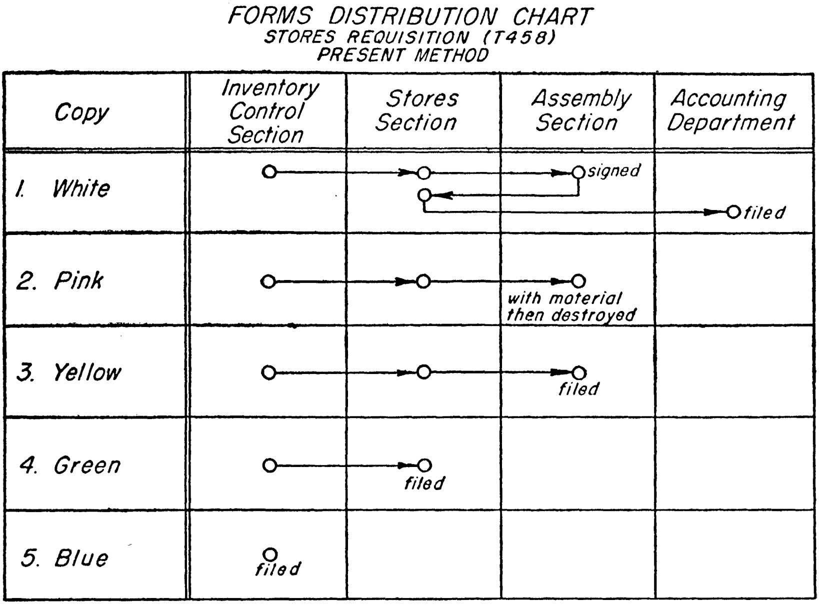


Figure 33. Forms Distribution Chart—shows the paths followed by the various copies of the stores requisition.

SAMPLE FORMS DISTRIBUTION ANALYSIS

1. *Why is each copy needed?*

Investigation discloses that the accounting department requires its copy for keeping its inventory records; the assembly section uses copy #2 (pink) to identify the material until it is used in the assembly units and copy #3 (yellow) for a reference file; the stores section posts to its bin card stock record from copy #4 (green); and copy #5 (blue) is used by the inventory-control section to post to the inventory record and is then filed.

2. *Are other copies needed?*

The assembly-control section, which is responsible for scheduling, loading, and controlling material in the assembly section, should know for its status records what material has been moved to the assembly floor. It should therefore receive a copy.

3. *Are all filed copies essential?*

Of the four copies filed, only accounting and inventory control really need the files for verification and justification of their records. Two complete files in the plant would be sufficient for all needs.

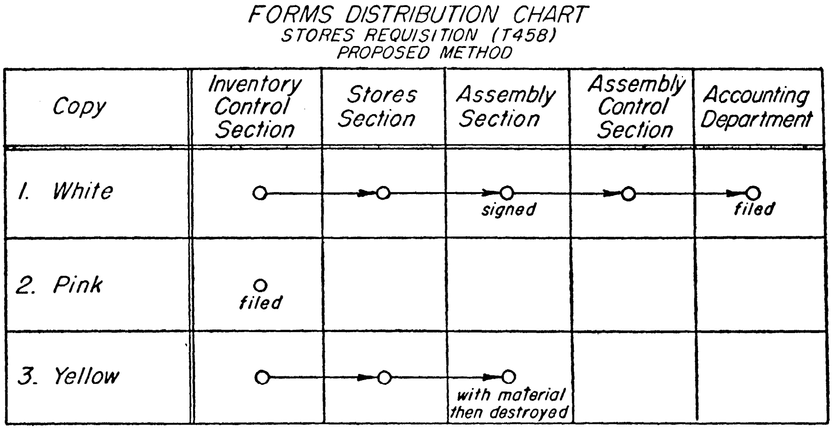


Figure 34. The simplicity of the proposed Stores Requisition procedure becomes apparent when this chart is compared with Figure 33.

4. *Can copies be eliminated by passing along?*

The stores section does not require a file of requisitions. By posting to the bin card from copy #1 (white) when the material is disbursed, copy #4 (green) will not be required.

5. *Are any duplicate copies received and required?*

The assembly section receives both copies #2 (pink) for identifying the material and #3 (yellow) for filing. The filing copy can be eliminated.

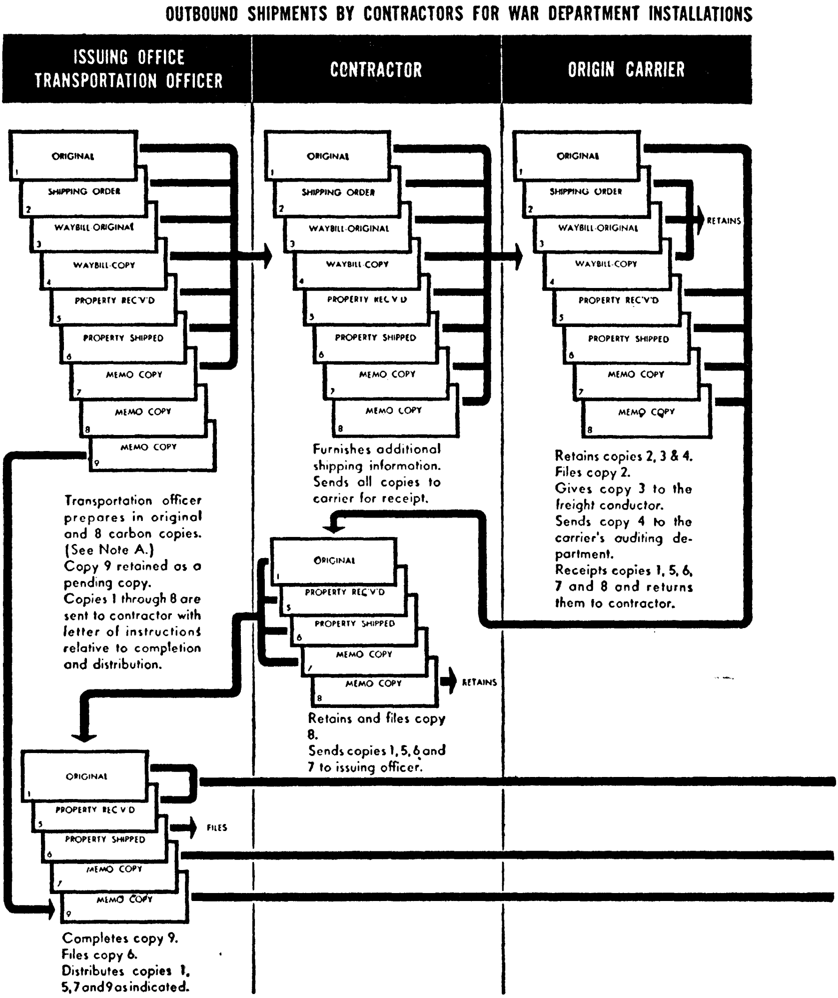
6. *Do the right groups get the clearest copies?*

The inventory-control section keeps copy #5 (blue), which is the worst copy, to post to its records, whereas #2 (pink) and #3 (yellow) are given to the assembly section. However, the importance of good visibility is much greater for inventory control than assembly.

7. *Is there useless back-tracking?*

Yes. Copy #1 (white) goes back to the stores section where the signed acceptance is recorded before the copy is forwarded to the accounting department. This is unnecessary since the signed acceptance is always available in the accounting department for verifications and the verifications are seldom required. The control function which the stores section performs in insuring that accounting gets its copy can be performed by the assembly-control section, by having serially prenumbered requisitions.

On the basis of this analysis, a new Forms Distribution Chart is con-



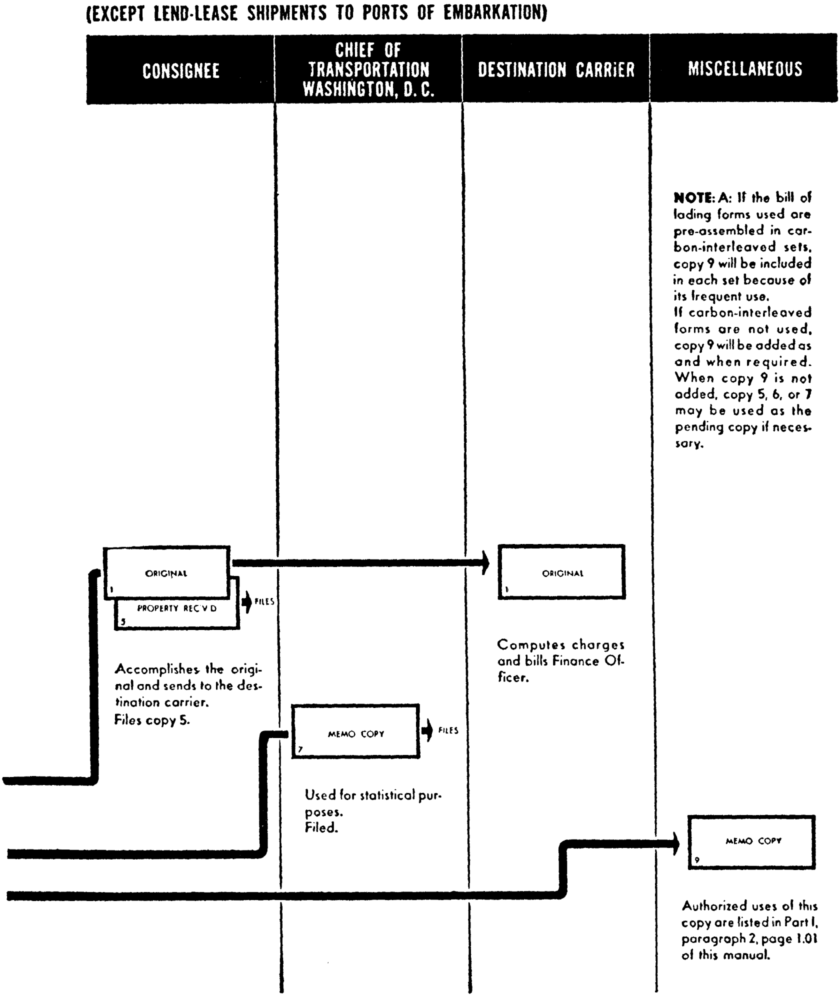
U.S. Army Service Forces

Figure 35. Forms Distribution Chart, with symbolic representation of the

structed. This chart, shown in Figure 34, has a simpler, more direct distribution pattern. Two copies of the form have been eliminated.

FORMS DISTRIBUTION CHART VARIATIONS

Three additional examples of the Forms Distribution Chart are shown to indicate some of the variations which may be useful. The



Manual M404

different copies of the bill of lading. The presentation is very effective.

example in Figure 35 is a bit more elaborate than the chart of the distribution of the material requisition. The use of limited textual material gives valuable information which may aid analysis. This type of chart is frequently used for instructional and demonstration as well as analytic purposes.

The Forms Distribution Chart on the processing of the copies of a

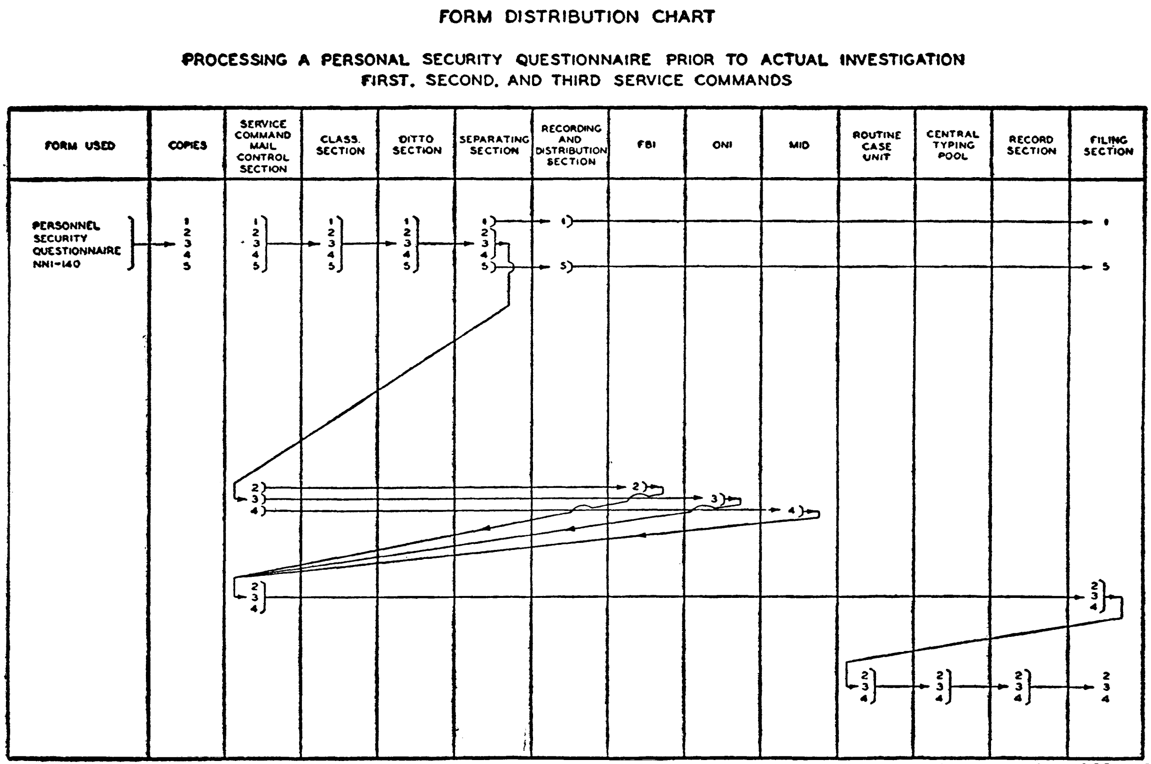


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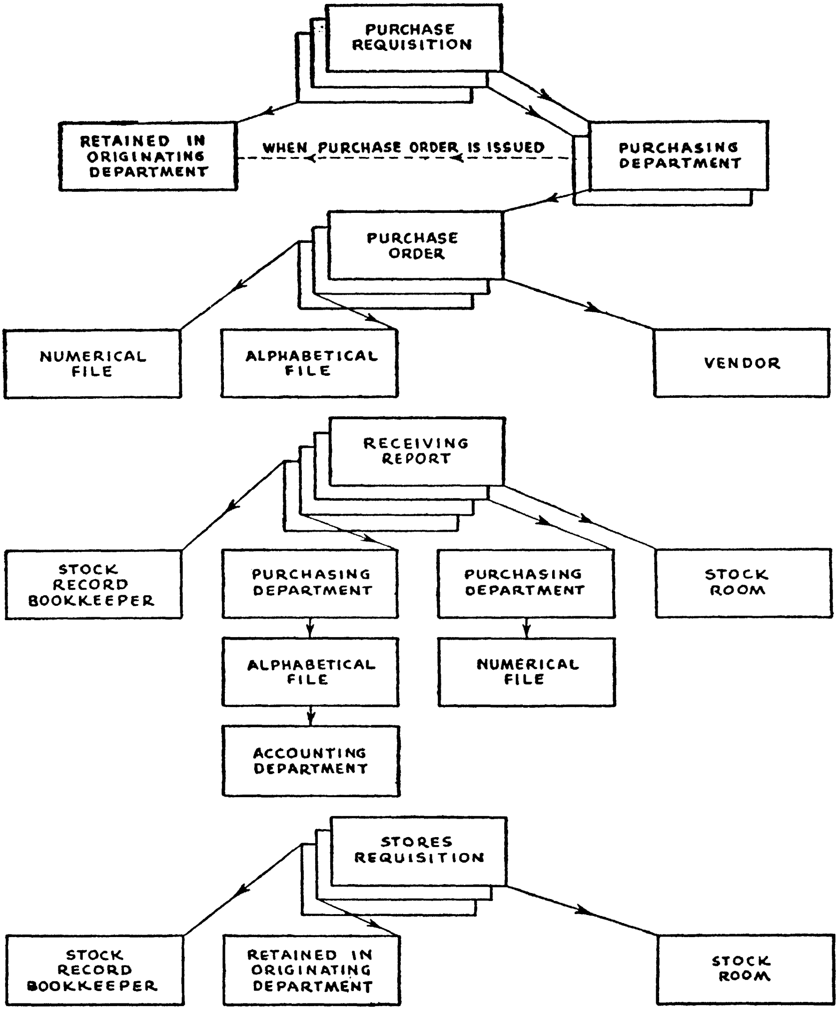
Figure 36. Forms Distribution Chart—gives a simple, clear picture of what happens to the various copies of the questionnaire.



The flow chart shown above graphically illustrates the routing of the Purchase Requisition, the Purchase Order, the Receiving Report and the Stores Requisition.

Courtesy Remington Rand, Inc.

Figure 37. Flow Chart.

questionnaire is shown in Figure 36. This chart has a clean simplicity. It clarifies a relatively complicated distribution pattern so that it may be carefully analyzed.

The Forms Flow Chart of Figure 37 does not as clearly classify movement between departments, but it does graphically show the routing of the various copies of the form. An example of a pictorial forms chart useful for instructional purposes is shown at page 262 of Chapter XII.

NO MAGICAL CHARTING TECHNIQUE

None of the charting techniques presented in these discussions will by itself provide you with a single systems answer nor will any one of them necessarily provide you with the best system. These techniques provide ways of arranging systems facts in clear, understandable form. Then, using common sense and past experience, applying the principles developed in Chapter III, and asking some key skeptical questions, ways of improving the procedures may suggest themselves. These suggested improvements must themselves be subjected to the same critical analysis as the existing system to insure that they are truly best.

VI

ANALYZING THE LAY-OUT

A COLLEGE FOOTBALL team constitutes a segment of an enterprise with a definitive purpose, a formal organizational structure, and a very highly specialized set of formalized systems. Many of these systems are, of course, the various plays established by the coaches and team. If these plays or systems are not effective, then the team will not accomplish its purpose of achieving victory. One of the most important factors in determining the effectiveness of a football play is the physical relationship of the individual players. If the blocker is not in the right position to protect the punter, the play will probably fail. If the receiver is not in the predetermined proper place to receive the pass, the play will most assuredly fail. And the defense play will undoubtedly fail if the end is pulled out of position. The physical relationship of the various members of the team constitute an essential part of the play or system and is a prime determinant of the success of the team.

Just as the physical arrangements or lay-outs of the football team are an essential part of the football systems or play, so the physical lay-out of the enterprise is an essential part of the systems of the enterprise. A poor lay-out can seriously impair the effectiveness of the enterprise's operations. The preparation and revision of lay-outs is therefore an integral and essential part of the systems function. No lay-out can be established or revised without a thorough consideration of the systems which will be affected. A new system or a systems revision must always be coordinated with an existing or proposed lay-out.

In this chapter we will deal almost exclusively with the office lay-out, recognizing the fact that the systems analyst attaches no small amount of importance to the factory lay-out. However, the systems analyst is usually more directly concerned with the matter of office lay-outs because most systems and procedures take place in the office. Nevertheless, the lay-out of the manufacturing departments will very frequently have a great effect on the character, costliness, and success of the factory systems. In addition, the location of the offices with relation to the factory operations they serve is of great importance. It is therefore a wise and necessary procedure to require the production engineers to consult with the systems engineers in preparing the lay-outs of the manufacturing departments.

IMPORTANCE OF OFFICE LAY-OUT

The office lay-out is of prime importance to the systems man. Space constitutes a communication obstacle. It costs money to bridge this obstacle by means of forms, letters, phone calls, etc. The physical arrangements of the office greatly affect the number and volume of the media of communication which are required.

Space is not only an obstacle but it costs money in the form of rent and building and plant costs. The more space required for operation of the enterprise's systems, the greater the costs.

The morale and efficiency of the office workers who operate the systems are affected for better or worse by the heating, lighting, ventilation, and visual and acoustical properties of the office. The systems analyst is therefore prompted to insure that these lay-out considerations receive proper attention.

Before considering the detailed mechanics of making an office lay-out, it would be valuable to discuss some of the more general systems principles and problems associated with office lay-outs. (The need for conformance with building and fire regulations is a non-systems consideration which vitally affects office population density, aisle width, exits, etc. These regulations will vary in different communities.)

REDUCTION OF LINES OF COMMUNICATION

A good lay-out reduces communication lines to a minimum and keeps them simple. Straight-line flow of forms, records, etc., with little criss-crossing of items, is desirable. A straight line is the shortest distance between two points and short communication lines reduce operating costs. The less criss-crossing and complications in the communication lines, the simpler and less confusing are the procedures.

CONSERVATION OF SPACE

An effective lay-out should conserve space as much as possible without hindering operations by cramping individuals or departments. When properly done, conservation of space may save an organization large sums of money.

ACCESSIBILITY TO PUBLIC

Offices which require a great deal of contact with the public should usually be located so as to accomplish the following two objectives:

1. They should be conveniently accessible to the public.
2. They should be located so that outsiders are kept away from other departments of the enterprise.

In a manufacturing enterprise, it is therefore generally advisable to have these offices segregated from the factory and located at the main entrance to the plant. Some purchasing, sales, and personnel activities fall in this category.

A student of the author, Lt. Colonel Philip Y. Browning, writes as follows about the effects of ignoring this consideration in the lay-out of temporary army depots in the last war:

> When the U. S. Army constructed their large temporary depots in the Philippine Islands, evidently not much consideration was given to this factor of physical layout because the local issue sections were generally located in the center of the depots instead of at the entrances. As a result all agencies drawing supplies had to enter the depot to transact their business. Due to security difficulties, traffic problems, division of workers, etc., this plan of operation was ineffective. In addition, the systems that had to be established to take care of the situation became very involved, burdensome, and costly. As a result, the physical layouts were eventually corrected where possible.

It is believed that this additional cost and effort would have been avoided if this factor had been originally considered.*

As corollary to the two previous statements, units performing secret work, or activities which it is desired to keep from the public, should be located far from the functions requiring public contact. These secret activities should be kept away from the public thoroughfares as well.

ORGANIZED ABOUT IMPORTANT FLOWS

The office lay-out should be built around the major flows of work. The minor activities should be grouped around the major functions. This increases the flexibility of the lay-out so that, when more space is required, the minor activities can be shifted to provide more space for the major function. Thus, the space arrangement and relationships of the major units would not be disturbed.

FLEXIBILITY

An office lay-out should be flexible. The partitioning arrangements should be planned to allow for maximum relocability. The use of standard movable partitioning units will reduce the cost of such changes as are nevertheless required.

Expansion plans should be forecast as much as possible. Allowances for such changes in lay-out should then be made to reduce the extent and cost of interim moves to a minimum. It might thus not be desirable to place next to each other two large departments which were expected to expand.

Another consideration which may seriously affect the flexibility of a lay-out is the amount of special wiring, plumbing, ventilation, or other special facilities which are required by the departments. Moving these facilities is very expensive. Such departments should therefore be placed so that their expansion needs can be met without relocating. They should not be located adjacent to each other because such an arrangement surely restricts the possibilities of caring for expansions without relocating at least one of them.

PROXIMITY TO UNITS BEING SERVICED

Offices which coordinate and service the operations of units of the enterprise should be located as close as possible to the units they con-

* From a paper prepared in connection with the author's graduate course at the College of Engineering, New York University.

trol or service. Space constitutes an obstacle to effective coordination and should therefore be minimized.

In a manufacturing enterprise, for example, the production-control activity should be located close to the shops whose activities it controls.

For similar reasons, the offices of the executives who control the operations of various offices should be placed close to the offices they supervise. The closer the executive is to the offices he controls, the greater the ease of supervision.

PROXIMITY TO RELATED UNITS

Departments that have the greatest amount of cross-communication of information should be placed closest to each other. To reduce the work flow to a minimum, departments that work closest with each other should be located in adjacent areas. The receiving and incoming material-inspection departments might be a good example of these related activities in one enterprise.

PRIVATE OFFICES

A private office may be defined as an enclosed work area for one individual, sometimes including his secretary. The private office problem must be successfully solved if the office lay-out is to be effective. This is a very touchy subject and requires much tact if some individuals are not to be offended.

The private office problem may be divided into two parts: the determination of a private office policy—establishing the criteria for ascertaining who should have private offices; and the application of the policy actually to name the positions which are eligible for private offices. Both of these aspects are of equal importance to the successful solution of this problem.

Many office planners advocate a reduction in the number of private offices. They claim numerous advantages for open, unpartitioned work areas for clerical, administrative, and supervisory personnel. What are some of these advantages?

1. Lower costs. Less space is required per person when open areas are used instead of private offices; more office equipment may be shared; partitioning and, in many cases, heating, lighting, and ventilating facilities are cheaper when open areas are used.

2. Greater flexibility. Rearrangements may be more easily made to take care of changing conditions when open areas are used.
3. Better lay-outs possible. Open areas are more readily arranged to provide effective communication and most direct flow of work.
4. Reduced time waste. Unnecessary visiting may sometimes be reduced.
5. Ease of supervision. In many instances, supervision and control may be exerted more effectively in open offices.

Despite the foregoing advantages of *open office areas,* there are many situations which call for private offices. *Private offices* possess many advantages:

1. Secret work. A person performing confidential work may require complete privacy.
2. Freedom from noise and distraction. A person who performs work requiring a high degree of concentration may be more effective in a private office.
3. Facility for contacts. When an individual must be in frequent contact with various inside or outside persons, the privacy of an enclosed office may be desirable to facilitate interviewing as well as to avoid distracting other employees in an open office.
4. Comfort, prestige, and morale. By adding to his comfort, increasing his prestige, and improving his morale, a private office for a supervisor or technical man may well pay for itself many times over.

Two devices have been used rather widely to reduce the number of required private offices.

The use of conference rooms possesses an advantage over the private offices in the ease of terminating interviews. They are at a disadvantage when extensive reference material is required for the interviews. In addition, all available conference rooms might be in use on some occasions when an executive required one.

Most of the advantages of the open office are gained by the use of an open area with railing separating each individual. These give prestige and a good deal of privacy and are especially to be recommended when the individuals must consult frequently with each other.

In establishing a private office policy, it is desirable to base eligibility for a private office on needs as well as rank. All persons above a certain relatively high rank would automatically be eligible. Positions below this rank would be analyzed in the light of some of the advantages previously presented:

Is an unusually high degree of concentration required?

Does the person perform a part of an operation sequence which would be slowed down by a private office?

Are contacts with employees or outsiders frequent?

Is the work very confidential?

WORKING CONDITIONS

A good office lay-out should provide desirable working conditions which will reduce strain and fatigue and maintain high worker efficiency. The selection and arrangement of office space and partitioning, the specifications for heating, ventilation, lighting, and decorations, and the acoustic treatment of the walls and ceilings should be arranged to promote the comfort and productivity of the worker.

PERSONALITY BIASES

Personalities should not be allowed to enter into the lay-out determination. The guiding principles should be maximum economy for the total organization and the best possible working conditions for the most people. Not only will this reduce costs, but it will render the lay-out more stable: changes in personnel will not be as likely to require alterations in the lay-out.

SYSTEMS INFORMATION

The initial step in applying these general principles of good office lay-out is the acquisition of a basic knowledge of the operations performed in the departments involved. Although a complete and detailed systems analysis would be very helpful in planning the best lay-out, it is possible to do a good lay-out job with a little less information when the time is not available for the detailed survey. In all cases, it is desirable to ascertain the following information:

1. Nature and flow of work in each department.
2. The flow of work between departments and sections.
3. The organizational locations and responsibilities of each organizational unit.
4. The relative importance and criticality of the work of each unit to the fulfilment of the objectives of the enterprise.
5. Which time cycles are most important.

6. The number of persons performing the various categories of duties in each organizational unit.
7. The kind and quantity of office equipment and machinery required in each unit.

LAY-OUT OF PRESENT ARRANGEMENT

If a rearrangement is under consideration, it is generally desirable to make a lay-out of the existing arrangement. This will usually materially help in planning an improved lay-out. It will aid in determining required areas and clearances, expansions and contractions, and the flow of work. Proposed changes can be more readily compared with the existing situations. Most important, a Lay-out Flow Chart of the existing arrangement can be constructed. This will help disclose where improvements can be made.

SPACE REQUIREMENT STANDARDS

To allocate floor areas intelligently for the various offices of the enterprise, it is first necessary to estimate the square-footage requirements of each office. When the problem is to rearrange a functioning office which is already fully staffed with equipment and personnel, then the existing areas, modified by the estimated effects of proposed changes, may be used as a basis for estimating space requirements.

As a check on present space utilization practice and as a tool for estimating space requirements for entirely new offices, various types of space standards have been suggested by different office surveys and planners. Moreover, these standards are materially affected by numerous factors such as the nature of the work and equipment used, the shapes of the available office spaces, the organizational structure, and the private office policies of the company.

Various authorities offer differing standards for square-feet usage of office space. Mr. K. H. Ripnen, who has done considerable work on office planning, suggests the following standards: *

For each individual in the office, allot an average of 100 sq. ft. per person.
For each major executive private office, allot 400 sq. ft.
For each subexecutive, allot 200 sq. ft.
For each conference room for 10 to 12, allot 600 sq. ft.
For each reception room, allot 600 sq. ft.

* Kenneth H. Ripnen, "Space Standards in the Office Layout," *Office Equipment Digest,* Nov. 1942.

For each interviewing room, allot 200 sq. ft.
For each central active file department, allot 5 sq. ft. per file.
For each inactive file department, allot 3½ sq. ft. per file.
The average of 100 square feet per person for office workers provides for office corridors; elimination of office corridors cuts the average to 80 square feet per person.

Whereas Mr. Ripnen gives standards for over-all planning, Mr. R. L. Foster gives detail requirement standards which must be applied on the basis of the functional needs of the organization. These are shown in Figure 38.

Surveys have been made at various times to determine actual space usage per person. Although the area required for an individual may vary from 50 to 500 square feet, an average of 100 square feet per person is sometimes used as an over-all average figure for large companies.

A survey of office space usage which was made in 1932 by Management Methods in cooperation with the National Office Management Association, disclosed the following practices in gross space usage per person: *

	Square feet per person		
Line of business	*Average*	*High*	*Low*
Manufacturing	106	402	36
Wholesale	77	163	67
Life insurance	177	416	84
Fire insurance	104	111	103
Banks	120	281	89
Financial	97	136	67
Railroads, utilities	99	153	72
Merchandising	110	118	101
All	127	416	36

ESTIMATING SPACE REQUIREMENTS

A plan is briefly described here for estimating approximate space requirements, using standards such as those just presented, and without reference to any existing lay-outs. This analysis should be made separately for each department to obtain departmental estimates. Adding up the departmental requirements gives the total required office area.

The first step is to establish personnel space grades and space stand-

* "Yardsticks of Business Practice." (Pamphlet), Management Methods, Chicago, Dartnell Corporation.

SPACE REQUIREMENT KEY

ASSIGNMENT	SQ. FT.	ACCOMMODATION
A - Executive Office	Variable	
B - Private Office	225	Functional privacy of one employee using table for conference meetings
C - Private Office	150	Secretary requiring private office. Allowance made for filing equipment.
D - Private Office	125	Functional privacy of one employee using desk and table as a working unit. (Allowance made for side chair and one file)
E - Private Office	100	Functional privacy of one employee with the minimum of furniture. (Desk - Swivel chair - Side chair)
F - Semi-Private Office	225	Functional privacy for two employees using two desks and two tables (Allowance made for two files and bookcase or similar equipment)
G - Semi-Private Office	200	Functional privacy for two employees using two desks and sharing one table (Allowance made for two files or similar equipment)
H through S - General Office		See template layout. Allowance made for aisles in all areas shown. Include any additional equipment under "Equipment" section
Equipment	Actual Measure *(including necessary work area)*	Extra furniture, filing equipment, coat racks, etc., not included in above
Conference Room	285	To accommodate 10-12 people (48" x 144" table)
Conference Room	225	To accommodate 8 people (42" x 96" table)
Conference Room	180	To accommodate 4-6 people (36" x 60" table)
Other Areas	Actual Measure	Reception, waiting or other similar areas; utilities; Corridors.

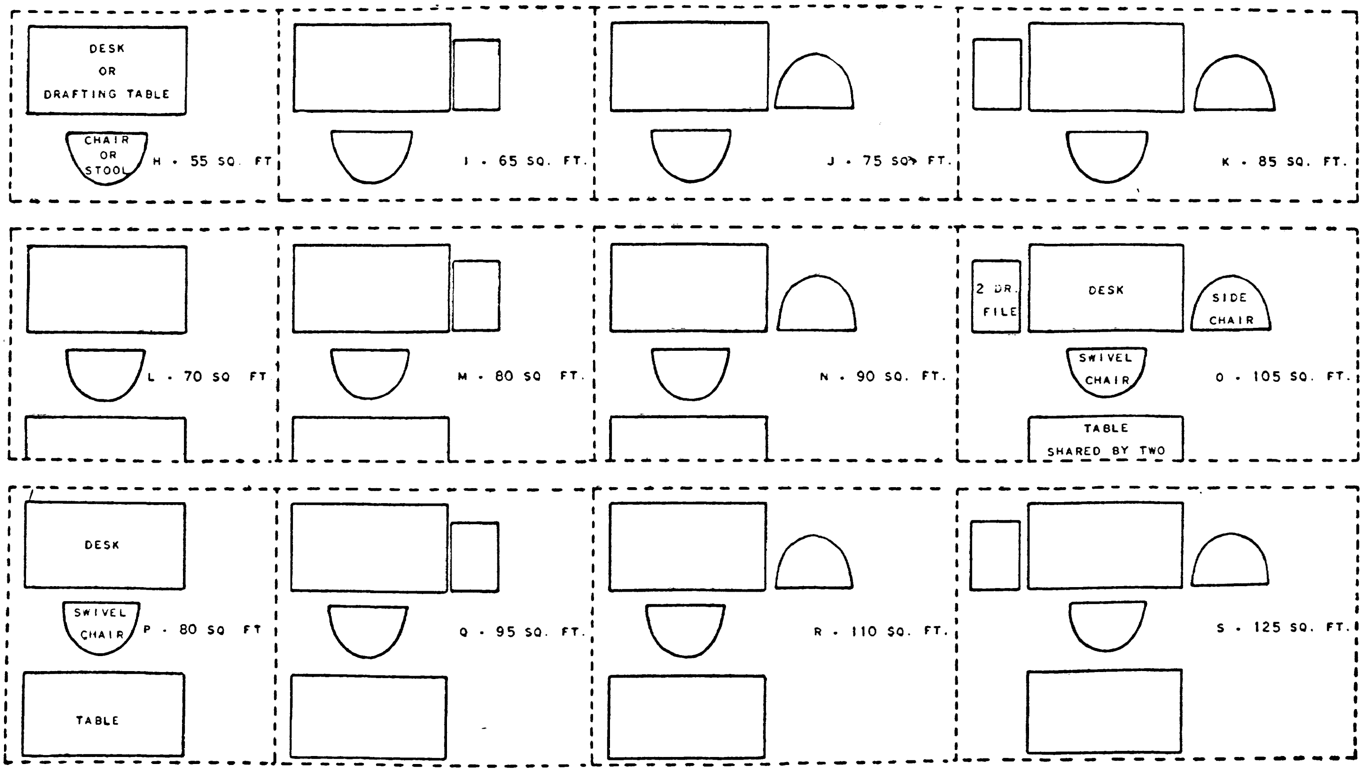


Figure 38. Space requirement standards based on functional needs.

ards for each grade. The space standards are prepared from area data such as were presented in the previous section, modified in accordance with company policy and/or past practice. For the company being considered, the standards shown in Table I were adopted.

TABLE I. STANDARDS FOR PERSONNEL SPACE CATEGORIES

Category	*Description*	*Square Feet*
I	Private office for top executive	350
II	Private office for division manager	300
III	Private office for department head	200
IV	Open space for department head	150
V	Open space for supervisory employee	100
VI	Open space for secretary	70
VII	Open space for clerk with large desk	50
VIII	Open space for clerk with small desk	45

In the preliminary survey prior to attempting a lay-out preparation, the number of persons in each category as well as the kinds and quantity of equipment used were determined. The estimate of space requirements is then computed by multiplying each space standard by the number of persons in that category and summing the products, as shown in Table II. Special personnel who do not fit in any of the standard categories are handled separately on a special listing (Sheet A) and then added. In addition, the space required for equipment other than standard furniture must also be estimated separately (Sheet B). Sheets A and B are not shown.

TABLE II. WORKSHEET SHOWING COMPUTATION OF SPACE ESTIMATE—DEPARTMENT Y

Category	*Standard (sq. ft.)*	*No. of Persons*	*Total (sq. ft.)*
I	350	0	0
II	300	0	0
III	200	1	200
IV	150	0	0
V	100	6	600
VI	70	8	560
VII	50	27	1350
VIII	45	42	1890
Other (See attached Sheet A)*		3	780
Special equipment (See attached Sheet B)*			290
	Total		5670

* Not shown here.

Space for various service areas must also be considered in estimating total square-footage requirements. Some of these are:

1. Coat rooms. Aisles should be at least 4 feet wide; wider if the open coat rod and hat shelf extends more than 12 feet.
2. Locker rooms. Six-foot aisles should be allowed for 12-inch lockers and 7 feet for 18-inch lockers.
3. Conference rooms. One which will accommodate about a dozen persons should occupy about 600 square feet; 12 by 16 feet is the minimum size for one with a 4-by-8-foot table.
4. Storage rooms:
   a. Stationery and office supplies. Minimum of 3-foot aisles between open shelving.
   b. Inactive transfer files. Minimum of 4-foot aisles.
   c. Inactive records, binders, etc. Minimum of 2½-foot aisles between open shelving.
5. Others. Vaults, showrooms, reception and interviewing rooms, rest and recreation rooms, mailrooms, telephone switchboards.

FORECAST OF FUTURE REQUIREMENTS

After determining the present area requirements, future expansion and contraction requirements should be predicted. One guide in making such forecasts is the rate of increase in volume of work over the past years. Top management plans for the enterprise and possible systems and organizational changes are other factors to be considered in these estimates. The lay-out can then be designed so that it may be adjusted to the forecasted requirements with minimum disruption.

FLOOR PLANS

Having estimated the present and future space requirements of each of the offices, it is necessary to prepare or obtain floor plans, drawn to scale, of the available space. Floor plans are prepared to scale, showing walls, doors, windows, columns, telephone and electrical outlets, permanent partitions, radiators, and all other building features which might affect the lay-out.

Scale. The scale to use in constructing a lay-out plan depends on the sizes of the areas being considered. A scale of four feet to the inch (¼ inch to the foot) is commonly found convenient. It is understandable and allows enough space for most required identifying notations.

However, if the area is very large, this small-scale ratio may make it difficult to get an over-all view of the lay-out. In that case, eight feet to the inch (⅛ inch to the foot) or, in some cases, an even higher ratio may be used.

ALLOCATION OF AREAS

The analyst must now allocate the available areas amongst the various departments. Using the principles developed in the early part of this chapter, the areas are allocated and reallocated to the various departments. Since there are numerous possible ways of allocating the areas, the tentative assignments are juggled around continually until, by trial and error, the best possible departmental arrangement is obtained.

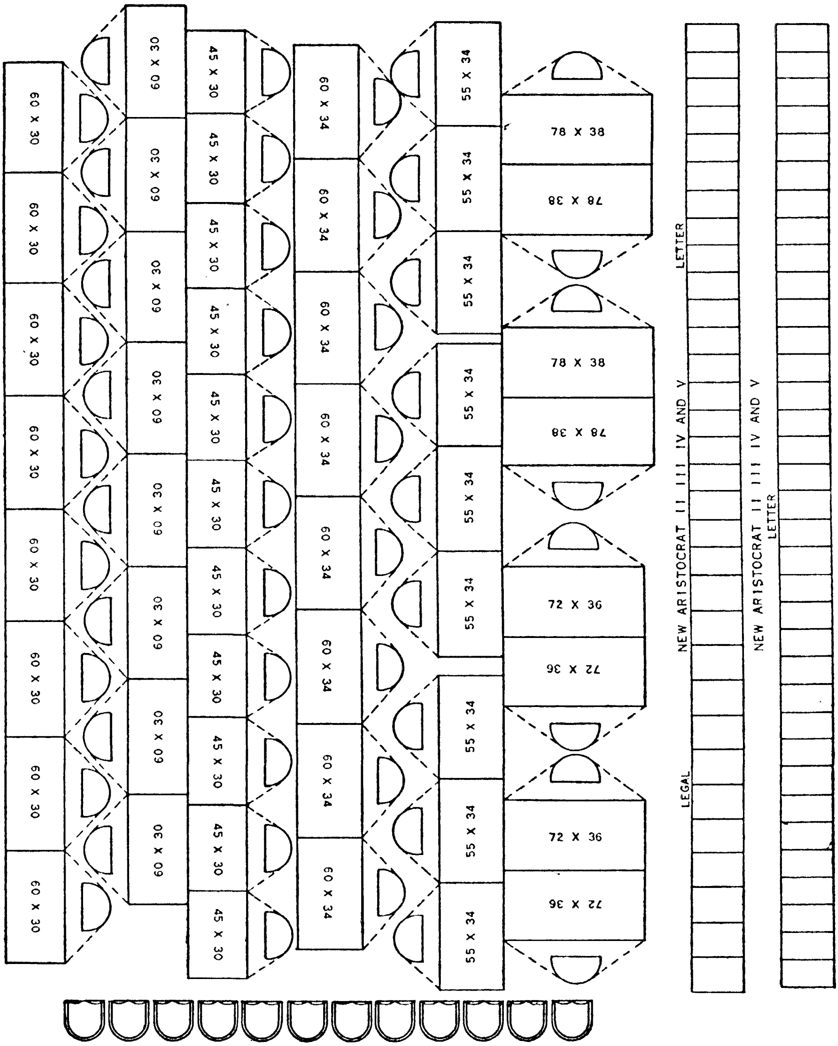
One factor not previously mentioned might influence these space allocations. When certain areas do not have good natural illumination, it is preferable to assign them to activities in which natural light is relatively unimportant. Examples of these are lunchrooms, washrooms, locker rooms, rest and recreation rooms, coat rooms, reception rooms, telephone switchboards.

PREPARATION OF LAY-OUT

After the available areas have been allocated to the departments, the partitioning and the lay-out of the furniture and equipment of each office within each department may proceed.

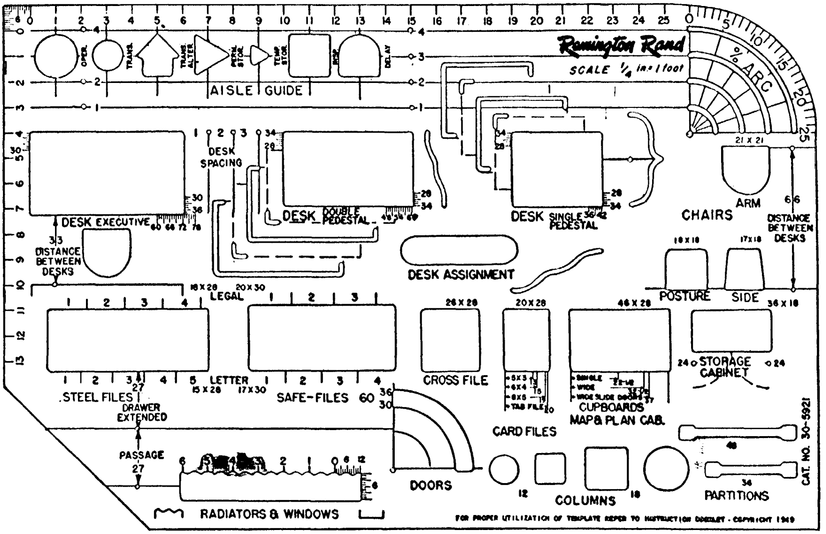
An outline or template, cut to the same scale as the floor plan, is made for each piece of equipment and furniture used. These templates can be home-made from heavy paper or light cardboard or can be purchased ready-to-cut in a form such as shown in Figure 39. When the outlines are home-made, a template such as is shown in Figure 40 may be used sometimes to simplify the drawing of the equipment outlines. It is well to have the templates cut from a color which contrasts with the floor plan color. In addition, different colors are sometimes used to differentiate between types of equipment or departments.

If the lay-out is to be reproduced by photographic methods and color distinctions are desired, the color scheme should be carefully selected so that the various colors produce different shadings when photographed. In addition, a color filter should be used to increase the contrast.



Courtesy Remington Rand, Inc.

Figure 39. Templates such as these are printed to scale on heavy stock paper or cardboard and can be cut out for use in lay-out planning.



Courtesy Remington Rand, Inc.

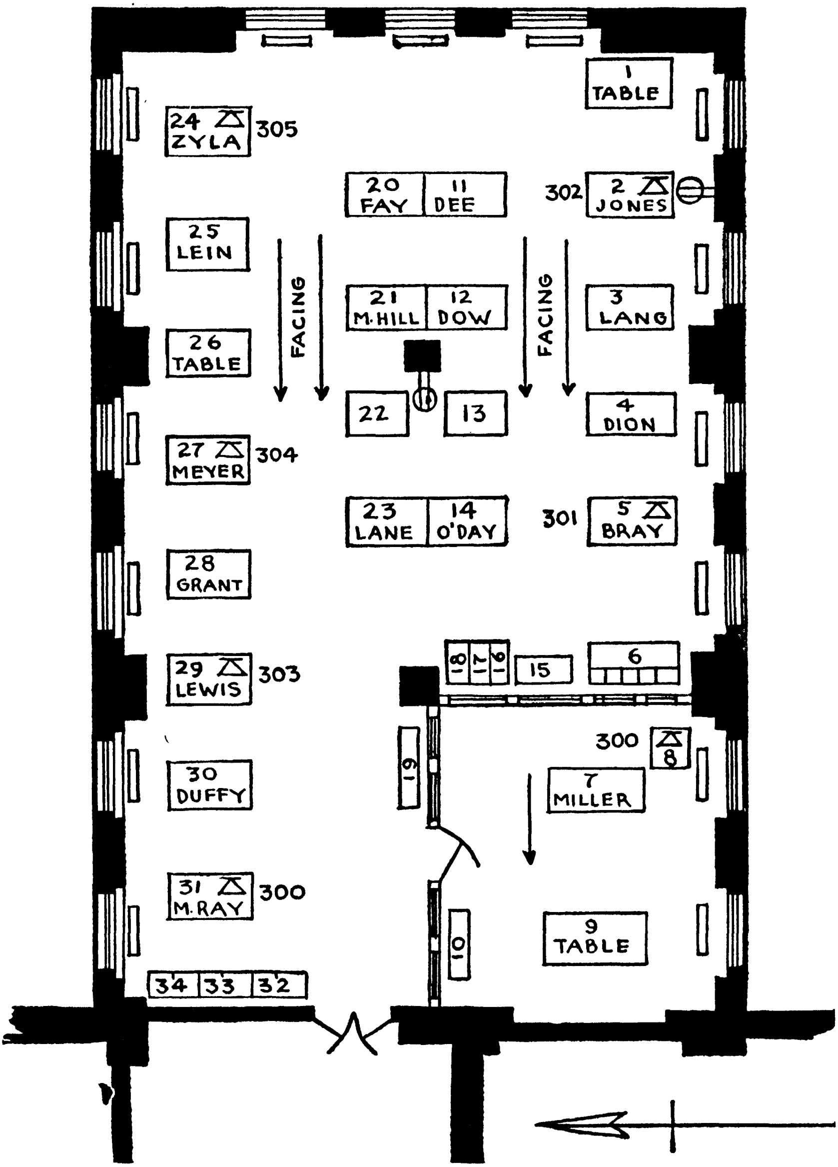
Figure 40. Stencil Lay-out Template with punched-in guides: convenient for drawing standard office furniture and equipment on lay-out plan.

Before these templates can be prepared, it is necessary to have a complete list or inventory of the furniture and equipment going into each department. This list should contain an accurate description of the equipment, with dimensions, as well as the quantities. Ready identification of the equipment is promoted by having each item numbered with a tab.

The identification number of the furniture and equipment is written on the template. In addition, the name of the person using the item is frequently indicated. The templates may best be attached to the floor plan by a rubber cement. This facilitates relocations and changes in the lay-out because the template can be easily removed from the floor plan.

A lay-out of a small office is shown in Figure 41. To avoid serious errors in laying out the office furniture and equipment within departments such as this, consideration should be given to the following points:

1. In arranging open offices, aisle spaces may vary from three feet and up, depending on importance: main aisles will usually be five feet or over, depending on the volume of traffic and fire regulation requirements. When files or other equipment open toward an aisle, the aisle space should be calculated with the equipment fully extended.



Courtesy Policyholders Service Bureau, Metropolitan Life Insurance Company

Figure 41. A template lay-out of a small office.

2. The chair area behind each desk should be at least two and one half feet. When several desks are lined up in a row, this passageway (from the back of the rear desks to the front of the forward desks) should be at least three feet.

3. To enable each person to get to his desk without disturbing anyone else, it is preferable not to set more than two desks in a row. When more than five or six are lined up, the amount of disturbance will usually become acute.

4. In arranging coat rooms, locker rooms, conference rooms, and storage rooms for stationery and office supplies and inactive files and records, the minimum aisle widths mentioned in the section on estimating office space requirements should be observed.

5. Whenever possible, files should be located against walls or as aisle guides. To reduce the strain on the beams, heavy safes should be placed as close to columns as possible.

6. Persons having most contact with other departments should be nearest the door.

7. Wherever possible, persons performing fine, close work should be placed closest to the windows or other source of natural light.

8. It is preferable for all employees in an office to face in one direction, with the light coming over the left shoulder or from the back. For typists, the light may also come over the right shoulder. Placing the back of a desk directly against a wall is undesirable.

9. Adequate exits should be provided from all partitioned areas.

THE LAY-OUT FLOW CHART

The Lay-out Flow Chart, such as shown in Figure 42, consists of a simple lay-out plan on which the principal flows of work have been indicated in colored pencil or crayon.

When the Lay-out Flow Chart shows considerable criss-crossing of flow lines or indicates long transportations, an intensive study should be made to ascertain if rearrangement would improve the situation. Figure 43 shows how rearrangement can simplify and shorten the flow lines of the office previously presented.

SCALE MODELS

Planning office lay-outs with scale models, such as shown in Figure 44, has some advantages. Placing scale models on a floor plan of the office areas aids in visualizing changes. It is particularly useful in conference planning sessions when models can be moved around to see the resulting office. The finished lay-out can be photographed.

OFFICE ENVIRONMENT

Proper partitioning, good lighting, effective ventilation, low noise level, and pleasant interior decoration all contribute to an effective lay-out. All of these factors are interrelated and all are important in the maintenance of proper office environment. In preparing an office lay-out, the analyst must, in some cases, give considerable attention to problems associated with these factors. These problems are in specialized technical fields and it will usually be valuable to consult specialists in each field. The local lighting company, for instance, will usually supply a competent lighting consultant without charge.

Partitioning. The type of partitioning used affects the flexibility of the lay-out as well as the lighting, ventilation, noise levels, interior decoration, and the privacy of the offices.

Lighting. The quantity of light, its color, source, and direction, as well as the shadows and glares produced, are all important aspects of the lighting problem.

Ventilation. Controlling the temperature, humidity, and airflows in the office is a technical problem which vitally affects the well-being and working comfort of the staff. In addition to maintaining uniform and proper temperature and relative humidity levels, the introduction of clean air, its circulation without drafts, and the emptying of the exhausted air must be accomplished economically.

Acoustics. Reducing the noise produced by office machines and personnel, keeping out noises originating elsewhere, and deadening the existing noises are the three principal aspects of noise control.

Interior Decoration. Although related to esthetics and taste, this aspect is closely associated with the lighting and acoustic treatment of the office. The different colors reflect varying amounts of light from walls and ceilings. Since hard, glazed surfaces reflect sound very readily, the use of soft drapes will materially reduce the noise level in many offices.

LAY-OUT IS PART OF SYSTEM

A new lay-out is generally an integral part of a whole new system. This new system must be sold to the supervisory and operating personnel as well as to top management; its installation must be planned

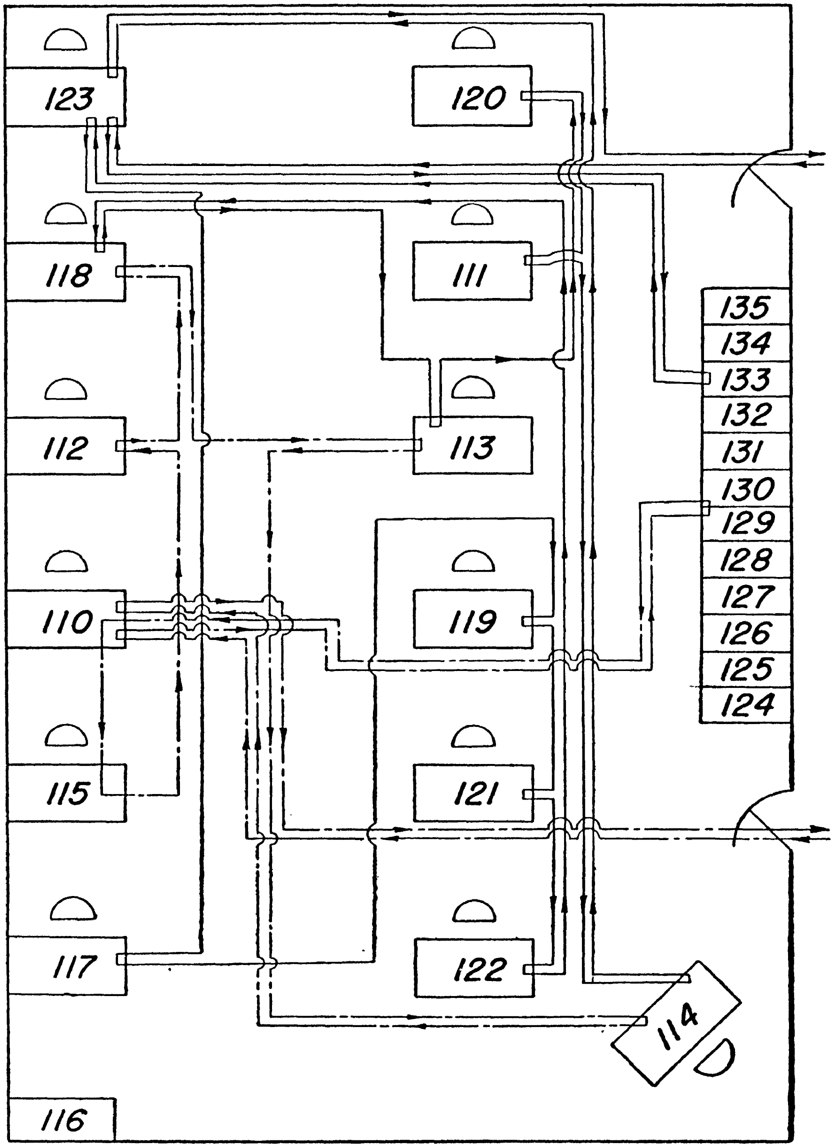


Figure 42. Lay-out Flow Chart of a small office—indicates tortuous paperwork flows for both of the procedures (one indicated by solid and one by dashed lines).

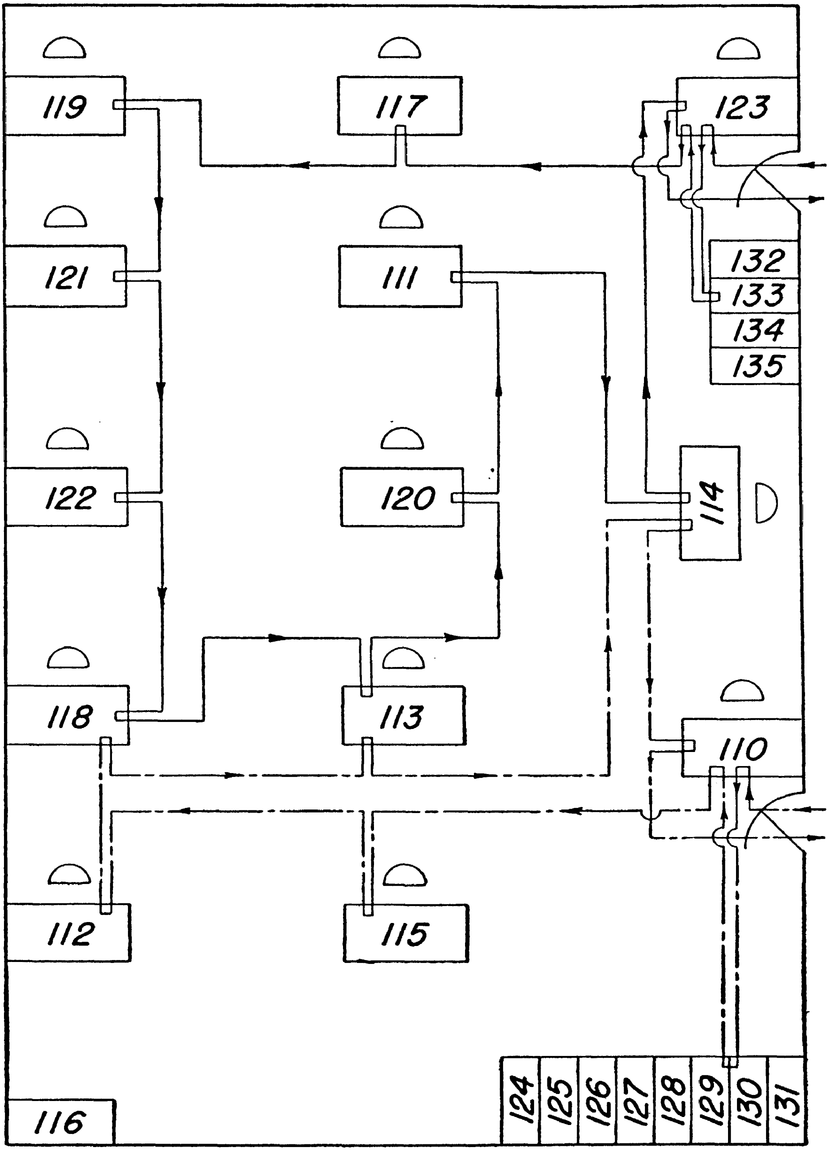
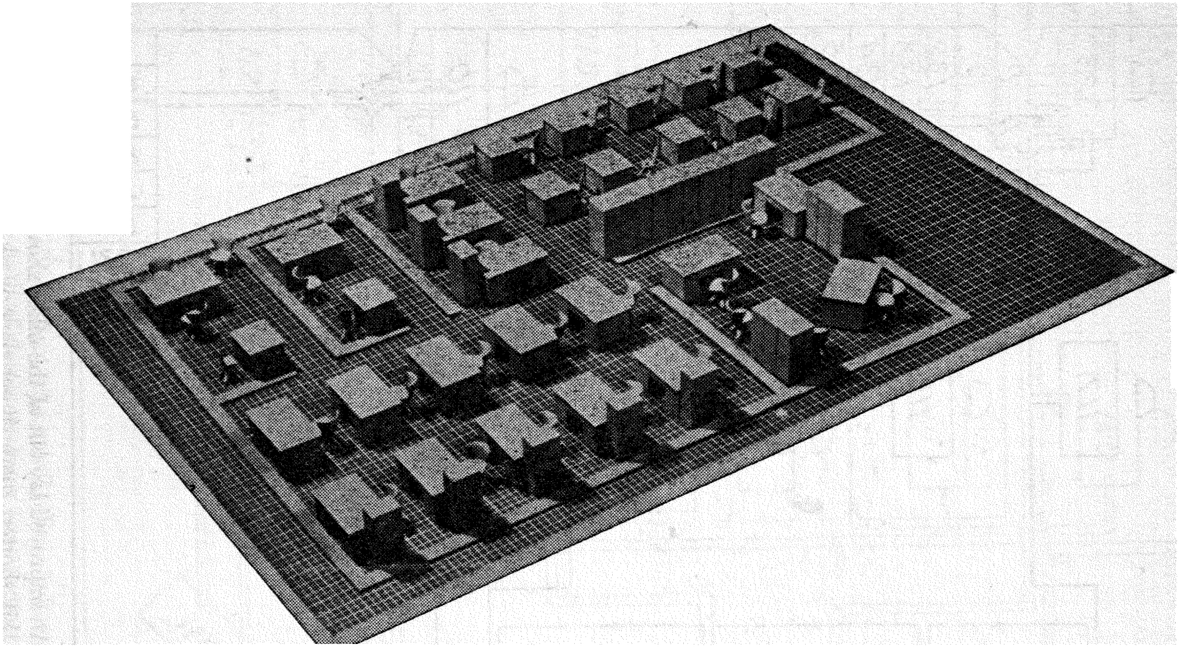


Figure 43. An improved lay-out of the office shown in Figure 42 has resulted in this shorter, more direct paperwork flow for each procedure.



Courtesy Visual Production Planning Inc.

Figure 44. Three-dimensional models of office furniture and equipment provide a way of getting a better visual picture of a lay-out.

in detail in advance so as to disrupt normal operations as little as possible (the timetable for rearranging the offices may be spread over a relatively long period in order to accomplish this); and follow-up activities must insure the proper functioning of the new system in accordance with plan. These selling, installation, and follow-up activities are described in later chapters.

VII

ANALYZING THE MOTION ECONOMY

SO FAR we have considered methods of analyzing the broad systems flows, the allocations of activities and functions amongst the various departments of the enterprise, and the methods and considerations involved in preparing office layouts. These techniques are applicable to the analytic problems covering fairly wide scopes of activity.

When these broader details of the business's operations have been established on a sound basis, the analyst will want to turn his attention to problems involving studies of smaller units of activity in much more refined detail. He will want to consider methods of improving one individual step or operation in the procedure which his previous anlyses have determined was necessary.

Two tools for making these more detailed analyses are known as motion study and micromotion study. These tools are especially valuable in analyzing operations involving considerable hand and body motions. The essential difference between motion and micromotion study is a matter of refinement. Micromotion study involves the break-down of the units of motion into such small elements that motion-picture equipment is required in making the analysis.

Motion study can be a valuable technique for reducing effort, increasing productivity, and lowering costs. Its goal is to enable the employees to perform the operation under analysis more times with less interruption, less effort, and less fatigue.

Before discussing the analytic charting technique which is used in motion and micromotion study, it would be well to consider certain basic principles which have been found very effective in promoting motion economy—in reducing the time required for the performance of clerical operations. These principles are based on the work of many men and women who have labored many years in the field of motion economy. One of the first and most valuable formulations of the rules for motion economy was developed by F. B. Gilbreth a number of years ago. The principles stated below are based on his work as well as the work of the many additional men who have labored so productively in this field.

The motion-economy principles presented below describe the conditions under which clerical operations can be performed for the longest periods of time with the least effort and fatigue and consuming the shortest average time. They are goals which the analyst should keep in mind at all times when searching for methods improvements. It is not possible to apply all these principles to all operations all the time. However, to achieve maximum motion economy, the analyst must constantly apply himself to produce motion patterns conforming to these rules as closely as possible.

PRINCIPLE NO. 1

Work should be performed with both hands which should begin and end each element of motion simultaneously, and these simultaneous motions should be in opposite and symmetrical directions wherever possible.

The term "element of motion" is subject to varying interpretations, depending on the fineness of the break-down, but the rule applies to all break-downs. Thus, reaching for a piece of paper may be one element, grasping the paper a second element, carrying the paper to a point in front of the worker a third element, etc. If analyzed in more detail by micromotion photographic study, this element of grasp might be seen to contain four micromotion elements: search for the sheet, find it, select it, and grasp it. In both of these analyses, it is desirable that both hands begin and end each element of motion simultaneously. The finer the analysis, however, the greater the possibility for economy.

The hand and arm motions in addition should be in opposite and symmetrical directions because, in this way, the best physical and mental balance is obtained.

The desirableness of these principles can be demonstrated somewhat simply by the exercises illustrated and described in Figures 45–48.

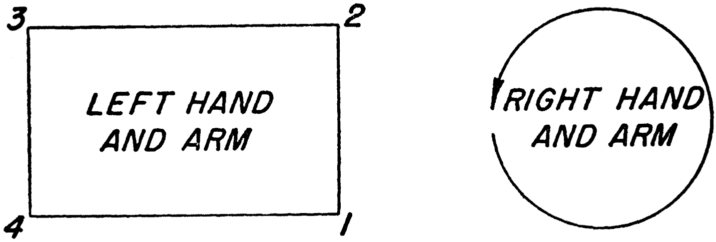


Figure 45. Motion Pattern: the right and left hands do not have the same pattern.

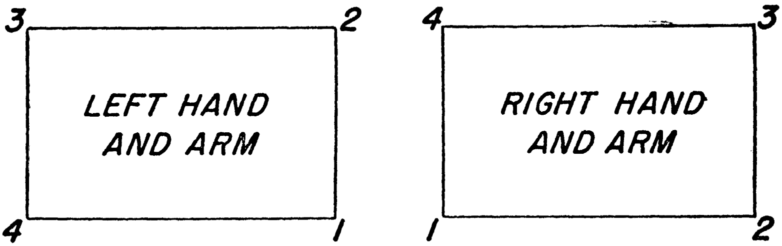


Figure 46. Motion Pattern: the same but out of phase.

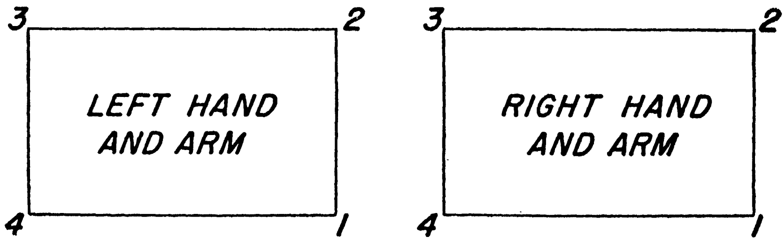


Figure 47. Motion Pattern: symmetrical but not opposite, thus throwing the body out of balance.

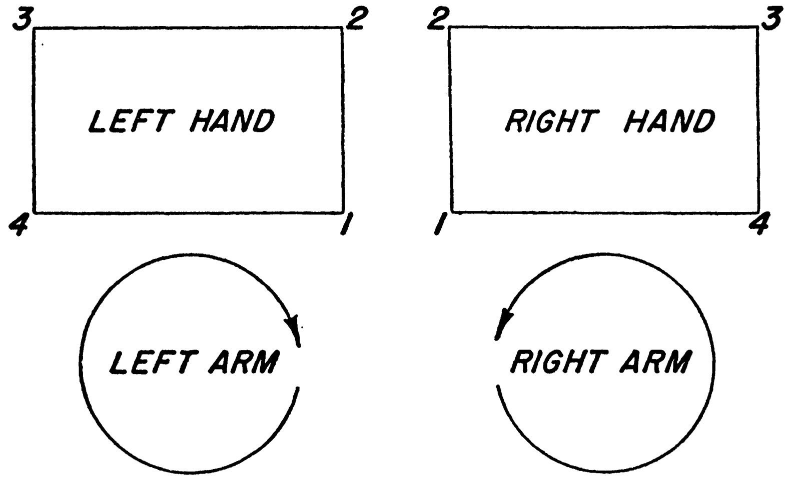


Figure 48. Motion Pattern: opposite and symmetrical.

Compare the facility of performing these motion patterns.

Sometimes it is impossible to arrange the work so that the arms move in opposite and symmetrical directions. In these cases, it is more desirable to arrange it so that they move in perpendicular paths rather than in the same direction.

One further point to remember is that when either hand holds the work or is idle, this first principle is violated. The motion economy is improved whenever this can be avoided by the use of fixtures to hold the work and proper arrangement of the work elements to eliminate idle hands.

PRINCIPLE No. 2

The activities at the work place should be arranged to provide a smooth flow in the shortest line of motion with the simplest and fewest motion elements.

A corollary to this principle is that the last element of motion in the cycle should be adjacent to the first element.

This is a most fundamental rule for economy of movement requiring consideration of three aspects of the elemental motions: elimination of unnecessary elements; simplification of necessary ones; and re-arrangement of the necessary ones so that the simplest, smoothest and shortest sequences of a repetitive cycle result.

PRINCIPLE No. 3

Free, rhythmic, curved motions are preferable to controlled motions which require sharp changes in direction.

Rhythmic curved motions take less time and are less fatiguing than motions requiring abrupt changes in direction. Thus, if the right hand must pass through points A, B, and C shown in Figure 49 it is preferable to have a circular rhythmic motion than an abrupt angular one, even though the distance is smaller using the triangular path:

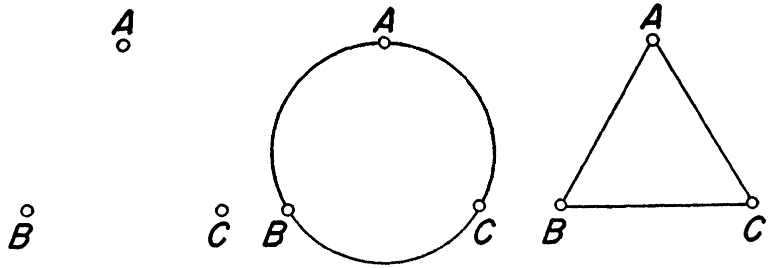


Figure 49. Motion Pattern: when the hand is to pass through points A, B, and C shown at the left, the circular motion pattern shown in the center is preferable to the angular motion pattern shown at the right.

In using this free, rhythmic pattern, several factors should be kept in mind. The opposite of a free motion occurs when you have opposing sets of muscles contracting against each other to give controlled motion (one set of muscles overbalances the other). When, in writing, the pencil is held between the index finger, middle finger, and thumb, the finger muscles oppose each other and more fatigue is produced than when the pencil is held in a freer position between the middle and forefinger. In the free and easy swing of a golf club, the contraction of single muscle groups is not opposed by the antagonistic opposing muscles. This free swing is stopped by the dissipation of the momentum of the movement when it hits the ball and continues its motion, or it could be stopped by contraction of the opposing muscles (losing the free motion). It is preferable to arrange the work so that the momentum is not opposed by the worker, but, as much as possible, follows the direction of the desired motion.

Professor Barnes, in his excellent text on motion and time study, illustrates very effectively the importance of continuous curved motions in his description of old and improved methods of folding paper.*

Old Method of Folding Paper. The worker, holding a smooth piece of bone in the palm of her right hand [see Figure 50], grasped the lower

* Reprinted by permission from *Motion and Time Study*—3rd ed. by R. M. Barnes, published by John Wiley & Sons, Inc., 1949.

right hand corner A of the sheet of paper to be folded. She folded this end of the sheet over to point B, where the two hands matched or lined up the two corners of the sheet of paper. Then, swinging the right hand away from the body and using the bone as a creasing tool, she struck the folded sheet of paper about mid-point at C, creasing the fold from C to D. At D she stopped and changed direction abruptly, doubled back, creasing the entire length of the fold from D to E. At E the hand again changed directions and swung around to F, where the end of the bone was inserted under the edge of the creased sheet to assist the left hand in disposing of it on the pile of folded sheets at G.

Improved Method of Folding Paper. In the improved method the worker grasps the lower right-hand corner A of the sheet of paper to be folded [see Figure 51]. She folds this end of the sheet over to point B, where the two hands match or line up the two corners of the sheet of paper. She then moves the right hand through a smooth S curve, the bone striking the paper and beginning to crease at X and ending at Y. Thus the entire crease is completed with the single stroke of the bone. The hand then swings around in a curved motion from Y to Z, where, as in the old method, the end of the bone is inserted under the creased sheet to assist the left hand in disposing of it on the pile of folded sheets at G.

Results. By using the improved method described above only one creasing motion was required to complete the cycle instead of the two (one short and one long one) in the old method. Moreover, in the improved method two curved motions of the hand were used instead of two complete change directions and one 90° change direction in the old method.

A micromotion study of these two methods shows that 0.009 minute was required to crease the fold by the old method and 0.005 minute by the improved method. The improved method of creasing the fold, plus some other changes in the cycle, reduced the total time from 0.058 to 0.033 minute per cycle.

Principle No. 4

Required muscular effort should be reduced to a minimum by keeping tools as light as possible, sliding small objects, and using gravity-activated devices to deliver and dispose of materials whenever possible.

Adherence to this principle reduces the work involved in an operation by disposing of finished work by dropping into a container; by using small, economically designed portable equipment and tools made of light materials; by pushing and sliding small materials and tools rather than picking them up.

Principle No. 5

Account should be taken of the inherent abilities and disabilities of all the parts of the human body.

Many of these abilities and disabilities are not fully known and rec-

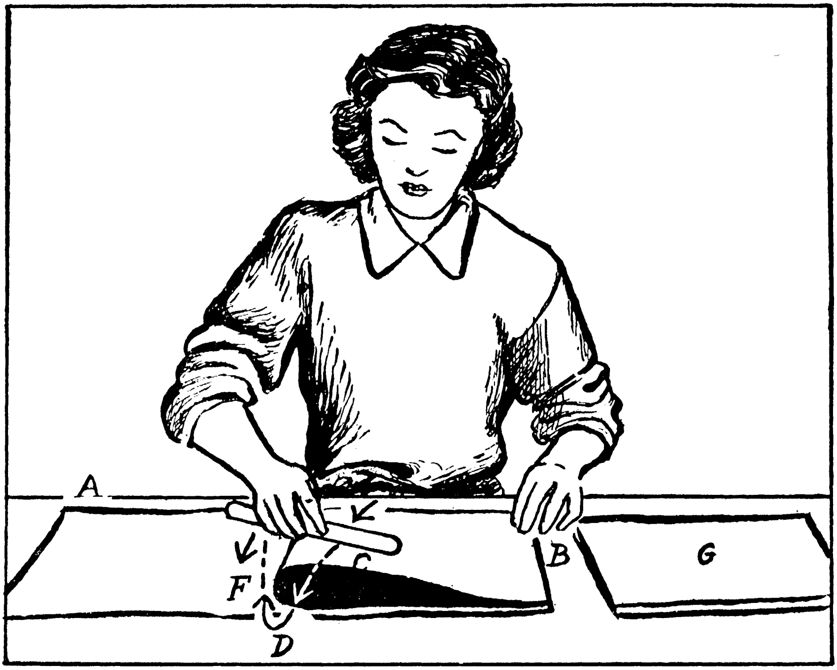


Figure 50. Path of hand in creasing folded sheet of paper—old method. Two fold. In Figure 51, the improved method, a smooth "S" curve made by the by permission from *Motion and Time Study*—3rd Ed., by R. M. Barnes,

ognized at present. Much productive research can and undoubtedly will be done in this field in the near future.

It is usually considered desirable to restrict motions to the lowest of the following numbered parts of the body as much as possible:

1. Finger
2. Wrist
3. Forearm
4. Upper arm
5. Shoulder

Thus motion patterns involving fingers alone have been considered preferable to those involving forearm as well. This is very frequently true. However, the free, rhythmic forearm and wrist motions are found less fatiguing and faster for handwriting. It is therefore necessary to take into account the total effect in each particular application.

In using the different parts of the body, a knowledge and consid-

strokes of the bone, with abrupt changes of direction, are used to crease the hand, is shown. Output was increased 43 percent. (Redrawn and reproduced published by John Wiley & Sons, Inc., 1949.)

eration of the relative strengths of the muscles may be very useful. For example, the right hand is generally stronger than the left hand. Also, the various fingers have unequal strength and inherent work capacities.

PRINCIPLE NO. 6

The feet and other members of the body should be assigned all possible activities which will relieve the hands for other work.

Examples of the application of this principle are the use of foot-controlled stapling machines and foot-activated collating and folding machines.

PRINCIPLE NO. 7

The materials, tools, and equipment controls should be located at definite and fixed positions, preferably in the position in which they will be used and within the smallest practicable adjacent work area.

The advantages of having tools, materials, and machine controls in definite and fixed positions is relatively obvious; when the materials and tools the worker must grasp are in the same place all the time, hunting and searching for these things is eliminated; as the clerical worker develops habitual automatic responses, mental effort and fatigue are reduced; and, if all materials are grasped from the same point, it is not ever necessary for the worker's eyes to follow his hands.

It is preferable to have these materials, tools, and equipment arranged around and in front of the worker so as to minimize the muscular effort of the operator in reaching them. In both the horizontal and vertical planes, there is a normal work area for the right hand, for the left hand, and for both hands. The normal work area for the right hand is found by drawing an arc with the right hand, extending only the forearm and letting the upper arm hang by the side of the body in its normal position. Following the same procedure with the left hand, the normal work area for the left hand is similarly obtained. The normal work area for both hands working together is the area common to both arcs. There are similarly maximum work areas for the right hand, the left hand, and both hands together and these areas are drawn in this case by arcs of the hands with the whole arms extended

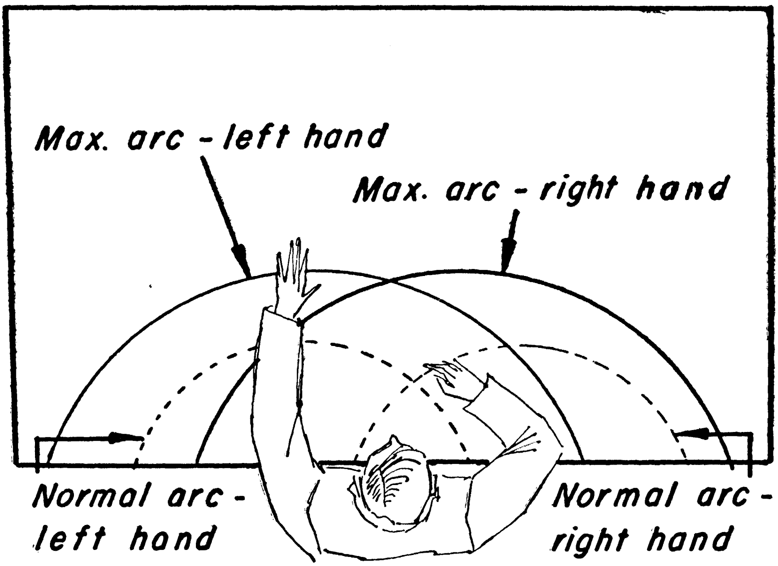


Figure 52. The normal and maximum work areas are shown for each hand of a clerical worker.

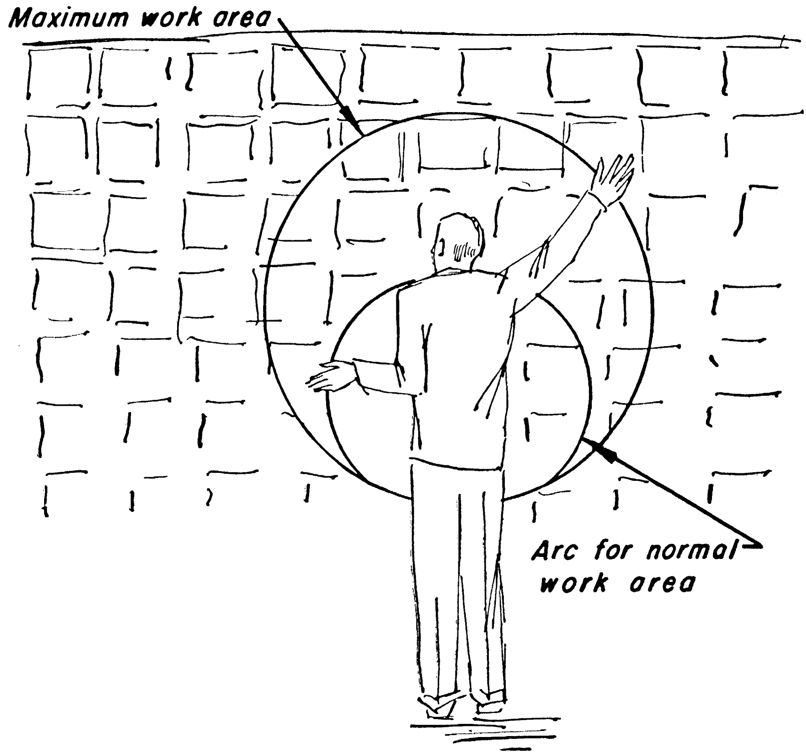


Figure 53. The normal and maximum work areas in the vertical plane are shown for a mail clerk.

and pivoted around the shoulder. In determining the fixed positions of materials, tools, and equipment, it is best to have them within the normal work areas for the hands involved.

The horizontal normal and maximum work areas for a desk worker are illustrated in Figure 52. The vertical normal and maximum work areas for a mail room clerk are shown in Figure 53.

In arranging the fixed work positions for equipment and materials, the more frequently used objects should be placed closest to the working area to minimize total traveling distance. Whenever possible, the materials and tools should be placed so that they may be quickly grasped in the position in which they will be used. A good example of this kind of positioning for quick grasp is the standard desk fountain pen and holder set in which the fountain pen is held in the fixed writing position when not in use.

THE RIGHT-AND-LEFT-HAND CHART

To analyze the office and clerical activities to promote maximum economy of motion, several charting techniques have been developed which have proved very useful. One of the simplest and most useful of these is the Right-and-Left-Hand Chart for analyzing the motions of the hands in the performance of an activity. The chart is essentially a process chart of each of the hands of the worker.

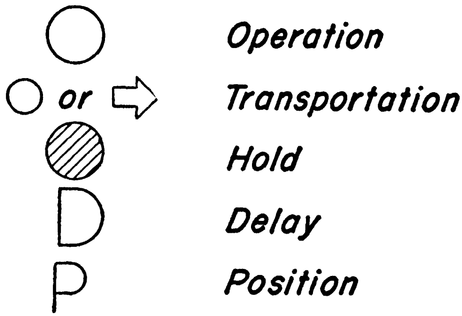


Figure 54. Some of the symbols used in Right-and-Left-Hand Charts.

The basic symbols used in this chart are similar to those used in the process flow chart. In general, only the first two symbols shown in Figure 54 are required; however, on some Right-and-Left-Hand Charts, other symbols, such as the last three, are used. The additional symbols provide further categorization and differentiation of the types of motion elements involved in the activity.

In making a Right-and-Left-Hand Chart, it is usually preferable to concentrate on the motions of each hand separately, listing the motions for the one hand before analyzing the other one. After both hands have been analyzed, then the symbols should be aligned, numbered, and connected with solid lines.

In Figure 55 is presented a Right-and-Left-Hand Chart of an operation of collating and stapling three sheets.

ANALYZING THE RIGHT-AND-LEFT-HAND CHART

In analyzing the Right-and-Left-Hand Chart, each of the principles of motion economy is reviewed individually and a determination is made of where and how any of the principles are violated by the exist-

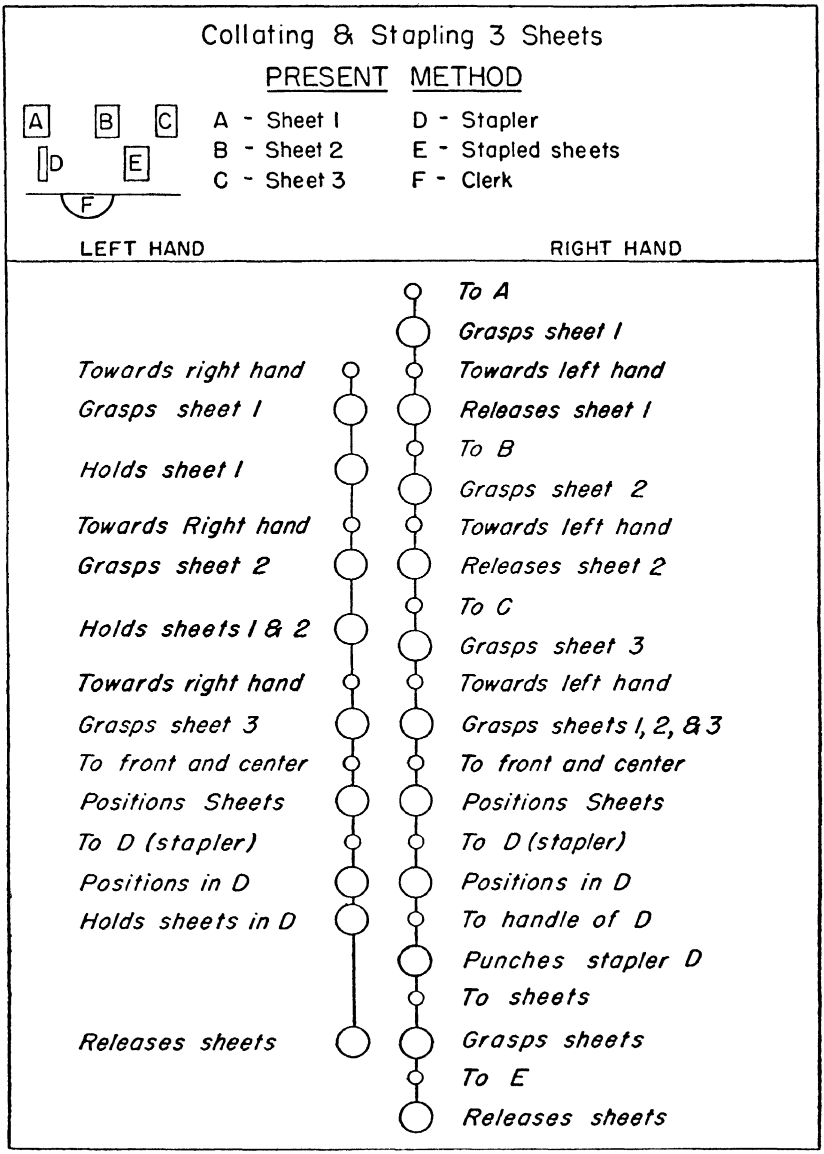


Figure 55. Right-and-Left-Hand Chart—shows a break-down of the present method of collating and stapling three sheets.

ing method. An attempt is then made to improve the motion patterns by eliminating the violations.

The following list of questions is designed to test conformance with the motion-economy principles previously presented and to suggest possible improvements:

1. Is either hand idle at any time?
2. Do the hands stop and start at the same time?
3. Do the hands perform similar motion elements at the same time?
4. Does either hand hold material which could be held by a fixture?
5. Do the hands move in opposite and symmetrical directions?
6. Can any of the motion elements be eliminated?
7. Can any of the elements be combined?
8. Can any of them be simplified?
9. Is the work arranged for the shortest line of motion?
10. Are the last elements of motion in the cycle adjacent to the first ones?
11. Do the motions have sharp changes in direction?
12. Are the motions free?
13. Is a rhythmic motion pattern present?
14. Can the finished work be disposed of by dropping?
15. Can sliding motions be used instead of picking up things?
16. Can the portable tools be made lighter?
17. Can muscular effort be reduced in any way?
18. Would greater speed and less fatigue be possible through the use of only the smaller extremities?
19. Have the relative strengths and abilities of the different parts of the body been considered?
20. Can the feet, or other parts of the body, operate devices presently actuated by the hands?
21. Are the materials, tools, etc. located at definite and fixed positions?
22. Are all these positions within the normal work areas for the hands involved? within the maximum work areas?
23. Are the tools and controls fixed in the position in which they are used?
24. Is the work place arrangement as compact as practicable?

ILLUSTRATIVE ANALYSIS

A simple and common office operation is presented in the Right-and-Left-Hand Chart shown in Figure 55. The method used for collating and stapling three sheets is a common one in many offices. Having analyzed the motions of each hand and constructed this chart, we desire to ascertain possible improvements by applying motion-economy principles. The chart is examined carefully and each of the 24 questions is answered in turn.

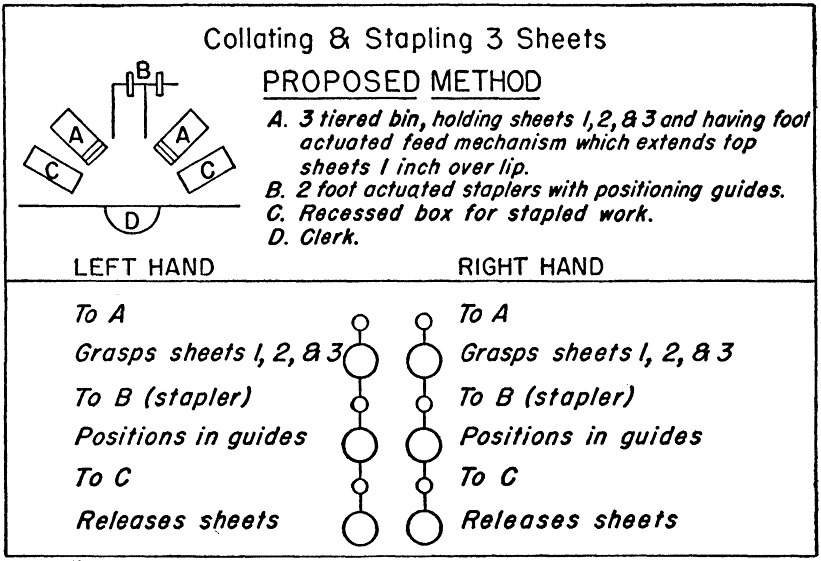


Figure 56. Right-and-Left-Hand Chart, with proposed improvements of the operation shown in Figure 55.

1. The left hand is idle part of the time.
2. The hands do not stop and start at the same time.
3. They do not always perform similar motion elements at the same time.
4. The left hand holds the sheets while the right hand punches the stapler. A fixture could hold just as well.
5. The hands do not move in opposite and symmetrical directions.
6. The movement to front and center for positioning can be eliminated.
7. The separate elements for grasping each sheet can be combined.
8. The positioning of the sheets can be simplified by the use of a guide.
9. By placing the sheets in tiered bins, the line of motion can be shortened.
10. The last elements in the cycle are not adjacent to the first.
11. There are relatively sharp changes in direction of motion.

12. The motions are quite cramped.
13. The pattern does not promote rhythmic motion.
14. The stapled sheets can be disposed of by dropping.
15. Instead of lifting the stapled sheets from the stapler, they can be dragged to a recessed box for drop disposal.
16. There are no portable tools to be made lighter.
17. Muscular effort can be reduced by adopting a shorter, more rhythmic pattern.
18. It is not practicable to use only the smaller extremities.
19. The relative abilities of the different parts of the body have been considered.
20. The feet can be used to actuate the stapler and to feed the sheets from tiered bins.
21. Materials, tools, etc. are located at definite, fixed positions.
22. Materials, tools, etc. are located within the maximum but not within the normal work areas.
23. No tools or controls are fixed.
24. The work place arrangement can be made more compact by the use of tiered bins to hold the sheets.

The proposed method, shown in Figure 56, corrects the violations of good motion economy disclosed by the 24 questions. The stapling machine is operated by a foot lever. Positioning guides are provided. Three-tiered bins are used to hold the sheets. The top sheet in each bin is fed one inch over the edge of the bin lips by a foot-actuated feed mechanism. The new balanced lay-out permits opposite simultaneous motions at all times within the normal work area.

The left hand now has 3 operations and 3 transportations as compared with 7 operations, 5 transportations, and one idle. The right hand also has 3 operations and 3 transportations now against a former 11 operations and 11 transportations.

SIZE OF MOTION ELEMENTS

One question which might be asked regarding the construction of the Right-and-Left-Hand Charts is: how fine should the elements of motion be broken down? For best results, the elements should, in general, be broken down into the smallest readily visible units.

The finer the units into which motion is analyzed, the greater the information which is obtained and the greater the possibilities of improvement. In addition, the greater the detail of the motion analysis, the greater is the opportunity to learn to understand motion study, to learn what constitutes good and bad motion patterns, and how bad patterns may be corrected. For these reasons, it is sometimes desirable to go to the trouble and expense of making very fine break-downs and timing these very small elements.

TIME STUDY ANALYSIS

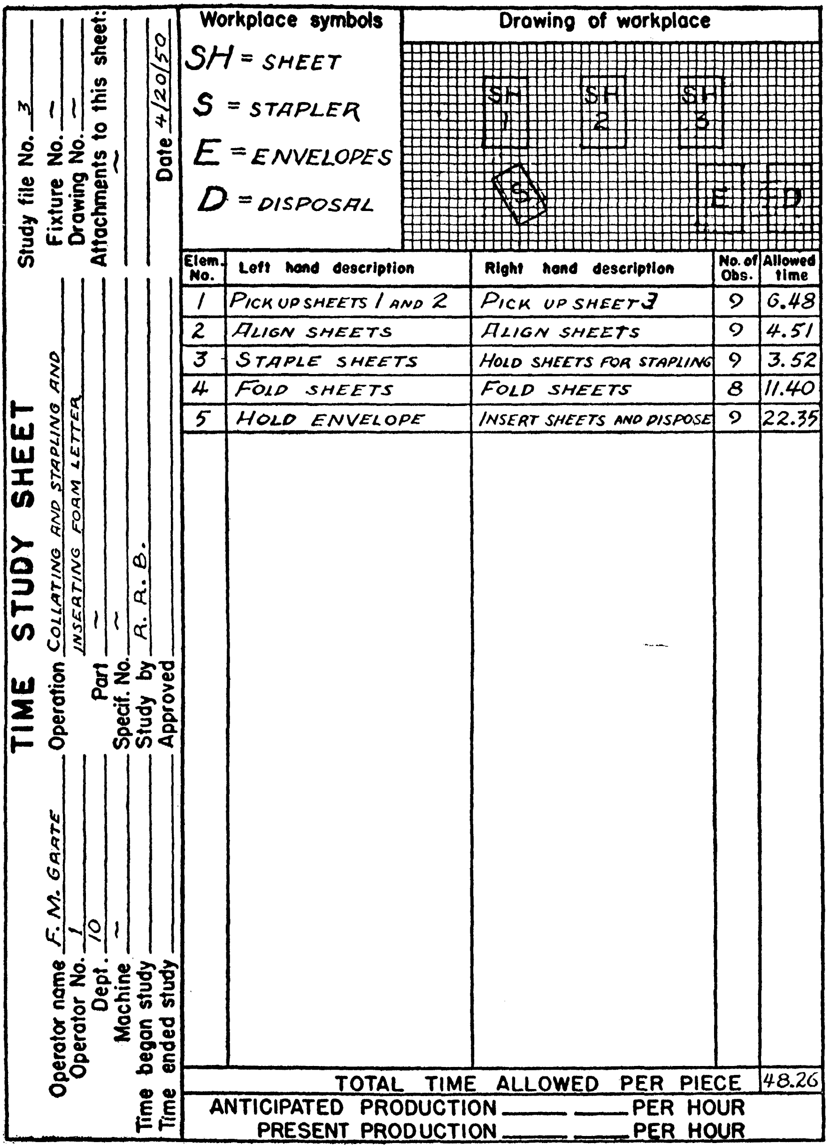
In studying the operations of any system or details of any series of motion patterns in the performance of a task, it is frequently valuable to measure the time required for the various steps. Time study analysis may prove very useful for a number of reasons:

1. It may provide clues as to which parts of the present system are poorly performed, where waste exists. It points up the time-consuming elements of the system on which major effort should be concentrated to make the greatest savings.
2. It provides a means of estimating the labor and time savings which may be made by the introduction of improved methods.
3. The time actually consumed in the performance of clerical activities may be compared with accepted standards to determine the effectiveness of the worker's performance.

Time study analyses may be made in a number of ways. A stopwatch may be used to ascertain the amount of time spent on each element of the operation cycle. To ascertain the amount of time that should be spent, standard time data may be used to construct a time standard by synthesis. The micromotion analysis made with motion pictures—described later in this chapter—also provides a relatively expensive means of obtaining an accurate time study as well as micromotion analysis.

The first step in taking a stopwatch time study is the logical subdivision of the job into readily distinguishable elements. The description of each step should definitely indicate the transition points. These elements are indicated in the headings of a time study observation sheet such as shown in Figure 57. The lay-out of the task being studied should also be shown, together with any other details required to clarify the details of the task.

There are three principal techniques for taking stopwatch readings: snapback readings, connected two-watch readings, and continuous readings. The snapback technique involves starting each element with the stopwatch at zero. At the end of each element, the watch is read,



TIME STUDY SHEET

Operator name F. M. GARTE
Operator No. 1
Dept. 10
Machine ~
Time began study
Time ended study

Operation COLLATING AND STAPLING AND INSERTING FORM LETTER
Part ~
Specif. No. ~
Study by R. R. B.
Approved

Study file No. 3
Fixture No. 1
Drawing No. ~
Attachments to this sheet: ~
Date 4/20/50

Workplace symbols

SH = SHEET
S = STAPLER
E = ENVELOPES
D = DISPOSAL

Drawing of workplace

Elem. No.	Left hand description	Right hand description	No. of Obs.	Allowed time
1	PICK UP SHEETS 1 AND 2	PICK UP SHEET 3	9	6.48
2	ALIGN SHEETS	ALIGN SHEETS	9	4.51
3	STAPLE SHEETS	HOLD SHEETS FOR STAPLING	9	3.52
4	FOLD SHEETS	FOLD SHEETS	8	11.40
5	HOLD ENVELOPE	INSERT SHEETS AND DISPOSE	9	22.35
	TOTAL TIME ALLOWED PER PIECE			48.26

ANTICIPATED PRODUCTION _______ PER HOUR
PRESENT PRODUCTION _______ PER HOUR

Figure 57. Time Study Sheet—gives analysis of a clerical operation. The sheet, and their analysis.

CYCLES→ ELEMENTS↓		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15	
No.	Description	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T
1	Assemble Sheets	5	5	50	5	90	6	25	5	70	6	10	5	40	5	86	5	17	4												
2	Align	10	5	53	3	93	3	29	4	73	3	13	3	44	4	89	3	21	4												
3	Staple	13	3	56	3	96	3	31	2	76	3	15	2	47	3	92	3	24	3												
4	Fold	21	8	64	8	2	6	42	9	87	11	16	1	59	12	1	9	33	9												
5	Insert	45	16	84	20	20	18	64	22	5	18	35	19	81	22	13	12	45	12												
6																															
7																															
8																															
9																															
10																															
11																															
12																															
13																															
14																															
15																															

ELEMENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total	46	32	25	72	159										
No. observations	9	9	9	8	9										
Average	5.11	3.56	2.78	9.0	17.67										
	-	-	-	-	-										
	-	-	-	-	-										
Rating	1.15	1.15	1.15	1.15	1.15										
	-	-	-	-	-										
Base time	5.89	4.10	3.20	10.35	20.32										
% Allowance	10	10	10	10	10										
Allowed time	6.48	4.51	3.52	11.40	22.35										

both sides of which are shown, permits recording of repeated observations

This form is used by permission of M. E. Mundel author of Systematic Motion and Time Study, *Prentice-Hall, Inc., 1947* recorded, and snapped back to zero. The time required for the snapback introduces some error in the readings.

The connected two-watch procedure involves the use of two watches which are arranged side by side with a linkage which automatically starts either of the other watches when one of them is stopped. In this technique, the snapback time interval is reduced because the analyst does not read the elapsed time until after he has started the other watch.

In the continuous-reading technique, the analyst observes and records the readings on the stopwatch as each element is completed. The time for each element is then obtained by subtraction of each reading from the previous. The continuous readings made by a competent observer are more accurate than the snapback and possess the added advantage that account must be taken in the readings of any idle time or unnecessary steps. It does have the disadvantage of requiring subtraction of the successive readings. Because of its simplicity and accuracy, it is the most usual stopwatch reading procedure.

The time for the operation is obtained by calculating an average time value for each element. Proper evaluation of this time also involves a judgment of the skill, effort, and consistency of the worker as well as the conditions under which the work was performed. This is known as rating the worker's performance. In addition, to determine expected output, allowance must be made for fatigue, avoidable and unavoidable delays, as well as time for the worker to attend to personal needs.

In Figure 57, the worker was rated at 115 percent of a normally skilled worker operating with normal effort and consistency, and under normal conditions. The allowance for fatigue, delays, personal needs, etc., was 10 percent of the base time.

The use of standard time data for determining the time required for the performance of various tasks may eliminate the requirement for stopwatch readings. These standard data are based on many studies of the basic time required for making various elementary motions. The task is then divided into these small elements and a time standard synthesized by adding up the basic time requirements for each element.

MICROMOTION STUDY

To make the very fine analyses used in micromotion study, motion pictures are usually taken of the activity and work place area, either with a special constant-speed camera or with a microchronometer in the field of vision. If a constant-speed camera is used, the time for each motion element is determined by counting the number of frames on the film between the beginning and end of the element.

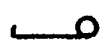
- STANDARD SYMBOLS AND COLORS FOR THERBLIGS -				
SYMBOL	ABBRE-VIATION	NAME OF SYMBOL	NAME AND NUMBER EAGLE PENCIL	JOSEPH DIXON PENCIL
	Sh	Search	Black #747	379
	F	Find	Gray #747½	352½
	St	Select	Light Gray #734½	352½
	G	Grasp	Carmine #745	321½
	TL	Transport Loaded	Grass Green #738	354
	P	Position	Indigo Blue #741	350
	A	Assemble	Violet #742	323
	U	Use	Lavender #742½	323½
	DA	Disassemble	Violet #742 Applied lightly	323
	I	Inspect	Terra Cotta #745½	335½
	PP	Pre-position	Sky Blue #740½	320
	RL	Release Load	Scarlet Red #744	321
	TE	Transport Empty	Olive Green #739½	325
	R	Rest for Overcoming Fatigue	Orange #737	324
	UD	Unavoidable Delay	Yellow Ochre #736	324½
	AD	Avoidable Delay	Canary Yellow #735	353½
	Pn	Plan	Sienna Brown #746	343
	H	Hold	Orange Ochre #736½	388

Figure 58. Table of therbligs, with standard symbols and colors.

The film of the operation is analyzed into very small elements of motion called therbligs. There are 18 therbligs. The symbols for these therbligs are shown in Figure 58.

The analysis of the film is made on an Analysis Sheet, as shown in Figure 59. The method of analysis is analogous to the method used for the Right-and-Left-Hand Chart. The film is projected onto a screen,

MICROMOTION STUDY
ANALYSIS SHEET

PART Bolt and washer assembly • Old Method   DEPARTMENT AY16   FILM NO. B21

OPERATION Assemble 3 washers on bolt   OP. NO. A32

OPERATOR M. Smith 1C634   DATE 1-26-48   ANALYSED BY M.E.R.   SHEET NO. 1 OF 1

CLOCK READING	SUBTRACTED TIME	THERBLIG SYMBOL	DESCRIPTION LEFT HAND	CLOCK READING	SUBTRACTED TIME	THERBLIG SYMBOL	DESCRIPTION RIGHT HAND
595	7	TL	Carries assembly to bin	595	26	TE	Reaches for lock washer
602	2	RL	Releases assembly	621	6	St+G	Selects and grasps washer
604	4	TE	Reaches for bolt	627	7	TL	Carries washer to bolt
608	2	St+G	Selects and grasps bolt	634	6	P	Positions washer
610	17	TL	Carries bolt to working position	640	12	A+RL	Assembles washer onto bolt and releases
627	5	P	Positions bolt	652	8	TE	Reaches for steel washer
632	104	H	Holds bolt	660	8	St+G	Selects and grasps washer
736	7	TL	Carries assembly to bin	668	9	TL	Carries washer to bolt
743	2	RL	Releases assembly	677	3	P	Positions washer
745				680	10	A+RL	Assembles steel washer and releases
				690	6	TE	Reaches for rubber washer
				696	10	St+G	Selects and grasps rubber washer
				706	9	TL	Carries washer to bolt
				715	5	P	Positions washer
				720	16	A+RL	Assembles washer and releases
				736			
			Time in 2000ths of a minute				

Figure 59. Analysis Sheet for bolt and washer assembly—old method. (Reproduced by permission from *Motion and Time Study*—3rd Ed., by R. M. Barnes, published by John Wiley & Sons, Inc., 1949.)

and one cycle is chosen for study. First one hand and then the other is analyzed.

With the data from the Analysis Sheet, a very detailed Right-and-Left-Hand Chart, with time as a vertical scale measured in winks (1/2,000 of a minute) is constructed.

This chart is usually called a simultaneous motion or Simo Chart. Figure 60 shows an example of such a chart constructed from the data shown in the analysis sheet. It is essentially a Right-and-Left-Hand Chart with two distinguishing features:

1. A much finer break-down of the elements of motion
2. A time scale in 1/2,000 of a minute intervals, giving the time for each element of motion.

The same method is used in analyzing a Simo Chart as a Right-and-Left-Hand Chart. Of course, the added element of time and the greater detail enables a better evaluation of the importance of each element and better knowledge of the true nature of the motions involved.

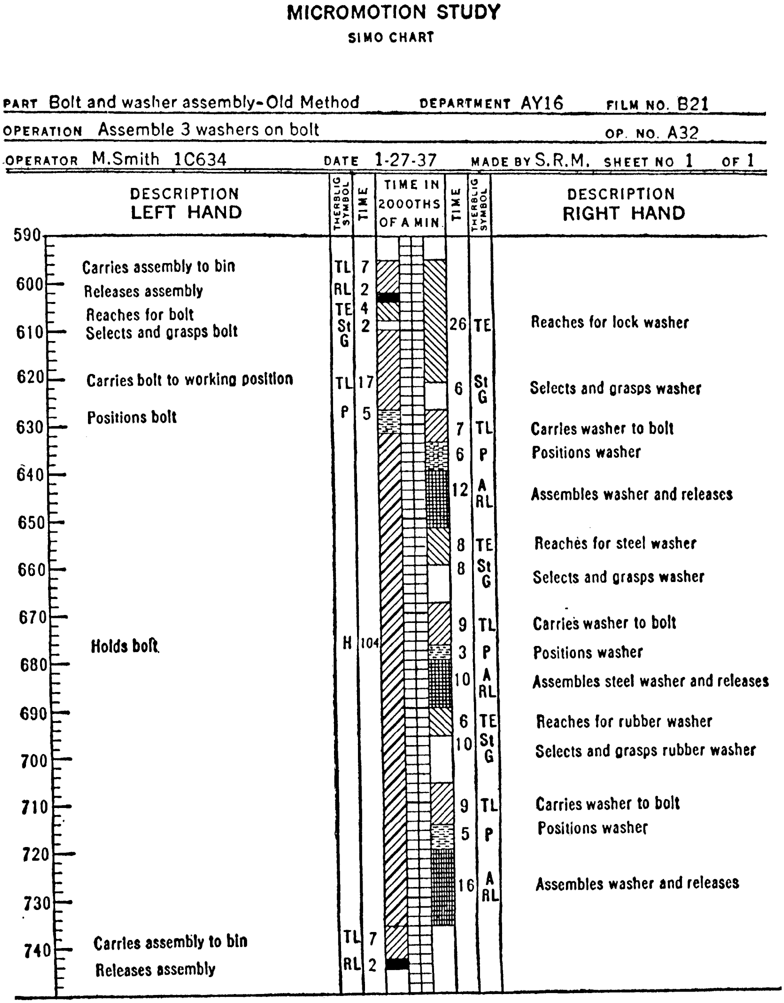


Figure 60. Simo Chart for bolt and washer assembly—old method. (Reproduced by permission from *Motion and Time Study*—3rd Ed., by R. M. Barnes, published by John Wiley & Sons, Inc., 1949.)

As a general practice, the added time and expense involved in making micromotion analyses of all operations makes it uneconomical to apply to most operations. However, when an operation is very highly repetitive or is performed by a large number of workers, this added expense may be worthwhile because any small additional saving derived from the finer analysis of a micro-motion study will be multiplied enormously.

There is, moreover, an important purpose for micromotion study as a training tool. Although its principles are essentially simple, acquisition of ability to apply these principles with maximum effectiveness comes only with much practice in following the fine details of motion patterns. Micromotion study is thus an educational tool for becoming motion-minded.

VIII

ANALYZING THE FORMS DESIGN

PRACTICALLY ALL of the communication, reporting, analysis, and coordination of information which is done in the performance of the systems of the enterprise utilize forms. The forms which are used to facilitate these activities may be good, mediocre, or bad. If they are poorly designed, the performance of the functions involved will be seriously hampered.

Forms constitute a basic part of most systems. The design of the form is a reflection of the design of the system. The form can only be properly designed when the analyst clearly and completely understands the systems for which it is to be used—its objectives, its requirements, and its functions.

A form may be defined as a duplicated document with blank spaces for the insertion of data by hand (ink or pencil), by typewriter, or by any other process. Reports and charts are prepared on forms.

As an integral part of one or several systems, the design of each form is, of necessity, determined by the functions it performs in the systems. There are, however, a number of fairly distinct general forms-design problems which warrant separate study by the analyst. In this chapter we will consider some of these design problems and develop some rules for effective forms design.

Good forms design, made effective by adequate forms-control policies, will produce numerous kinds of savings for the enterprise: the amount of clerical labor required for filling in the forms will be reduced; the frequency of clerical errors in completing the form will be lowered; managerial efficiency will be increased by providing all required information and eliminating non-essential data on forms and reports; the printing and the paper costs of the forms will be reduced.

We will not consider here the analysis of the distribution of multicopy forms. Methods of analyzing this problem were considered in some detail in Chapter V, where the Forms Distribution Chart was discussed. Suffice it to say here that such an analysis should always precede the design of a multicopy form.

In designing forms, the fundamental consideration is, quite naturally, the maximum promotion of the systems objective. The requirements of the procedure are therefore the prime determinant in prescribing the nature of the forms. Within the latitude allowed by the procedural consideration, alternative arrangements of the form are possible. These must be evaluated to produce that design which will be most economical to the entire enterprise.

COMBINING FORMS

One of the advantages which will result from a logical analysis of the forms of an enterprise is a reduction in the number of different forms. This comes about by redesigning slightly different forms which were used for similar purposes and by standardizing on some clerical practices. There are obvious advantages to this procedure: lower printing costs; uniform practices throughout the enterprise; greater flexibility in transferring personnel and equipment from one section to another. Moreover, sometimes a form may be eliminated by using an extra copy of the source record, thus saving the entire clerical cost of filling out the form, as well as eliminating the possibilities for transcription errors.

However, reduction of the number of forms is not in itself always a profitable step. One form is not always preferable to two. In some cases, two simple forms will perform much more economically than one complicated form. In attempting to combine forms, one must not lose sight of the total goal: effective service at the lowest total cost of performance.

A convenient tool for analyzing a group of similar forms or reports which it is believed might be consolidated into a smaller number is the Forms Data correlation chart shown in Figure 61. The form titles and numbers are listed along the top of the analysis sheet. All the different data itemized on the forms are indicated in the left-hand column. Then, whenever the data appear on a form, an "X" mark is placed in

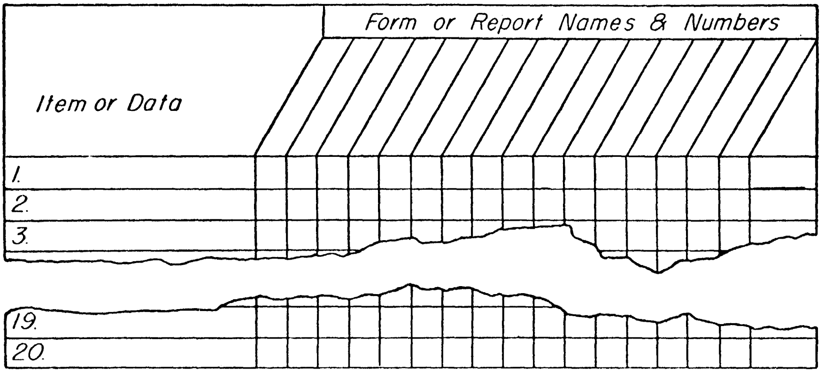


Figure 61. Forms Data Correlation Chart, an analytic tool for the prosecution of a forms simplification program.

the box of the column headed by that form. When all the information on each form is thus listed and checked against all the forms, this correlation chart will point up those forms which will lend themselves best to consolidation.

ARRANGEMENT OF DATA

The arrangement of information on forms should be in as logical a sequence as possible. This improves the readability, intelligibility, and usefulness of the form as well as reducing the clerical fill-in time. The principles of motion economy discussed in the last chapter should be applied in designing the form for economical use of space, minimum hand travel, and easiest motion. Items should be arranged to minimize back-tracking and searching. To reduce the work of filling in the forms, the use of check boxes should be considered. The Printing Specifications Form, Figure 96, illustrates the use of check boxes to reduce clerical labor.

As much as possible the information on a form should be in the same sequence as it appears on the forms from which and to which the information is copied. This will simplify transcription. In addition, the sequence of information should be as similar as possible to that on other forms used in the organization. When standard sequences and designs are used, the clerical workers become accustomed to these designs and work more efficiently.

Where several departments will transcribe information onto the same form, it is advisable to group the information spaces for each department. This will tend to save time searching for spaces and reduce errors.

"To" and "From" boxes are advisable on forms which are sent from person to person.

When the form consists of a letter for external use, the spacing should be arranged to allow for the use of window envelopes to save extra addressing time, if window envelopes are considered appropriate.

POTENTIALITY OF ERRORS

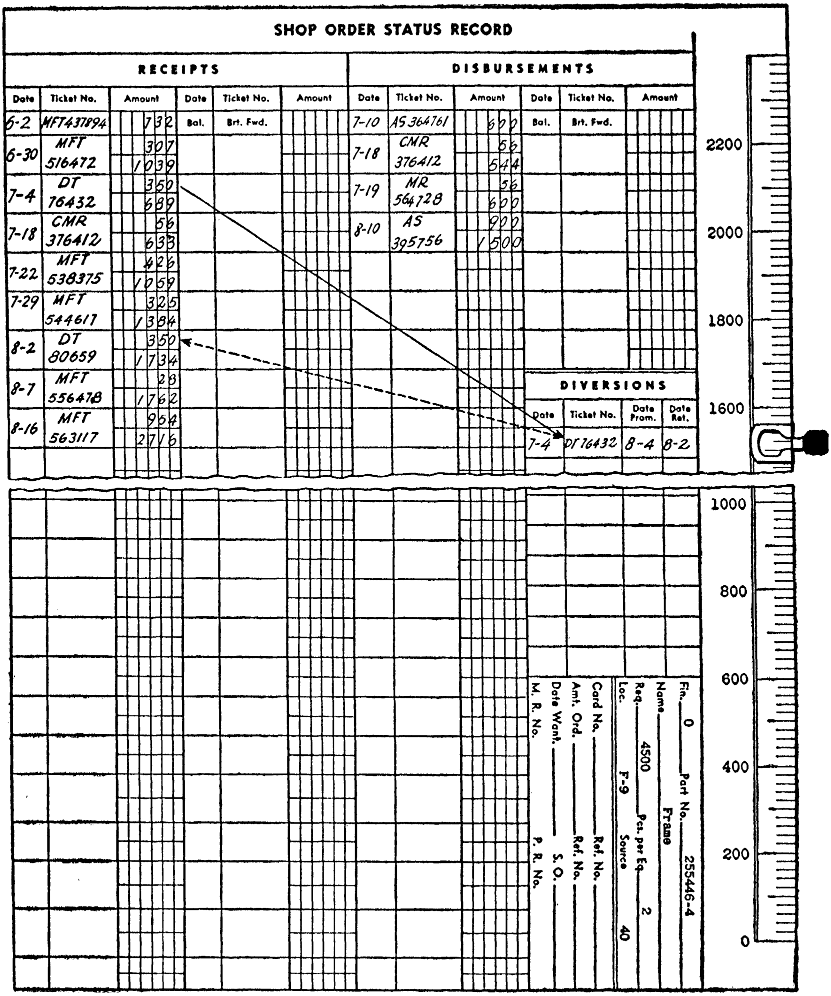
It is frequently possible to reduce the number of clerical errors by designing the form to reduce the mental efforts of the worker. For example, material-control forms normally provide the type of arrangement shown in Figure 62 for maintaining a total or balance of previously posted items:

Date	*Amount Received*	*Total Received*

Figure 62. Typical arrangement of form for keeping a running record of material receipts.

In filling in this kind of record, to obtain the new total the clerk must either perform the addition of the previous total received and the latest receipt by mentally arranging the two quantities in columnar fashion or he must perform the operation on a machine or on a separate piece of scratch paper. A design which the writer made of a material-control form which simplifies the process is shown in Figure 63. Here the previous total and current quantity are arranged with all pertinent numerals in vertical order for ready addition.

Another device, which may sometimes increase the accuracy and



SHOP ORDER STATUS RECORD

RECEIPTS						DISBURSEMENTS					
Date	Ticket No.	Amount	Date	Ticket No.	Amount	Date	Ticket No.	Amount	Date	Ticket No.	Amount
6-2	MFT437894	732	Bal.	Brt. Fwd.		7-10	AS364761	600	Bal.	Brt. Fwd.	
6-30	MFT 516472	307 1039				7-18	CMR 376412	56 544			
7-4	DT 76432	350 689				7-19	MR 564728	56 600			
7-18	CMR 376412	56 633				8-10	AS 395756	900 1500			
7-22	MFT 538375	426 1059									
7-29	MFT 544617	325 1384									
8-2	DT 80659	350 1734									
8-7	MFT 556478	28 1762									
8-16	MFT 563117	954 2716									

DIVERSIONS

Date	Ticket No.	Date Prom.	Date Ret.
7-4	DT 76432	8-4	8-2

Fin. 0 Part No. 255446-4
Name Frame
Req. 4500 Pcs. per Eq. 2
Loc. F-9 Source 40
Card No. Ref. No.
Amt. Ord. Ref. No.
Date Want. S.O.
M. R. No. P. R. No.

Courtesy RCA Victor and "Factory Management and Maintenance," May, 1946

Figure 63. Shop Order Status Record for controlling materials.

readability of a form as well as improve its appearance, is to shade certain areas to set them off from the main body of the form.

VERTICAL AND HORIZONTAL SPACING

In designing a form, it is necessary to allow enough space in each area for the maximum amount of information that will be entered, plus a small margin of safety. As guides in determining these space requirements, the following information is useful.

When forms are to be filled in by hand in pencil or ink, lightweight horizontal lines spaced three to five lines to the inch, should ordinarily be used. Although clerical workers can write on lines spaced four or five to the inch, it is usually desirable to have only three lines to the inch on forms to be filled in by non-clerical workers.

When the forms are to be filled in by typewriter, horizontal lines should not be ruled in except to provide the fill-in blanks for the information. Leaving out the horizontal ruling used on hand-filled forms increases legibility. For single-spaced typing, six lines can be typed per inch of vertical distance. However, it is usually preferable to use double spacing, allowing three lines per inch.

In planning the horizontal spacing on typewriter-filled forms, twelve spaces per inch should be allowed for elite type and ten spaces per inch for pica type. All fill-in areas should be alined to have as few vertical starting lines as possible, so that typing can start at relatively few tabular stops.

Forms designed for use in connection with accounting or tabulating machines must have spacings which conform to the machine settings which will be used. After the design of a form has been completed, it is desirable to make an actual test to see whether the maximum amount of information can be comfortably placed in the allotted spaces.

HEADINGS AND INSTRUCTIONS

The headings and instructions on the form should be brief and clear. If the instructions are too detailed, they should not be placed on the form at all, but should be the subject of separate written instructions. Too much detailed instruction on a form reduces its flexibility: it cannot be used for as many different purposes; it will be obsolete sooner when some of the details of the instructions change.

It is sometimes desirable to number the columns or spaces on a form to facilitate the writing and understanding of detailed instructions, which then refer to the columns or spaces by number.

FILING DATA OR SYMBOLS

Data or symbols which are used for filing or sorting the forms should be located prominently. The upper right-hand corner is usually reserved for these purposes, but this is not necessarily the best design in all cases.

VISIBLE FILE

If the form is designed for use in a visible file, the visible area and the information to be included in that area must be determined in the initial stages of the design.

SERIAL NUMBERING

Serial or consecutive numbering is desirable when a numerical control of the forms is required. Purchase orders, inventory move tickets, checks, and accounting requisitions are examples of forms which might be serially numbered to promote control of the respective activities and ready identification of any issued form. Serial numbering should only be used when really required because of the additional printing cost it entails.

When a form is to be serially numbered, allowance should be made in the design for the mechanical numbering device which must be locked in the type form if an extra press run is to be avoided. This usually involves leaving a clear space of at least one and one half inches horizontally and one inch vertically, ordinarily in the upper right-hand corner.

MARGINS

The minimum allowable margins on a printed form are determined by the space necessary for the grippers on the printing press, usually 3/16 inch or more. If the form is to be put into a binder, at least ⅝ inch should be allowed on the left margin for the ring type and 1¼ inches for the post type.

For flat forms (single copies) to be filled in on the typewriter, it is possible to fill in spaces down to ¼ inch of the bottom of the sheet although it is preferable to not go within ¾ inch of the bottom. For multiple copy forms, the lowest it is advisable to go is ¾ inch.

USING BOTH SIDES OF FORM

Although it is very frequently desirable to use both sides of a form, careful consideration should be given to the possible greater economy of clerical handling when only one side is used. Among the factors to be evaluated in each application are:

1. The clerical handling costs
2. The required filing spaces
3. The printing and paper costs using both sides of a form as compared with using two one-sided forms or one larger size sheet. The paper may have to be heavier if both sides are used because of the heavier usage and, perhaps, the problem of transparency.

When a form is to be printed on both sides, it is usually desirable to have it "tumbled": when the bottom of the form is turned over, the opposite side should be right side up. If the form is to be used in a binder or folder, however, "tumbling" would not be used.

TITLE OF FORM

The selection of the title of the form is of some importance. Good titles will eliminate confusions when the forms are mentioned. The title should, of course, be clear and indicate the purpose of the form. It should, in addition, be as definitive and distinctive as possible. For instance, the title "Personnel Record" would not be as good a title for a record of the wage payments to laboratory personnel as "Laboratory Pay Record."

The title is generally centered at the top of the form. Another convenient location for the title is the upper left-hand corner.

FORMS-CONTROL NUMBER

All forms should be numbered in accordance with the forms-control system. This number is usually placed in the lower left-hand corner in very small type. The forms numbering system is discussed later in connection with the operation of the forms-control function in the systems department.

COLORED PAPER

Colors can be very useful in sorting different forms. Inventory reports, requisitions, and purchase orders become easy to sort when they are different colors. Time slips can be more easily separated by weeks when different colors are used. The various copies of a form are easily identified by color.

Although the use of colored forms may prove useful, they must be chosen with care or they will prove to be a liability. Two requirements for a good colored forms scheme are: each color should have the same definite and useful meaning all the time; there should be no more than three to five different colors or the scheme will get too elaborate. If these requirements cannot be met, it is usually desirable to stick to white paper, which is cheapest. For distinguishing multiple copies of a form, the copies can be numbered.

PERFORATIONS, CORNERS, HOLES, ETC.

When the system requires that a form be separated into two or more parts, perforations (a series of holes) may be used to weaken the paper so that it may be easily torn in the desired manner. Various kinds of machines make slightly different kinds of perforations. The proper choice depends upon the reproduction process being used and the requirements of the procedure.

When a form will be subjected to a great deal of handling, the use of round corners may result in fewer dog-eared specimens.

When a form is to be folded, scoring (weakening the fibers by pressure along a line) will provide for easier and neater results.

When a form is to be inserted in a looseleaf binder, it is usually cheaper to have the holes machine-drilled than to have each person hand-punch the forms as they are used.

SIZES OF PAPER

To save money on paper costs, it is desirable to use paper sizes which can be cut from the following standard sheets with no waste (dimensions are in inches):

1. 17 x 22 (can be cut from sizes 4 and 6)
2. 17 x 28
3. 19 x 24
4. 22 x 34 (can be cut from size 6)
5. 28 x 34
6. 34 x 44

Table III below indicates some of the form sizes which can be cut from these standard sheets with no waste. From this list of sizes, as small a variety as is practical should be chosen as standard company sizes. The smaller the variety of sizes used, the greater the possible economy from standardization of filing and other office equipment.

Table III. Most Economical Sizes for Forms

Size of form (in inches)	*Cuts without waste from standard sheet measuring*	*Number of forms per standard sheet*	*Thousands of forms per ream (500 sheets) of standard sheet*
2¾ x 4¼	17 x 22	32	16
2¾ x 8½	17 x 22	16	8
3½ x 4¼	17 x 28	32	16
3½ x 5½	17 x 28	24	12
3½ x 8½	17 x 28	16	8
3½ x 17	17 x 28	8	4
4 x 6¼	19 x 24	18	9
4 x 9½	19 x 24	12	6
4¼ x 5½	17 x 22	16	8
4¼ x 7	17 x 28	16	8
4¼ x 11	17 x 22	8	4
4¼ x 14	17 x 28	8	4
4¼ x 28	17 x 28	4	2
4¾ x 6	19 x 24	16	8
4¾ x 8	19 x 24	12	6
5½ x 7	17 x 28	12	6
5½ x 8½	17 x 22	8	4
5½ x 17	17 x 22	4	2
6 x 9½	19 x 24	8	4
7 x 8½	17 x 28	8	4
7 x 17	17 x 28	4	2
8 x 9½	19 x 24	6	3
8½ x 11	17 x 22	4	2
8½ x 14	17 x 28	4	2
8½ x 22	17 x 22	2	1
8½ x 28	17 x 28	2	1
11 x 17	17 x 22	2	1
12 x 19	24 x 38	4	2
14 x 17	17 x 28	2	1

When designing typewriter forms wider that 8½ inches, the width of the standard typewriter carriages in use in the enterprise should be considered.

WEIGHT AND GRADE OF PAPER

The weight and grade of paper to be used depend on a number of factors which must be separately evaluated in all cases:

1. The amount and kind of treatment to which the form will be subjected.
2. The desired appearance.
3. The method of filing the form. It is desirable for a vertically filed record not to sag under its own weight.
4. The length of time the form is expected to be in use.
5. The number of copies to be made at one time.
6. The methods by which the information will be filled in, e.g. by hand, by typewriter, by carbon copy, by accounting machine.
7. The properties of the different weights and grades with respect to the above factors as well as the relative costs of the different weights and grades.

The weight of paper or card stock, usually called its substance, is specified as the weight in pounds of 500 sheets (one ream) of a specified sheet size. For bond and ledger paper, the specified sheet size is 17 x 22 and for post card stock it is 22½ x 28½ inches. The thickness of the sheets is, of course, related to the weight or substance.

The grade of the paper is determined by a number of factors. The highest quality and most permanent papers are made from rag stock and the cheaper papers are made from wood pulp. However, there are various qualities of rag stock and wood pulp and there are variations in the manufacturing process which affect the quality. Light or medium-weight papers of the type used in offices are usually bond papers. Although 100 percent rag bond is the highest quality, differences between the various trade names exist. Next come the 75, 50, and 25 percent rag-content bonds which are combinations of decreasing proportions of rag stock with wood pulp prepared by the sulphite process. Hundred percent sulphite bond papers are graded Nos. 1 through 5 in order of decreasing quality and there are quite large differences in the qualities of these grades.

Ledger paper is used for records which must withstand a good deal of handling and are therefore made in heavier weights. It is otherwise similar to bond.

Manifold (including onionskin) papers are the same as bond but of lighter weights.

Other factors which may vary are the surface finish, the opacity (which may vary somewhat with color of paper), and the grain (which should generally be vertical in a filed form). If the grain on a form which is used around a roller, such as on a typewriter, runs in the same direction as the axis of the roller, the form will have a tendency to remain curled after passing through the roller.

It is desirable to standardize on several combinations of weights and grades to satisfy the varying requirements. In general, the least expensive which will give satisfactory service should be chosen. The paper companies and the company printer will generally furnish samples of the various types and grades and technical advice to aid in selecting the most suitable papers. To aid in choosing, the papers should be tested by using and misusing them under simulated conditions. Make erasures on the paper and note the condition of the surface. Is it still smooth? Write with ink over the erased area. Does the ink blur and run down the fibres? You can also test by the sharpness of the snap or ring of the paper when struck or bent against a desk and by the sharpness of the edges when the paper is torn both with and against the grain. There are many other tests which might be made depending on the uses to which the paper will be put and the testing facilities available: tensile as well as bursting strength, fading and discoloration, stiffness, opacity, gloss, etc.

ORDERING QUANTITIES

The quantity of a form to be ordered should be decided judiciously, keeping the following points in mind:

1. Expected monthly usage.
2. Relative costs of alternative quantities.
3. The possibility of changes in the near future—a new form, or a drastically revised form, will more frequently require such changes.
4. With some exceptions, a year's supply is the maximum quantity of any form that should be ordered.

It is generally desirable to adopt a very conservative attitude in determining order quantities. The destruction of obsolete forms will frequently more than offset the economies obtained by printing large quantities.

PRODUCTION METHOD

Forms may be produced by letterpress, photo offset, direct plate offset, Multigraph, Mimeograph, etc. Each of these methods of producing forms is briefly described in the section of Chapter IX devoted to reproducing machines.

Each of these form-production methods is best under a certain combination of circumstances. Some of the factors determining the choice of method are:

1. Purpose for which form will be used
2. Kind of form
3. Size of form
4. Grade and weight of paper
5. Quantity required
6. Quality of finished copy required

TYPE STYLE

It is frequently considered desirable to standardize on the type faces used in letterpress work. This has the advantages of promoting uniformity of appearance among the enterprise's forms and of simplifying the task of specifying type when ordering the forms. Figure 64 shows samples of gothic type up to 18-point size. Gothic type is the most satisfactory type for most forms because it is neat, uniform, and distinctive. It is kept by all printers and photographs very well.

THIS IS GOTHIC TYPE	6 point
This is Gothic Type	8 point
THIS IS GOTHIC TYPE	10 point
This is Gothic type	12 point
THIS IS GOTHIC TYPE	14 point
This is Gothic type	18 point

Figure 64. Gothic type will give good uniform results for most form requirements.

Reverse printing (white letters against a patch of dark background) is sometimes desirable to attract attention to an important detail.

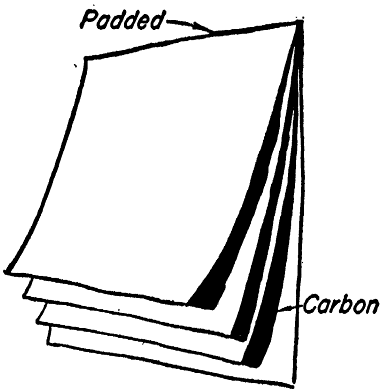


Fig. 65

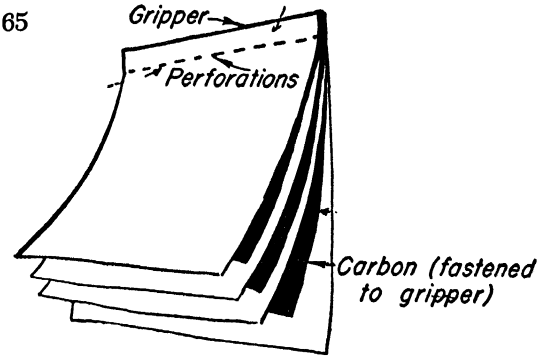


Fig. 66

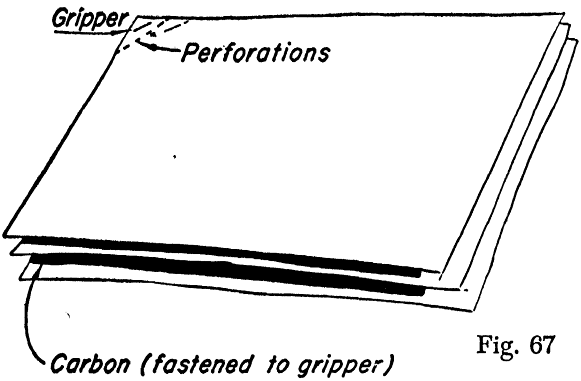


Fig. 67

Figure 65. Interleaved carbon forms eliminate carbon insertions by typist.
Figure 66. Single-stub snap-out form facilitates separating the copies.
Figure 67. Single-stub snap-out form may have perforation in corner.

CONSULT PRINTERS AND MANUFACTURERS

In the determination of the best methods of designing and producing forms, printers and manufacturers should be consulted freely. They can frequently offer valuable advice and guidance which will give better results at lower cost. In addition, it is usually very desirable to conduct actual tests of papers and carbons before placing large orders. This is especially true when exceptional legibility, a large number of copies, or unusual wearing qualities are required.

KINDS OF FORMS

Most forms consist of single sheets of paper, sometimes arranged in pads. These forms, consisting of only one part, are commonly known as flat forms. Flat forms are the simplest arrangement and are the cheapest to produce. Various improved arrangements of sets of multicopy forms are possible and are described here.

Although they are more expensive to produce, many of these arrangements save many times the additional production cost in reduced clerical cost and more accurately prepared forms. Inserting and removing carbons in multicopy forms; positioning the forms into alinement; the inserting into and removing from the typewriter of each form; alining each form in the typewriter—these are some of the steps which can be eliminated by specially arranged forms, some of which are described below. More accurate registration on copies is another advantage associated with these arrangements.

1. *Collated forms.* Multiple copy forms which are padded and arranged in sets according to color of paper, color of ink, or numbered copies.
2. *Interleaved carbon forms.* Same as collated forms, with the addition of carbon paper padded between the copies of each set. Construction is shown in Figure 65.
3. *Snap-out forms.* Each set of forms has carbons inserted between copies, with forms and carbons held in place by a stub. In both the single- and double-stub sets, the forms are perforated along the gripper stubs. In the single-stub variety, shown in Figures 66 and 67, the carbons are all attached to the gripper and are short of the edge of the form opposite the gripper. By pulling the gripper, and holding the sheets of the form at the edge which is carbonless, all carbons can be removed in one motion. In the double-stub variety, shown in Figure 68, each gripper is removable separately.

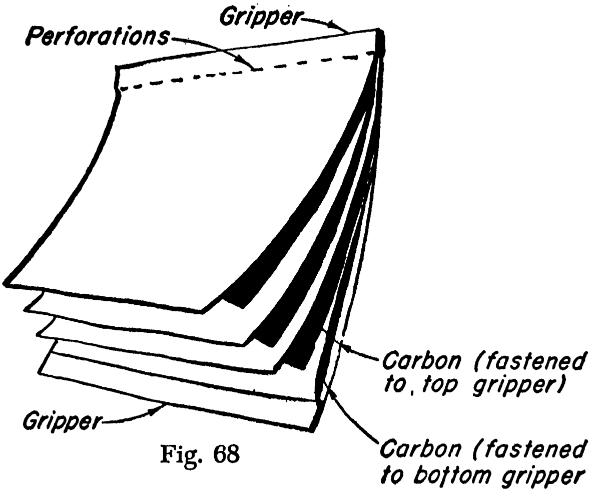


Fig. 68

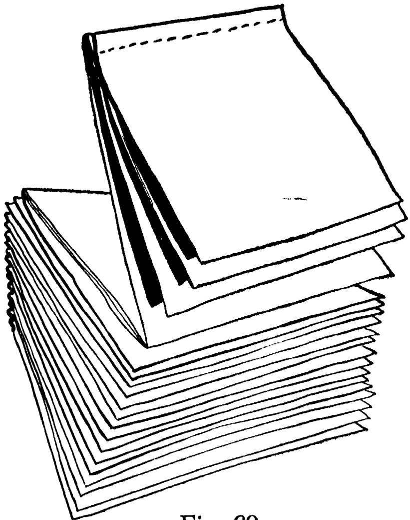


Fig. 69

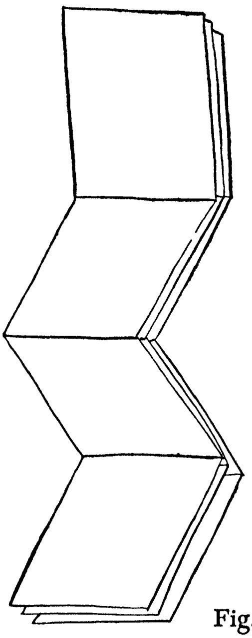


Fig. 70

Figure 68. Double-stub snap-out form permits removal of specified copies while retaining remaining copies intact for further transcription.
Figure 69. The continuous construction of these snap-out forms is useful in machine work where separate manual insertions are eliminated.
Figure 70. Continuous-strip form, no interleaved carbon.

By having some of the carbons attached to different grippers, some of the carbons may be retained after others have been removed. Information can then be added to those copies with the retained carbons.

4. *Continuous-strip forms.* Each set of identical forms is joined by perforations at top and bottom with the preceding and following set. Continuous-strip forms may or may not have interleaved carbons. The principal advantage of continuous-strip construction is that it eliminates the necessity of separately inserting the form in a typewriter or other machine each time a form is to be completed. Using continuous forms with mechanical attachments, rapid feeding, alining, and positioning of forms can be obtained.

   The single-stub snap-out continuous-strip form, shown in Figure 69, is the same as the single-stub snap-out form except that the bottom copy of each set is joined to the following set by perforations. Some of the information can thus be entered while the form is continuous, then the separated form remains intact with interleaved carbons for further entries and snap-out of the carbons. The continuous-strip form shown in Figure 70 is perforated at the folds, but does not have carbons interleaving. This type of form is commonly used on a standard typewriter with a "floating carbon" device which feeds continuous carbons between the continuous-strip forms.

   The continuous-strip form with single marginal punching, Figure 71, and double marginal punching, Figure 72, are used with a mechanical device attached to the typewriter or other machine and containing rotating teeth which aline the copies for more accurate positioning.

   Although not shown in the illustrations, the continuous-strip forms shown above also come with interleaved carbons.

   When it is important to insure an untampered copy of a form, continuous-strip forms with marginal punching are very useful in connection with special equipment (see page 211) which automatically retains a proof copy which cannot be altered.

5. *Fanfold forms.* The individual parts of each set are connected at the sides by a fanfold or accordion arrangement and at top and bottom as in continuous forms. All edges are perforated and the forms may or may not have interleaved carbons. The construction is shown in Figures 73 and 74. A set or part of a set may be separated from the continuous strip and it will still hold together, with carbons in place, because the forms are joined at the sides.

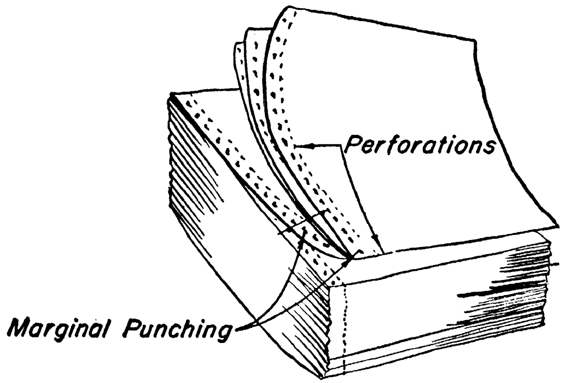


Fig. 71

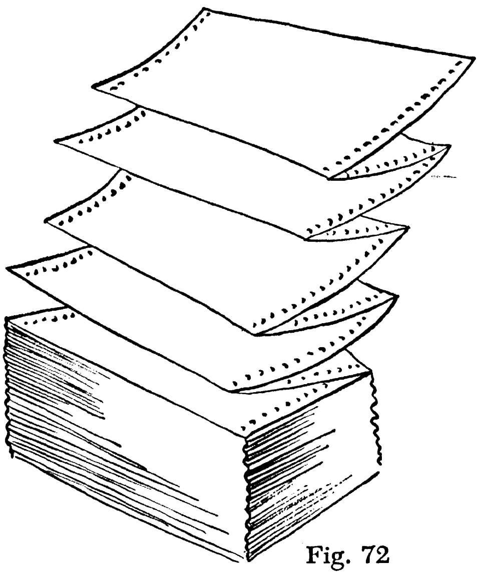


Fig. 72

Figure 71. Continuous-strip form with single marginal punching such as is used in connection with various mechanical devices.
Figure 72. Continuous-strip form with double marginal punching.

6. *Carbons.* When multicopy forms are being used, carbons may or may not be interleaved. When non-interleaved continuous-strip forms are used, one of a number of devices may be used on the typewriter to save on carbon costs. Interleaved carbons may be desirable in forms which are to be handwritten to save the time of setting up carbons, in typewritten forms which will require subsequent entries, in certain types of writing machines, as well as other situations. The carbons should always be chosen with care, especially when a relatively large number of legible copies are required. There are many different types and grades of carbons designed for different usages—typewriting, handwriting, and various types of office machines—to choose from.
7. *Uncoated or cut carbons.* When it is desired to withhold information from one or more copies of a form, certain areas of selected carbons may be uncoated or may be die cut to eliminate the carbon in the spaces where reproduction is not wanted.
8. *Block-out areas.* By blocking an area with solid ink, the visibility of a carbon imprint is eliminated for most purposes. Where applicable, this procedure is cheaper than the uncoated or cut-carbon techniques.
9. *Carbon-coated backs.* The backs of forms may be carbon-coated to eliminate the necessity for carbon sheets. This practice must be used with caution, because carbon tends to smear on the hands of the persons handling forms and may become very messy. However, when only one or two small areas are to be copied, a satisfactory practice is to spot carbon, placing the carbon only over the required areas.
10. *Sets with different widths or lengths of copies.* These can be used to keep off information not desired on certain copies.
11. *Various size carbons.* These can sometimes be used in one set of forms to keep certain information from one or more copies.
12. *Uncoated-edge carbon.* Another device to avoid transferring information to one or more copies of a snap-out form set. The edge of one or more of the carbons in the snap-out form protrudes beyond the forms and is uncoated. When pulled out, the remaining forms and carbons are left intact for further entries.
13. *Duplicating master form.* Used when more copies are required than can be produced by carbon copies. The form is printed on one side of a sheet of master paper to which a sheet of duplicating carbon is attached. The carbonized surface faces the reverse side of the master paper. When the form is printed on the master paper,

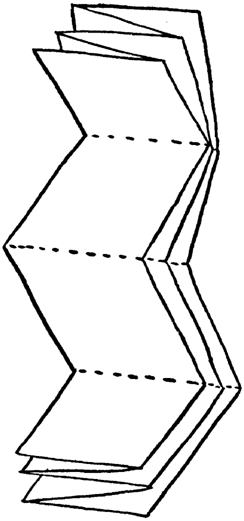


Fig. 73

Fig. 74

Figure 73. Fanfold forms, no interleaved carbon.
Figure 74. Fanfold form, with interleaved carbons.

a negative carbonized impression is produced on the reverse side. Pending use of the duplicating master form, a tissue sheet is usually placed between the carbon and the master paper. When the form is used, the tissue sheet is removed and the pressure of the pencil, typewriter, or other machine will fill in the spaces on the form and cause the duplicating carbon to create an impression on the reverse side. The completed form is then duplicated by a spirit duplicating machine as described in Chapter IX.

The duplicating master form may also provide flexibility in adding and removing information. Partial data may be placed in the master form and copies run off. Then additional information can be added and more copies reproduced. Or, information may be withheld from certain copies by covering any of the carbonized impressions with tape.

Because the specially arranged forms just described are more expensive to produce than simple flat forms, careful analysis should be made before ordering them. Detailed estimates should be compiled of the time saved by their use. In general, only if the cost of this saved labor compensates for the extra cost of the specially arranged forms is it desirable to use them.

FORMS-CONTROL SYSTEM

To insure that the advantages of good forms design are applied on a systematic basis to all the forms used in the enterprise, a forms-control system should be instituted. The full benefits of good forms design and standardization cannot be obtained without a vigorous forms-control program to insure universal and uniform treatment of all the forms in the enterprise. The essential characteristics of such a program are described in a later chapter, where the performance of the various functions of a systems department is discussed in some detail.

ANALYZING THE FORMS—A CHECK LIST

Proposed and existing forms should be analyzed in accordance with all the principles which have been discussed. Each item must be considered separately or important design considerations will be overlooked. To aid in assuring complete analysis, a forms-design check list should be used in connection with each form. The check list should ask questions which will tend to make possible improvements more evident.

A check list, such as the following, should be consulted in connection with the analysis of each form:

I GENERAL USE

1. What are the purposes of the form?
   _____ Are the purposes necessary?
   _____ Does the form completely accomplish its purposes?
2. _____ Can some other form be used for this purpose?
3. _____ Can this form be combined with some other form?
4. _____ Should the form be divided into separate forms?
5. _____ Are all necessary copies included?
6. _____ Are all copies necessary?
7. _____ Does the title indicate the use of the form?
8. _____ Is the title distinctive?

II CONTENT

9. _____ Has the form-control number been included?
10. _____ Are all recurring data printed?
11. _____ Have spaces been left for required dates?
12. _____ For forms to be transmitted, should spaces be provided for "to" and "from" information?
13. _____ Has required space for signatures and approvals been included?
14. _____ Should simple routing or handling instructions be printed on the form?
15. _____ Is serial numbering desirable?
16. _____ Are all included items necessary?
17. _____ Are all necessary items included?

III ARRANGEMENT

18. _____ Have adequate spacing and margin standards been used?
19. _____ Has it been tested for proper spacing?
20. _____ Are the most important data in the most prominent locations?
21. _____ Should both sides of form be used?
22. _____ Are data required for filing and sorting prominently located?
23. _____ Is spacing sequence logical (minimum hand travel and easiest motions)?
24. _____ Is sequence of items same as on forms from which and to which information is transcribed?
25. _____ Is sequence of items the same as used on similar forms?
26. _____ If it is to be mailed outside, should form be designed for window envelope?

IV SOURCES OF INFORMATION

27. _____ Have all users and potential users been consulted for suggestions?

28. _____ Have the persons responsible for the system been consulted for suggestions and approvals (supervisors, systems men, etc.)?

V PAPER AND PRINTING

29. _____ Is the size standard?
30. _____ Are the grades and weights standard and correct for usage, expected life, filing, and handling?
31. _____ Has colored paper been considered?
32. _____ Have all other required items been accurately specified on printing request (*e.g.*, size of order, method of printing, ink, holes for binders and special machines, collating requirements, carbon requirements, etc.)?

REPORTS AND CHARTS

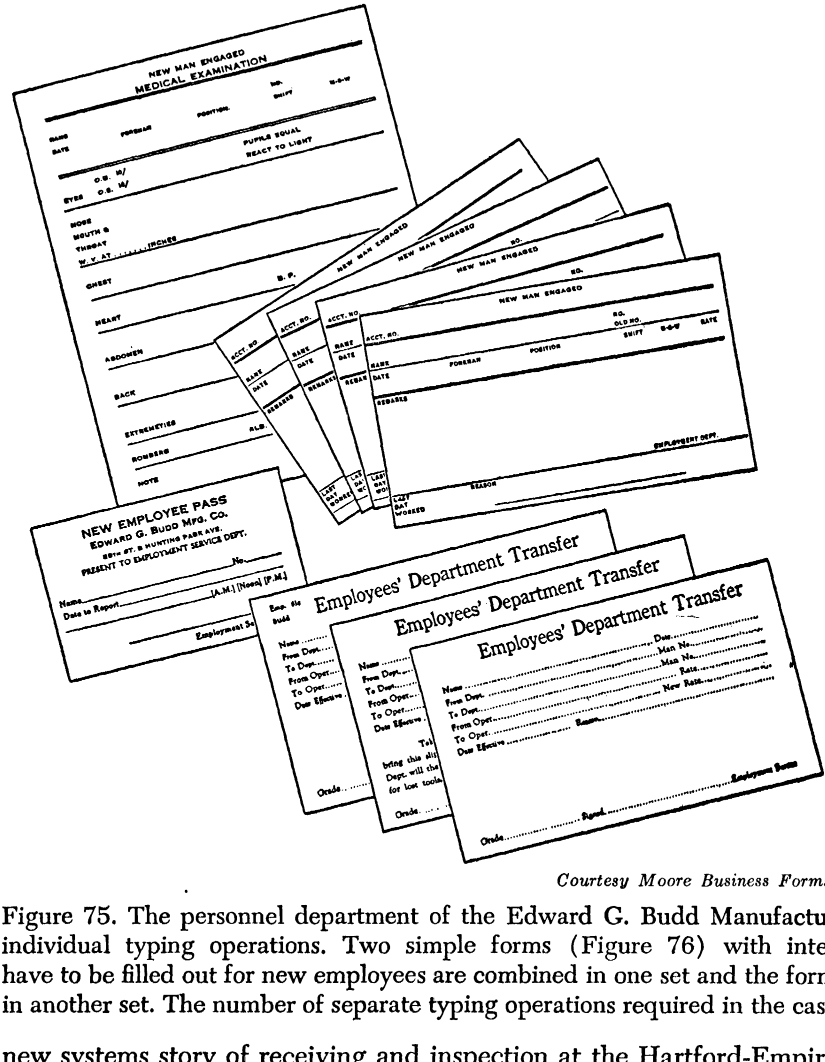
Reports and charts are forms which should be subject to the same kind of analysis as all other forms in the enterprise. Figures 12 and 13 in Chapter IV show suggested methods for gathering data. Reports, graphs, and charts of all kinds should be organized as efficient instruments for providing management with all the facts it requires for controlling operations and making policy decisions. Some essential questions in examining the reporting system of the enterprise are:

1. Are the various reports coordinated with each other—no unnecessary overlap and complete coverage of all essentials?
2. Are they issued at the right times—so that action can be taken before things go wrong or, next best, while they are happening rather than after they have happened?
3. Do they read easily—at a glance?
4. Do they compare performance with standards—highlight things which are not as they should be?
5. Do the reports summarize important facts—or do they present relatively unimportant details; or opinions where facts are available?

EXAMPLES OF IMPROVED FORMS DESIGNS

A few examples of how forms design can simplify operations are presented here pictorially. How the four sets of forms used in the Personnel Department of the Edward G. Budd Manufacturing Company were changed to two sets is shown in Figures 75 and 76. How R. H. Macy's uses a form to save the typing of a letter when sending a refund check to a customer is shown in Figure 77. How the forms were redesigned to simplify the receiving-inspection system at the Hartford-Empire Company is shown in Figures 78 and 79. The old and

BEFORE



Courtesy Moore Business Forms,

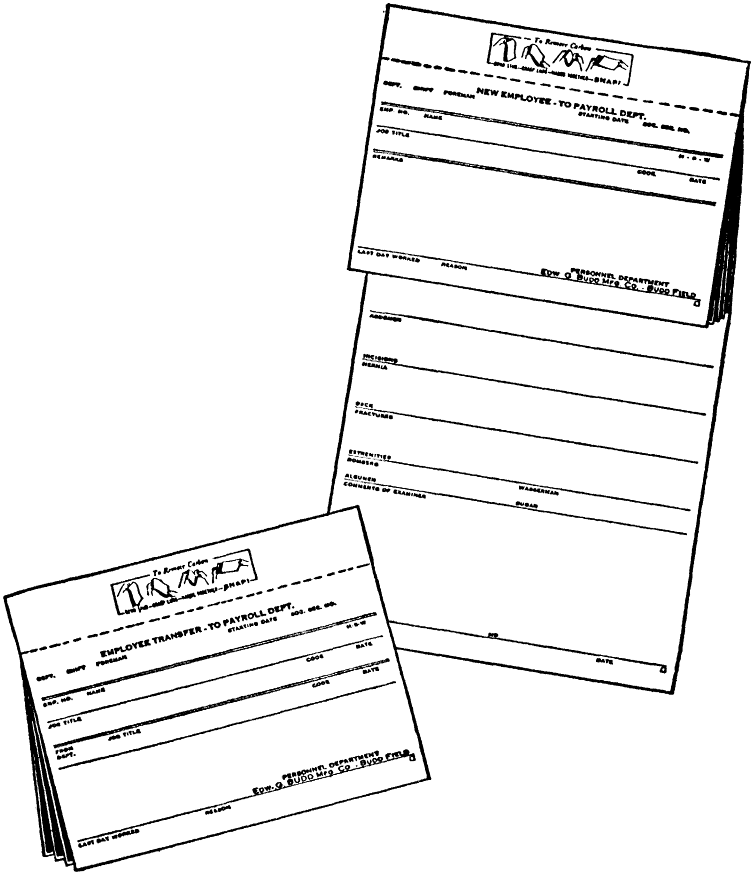
Figure 75. The personnel department of the Edward G. Budd Manufactur individual typing operations. Two simple forms (Figure 76) with inter have to be filled out for new employees are combined in one set and the form in another set. The number of separate typing operations required in the case

new systems story of receiving and inspection at the Hartford-Empire Company is described below:

THE OLD SYSTEM:

A copy of the Purchase Order and two copies of the Requisition are sent to the Receiving Department usually before material is received. But frequently delays occur in sending these to receiving. When material is received

AFTER



Inc. and The Budd Company

ing Company were using the above four sets of forms. This meant four leaved carbon sets were substituted for the four forms. All the forms that that is necessary for a transfer of an old employee to a new department is of a new employee is reduced from three to one.

first, confusion, misplaced materials and loss of control result. Lack of provision for recording and rerouting of materials delivered in error to the wrong building frequently caused delays in production and shipping.

Receipt of material is recorded on the Purchase Order and each copy of the Requisition, a total of three times.

A more complete record of each receival is made on the "Daily Report of Goods Received," a chronological list of each item. One copy was circulated

PLEASE NOTE

The enclosed check was issued as our refund for the merchandise you recently returned. If you requested an exchange of merchandise, we were unable to carry out your instructions.

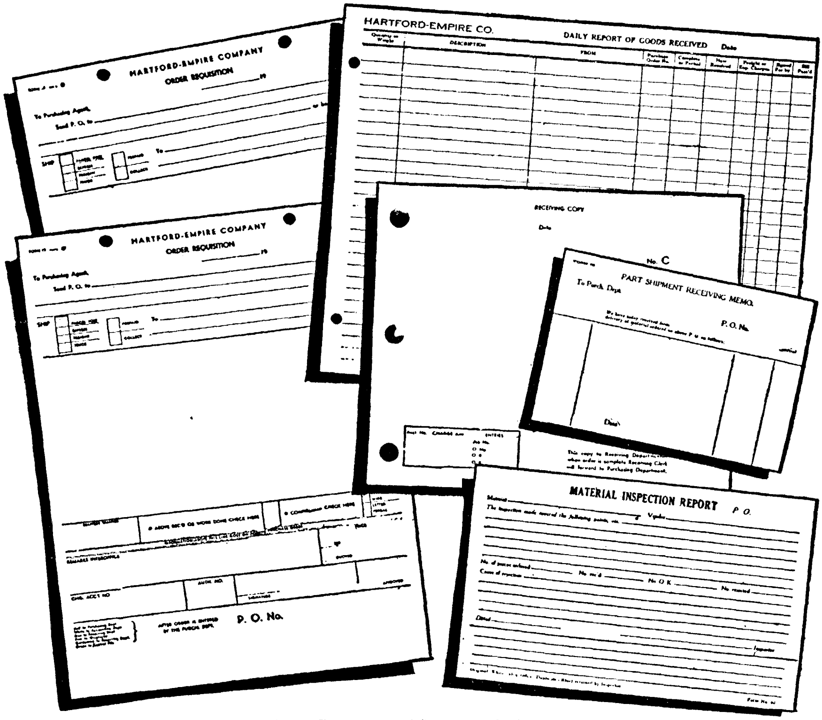
If the salescheck was not returned with the merchandise, the refund was issued at the current selling price. Cut lengths of material over two yards (three yards for upholstery fabrics) are acceptable for refund at 25% less than the purchase price.

Macy's
HERALD SQUARE, NEW YORK 1, N.Y.

F 4631A 5-50

Courtesy Macy's New York

Figure 77. This Macy's form eliminates the necessity for typing of a letter when issuing a refund.



Courtesy Standard Register Company of Dayton, Ohio, and the Hartford-Empire Company

Figure 78. The old forms situation in the receiving-inspection system at the Hartford-Empire Company.

to the head of every department which had requisitioned one or more of the materials recorded on the sheet. This caused delay in advising the various departments and loss of time by each department in searching the entire sheet to find the items they were concerned with on the sheet.

When material required inspection, an Inspection Report (original only) was written, then posted to a log book. The report went either to the shop or Inspection file. The only complete record of inspections was the log book in chronological order which made reference difficult.

When a partial shipment was received, a 3-part Receiving Report was written and the item entered on the "Daily Report of Goods Received."

Two copies of the Report went to Purchasing. One of these with the approved invoice attached went to Accounting. The third copy traveled with the material.

THE NEW SYSTEM:

A combined receiving-inspection form was designed for both complete and partial receivings. All information required by any interested department was

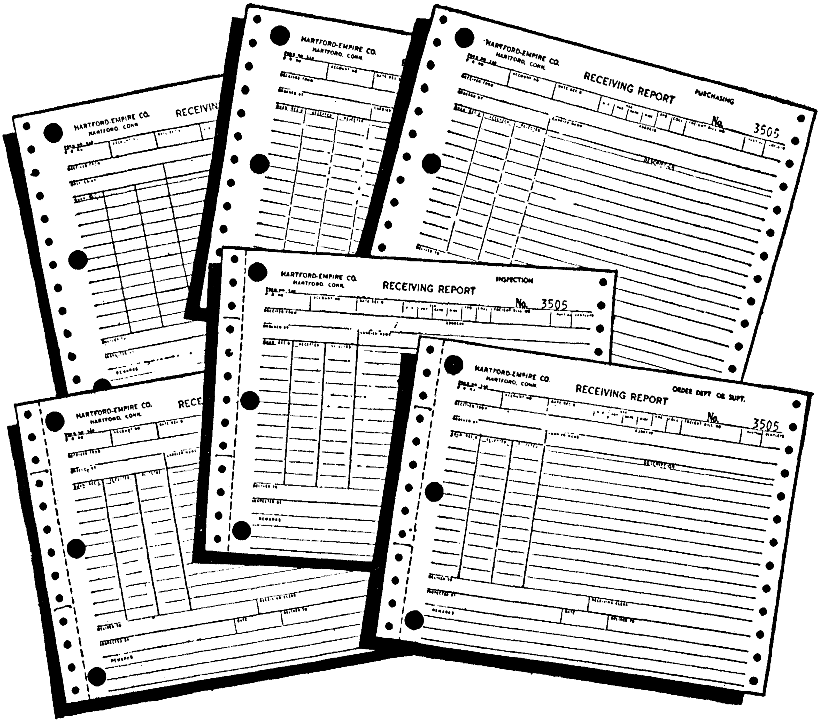


Figure 79. The new forms situation at the Hartford-Empire Company after analysis of the receiving-inspection system.

included in the form. This eliminated delays formerly encountered in searching for additional information, particularly in the Accounting Department.

Sufficient copies were provided so that from a single writing everybody interested in both materials received and the result of the inspection would be notified. This eliminates the need for rewriting all or part of the information several times.

The inspection set was designed with three copies, one of which identified the material and required inspection information before the use or showing of the material identified. A second copy gave the inspection department a complete record of materials inspected. The third copy assured delivery of the information required for inventory control.

Two copies refold in a locked compartment to be delivered later to the requisitioner and Accounting Department assuring both of complete, accurate copies of all receiving records.

A three-part Receiving Report, identical in design, provided control for materials delivered to the wrong building. The first copy is used to advise the purchasing department, the second to identify the material to the proper building for receiving, the third is a record of materials transferred to the other building.

TYPES OF SAVINGS

It is desirable to keep in mind the three areas where cost savings may be made by effective forms design:

1. The cost of the form
2. The cost of filling in the form
3. The cost of operating the system with the form

The potential savings in each of these three areas will vary from enterprise to enterprise. Moreover, in some cases, a saving in one category must be sacrificed to enable a saving in another. For example, by spending a little more on the production of a form, it might be possible to save quite a bit on the cost of filling in the form. In these cases, the magnitude of the possible savings will determine which alternative will be adopted.

In evaluating the possibilities of savings in each of these areas, it is worthwhile to consider the relative amount of money represented by these costs. It is pretty safe to say that in most companies the cost of filling in the forms is very large as compared with the cost of the forms and that the cost of the operating systems is very large as compared with the cost of filling in the forms. For this reason, the logical approach in designing a form is to give first consideration to the requirements of the system; then consider reducing the clerical cost to a minimum; and finally save as much as practical on the paper and printing costs. In all cases, alternative costs must be accurately evaluated: will a $100 saving in one area be made at the sacrifice of more than $100 in another area?

IX

ANALYZING MACHINE UTILIZATION

ONE OF THE OUTSTANDING features of modern industrial enterprise is the great economy in the production of goods and services which has been effected through the use of labor-saving machinery and equipment. During the earlier stages of the development of our present mechanized economy, the use of labor-saving devices was largely confined to direct-labor factory operations. With increased specialization of functions in most enterprises, the importance of costs of the service and coordinating activities of the enterprise which are performed in offices has increased. Properly to administer the huge business organizations, top management requires much larger amounts of statistical and other control information. The cost of these indirect service activities may now exceed the cost of the direct productive activities.

As a result of this rather recently acquired added importance and cost, more and more emphasis is being placed on the design and development of labor-saving equipment for the office and on the correct utilization of this equipment. In this chapter, we will discuss some of the methods for promoting the best utilization of office equipment. We will also outline the principal kinds of equipment which might be of use for promoting the operation of procedures.

Can you perform systems activities without furniture and equipment? The answer to the question is the same as the answer to the question: Can you manufacture a product without machinery? Obviously, no.

However, you can manufacture a product using hand tools rather than power-driven automatic machinery. Your production costs will be very high if you do and, before long, you will find that your costs are not competitive with the other members of your industry.

Similarly, you can perform your systems operations with the crudest kind of equipment. However, the results of your backward policy may be very high overhead costs which inflate product cost.

It therefore behooves the systems analyst to be certain that he has, wherever possible, considered the use and economy of all possible labor-saving equipment for the performance of the clerical activities in his procedure. The obtaining of facts on machine utilization was discussed and illustrated in Chapter IV. We will outline in this chapter some of the principal types of equipment used for the performance of clerical operations. This outline cannot disclose the places where practical economical application is possible. The possibility and advisability of applications vary from enterprise to enterprise. Only a thorough knowledge and study of the systems requirements and detailed study of the relative economy of operation will disclose the best areas for application.

POSSIBLE ADVANTAGES FROM THE USE OF EQUIPMENT

Some specific advantages will accrue when maximum advantage is taken of possible savings through the use of mechanical devices.

1. Clerical labor may be reduced. This will frequently more than pay for the machine cost in a short time.
2. Machine transcription of work is usually more legible, neater, and more accurate.
3. The simplification and standardization of the work which is frequently made economically possible by the machine may permit the employment of less skilled and less expensive office help.
4. Reports and statistical information for control and coordinating purposes can often be made available more frequently, more currently, and at lower cost as a result of the use of office machines.

5. Properly chosen equipment may save space (fewer people required and less equipment space), and permit improved lay-out.

STANDARDIZATION OF EQUIPMENT

Some degree of standardization on particular makes and kinds of office equipment is usually advisable. Carefully chosen standards should promote efficient use of equipment which is well suited to the enterprise's needs.

Standardization provides for increased flexibility in the use of both equipment and personnel. It may thus reduce the total amount of equipment needed because the units are interchangeable between departments. Standardization allows for easy transfer of personnel from one department to another, with no loss of time to learn how to operate the equipment. It may thus also reduce the number of required personnel because of this ability to shift them so readily to handle peak loads.

In addition, maintenance and repair costs will probably be lower with fewer different models. Price savings may be possible because of the purchase of large quantities of equipment and supplies from one company.

Standardization, however, should not be allowed to stand in the way of using the best-suited equipment for each job. Whereas it would be very nice to standardize on one size of file, if different requirements call for different sizes, it would not be economical to prescribe the use of letter-size files at all times. In this case, two or more standard sizes should be adopted.

SYNCHRONIZING PERSONNEL AND EQUIPMENT

To use office equipment and personnel to maximum effectiveness, it is necessary to balance the time of both equipment and personnel. When the personnel must wait for the machine a portion of the time, valuable labor is wasted. When the machine is idle a portion of the time, rental or depreciation charges accrue. Perfect synchronization of the personnel and machines is therefore the desirable objective.

When perfect synchronization cannot be obtained, it is necessary to compromise in favor of maximum utilization of either the personnel or the equipment. When the hourly personnel cost is greater than the hourly machine cost, the compromise will favor personnel utilization. In some cases, where the equipment cost is great in comparison with the labor cost, maximum utilization of the machine will be the more important goal.

In analyzing the work of jobs involving the concurrent performance of personnel and equipment, a Multiple Activity Process Chart is frequently very valuable. In these problems, time is the important coordinating element. The Multiple Activity Process Chart permits the analysis of the details which are performed both simultaneously and alternately by one or more persons and/or one or more machines.

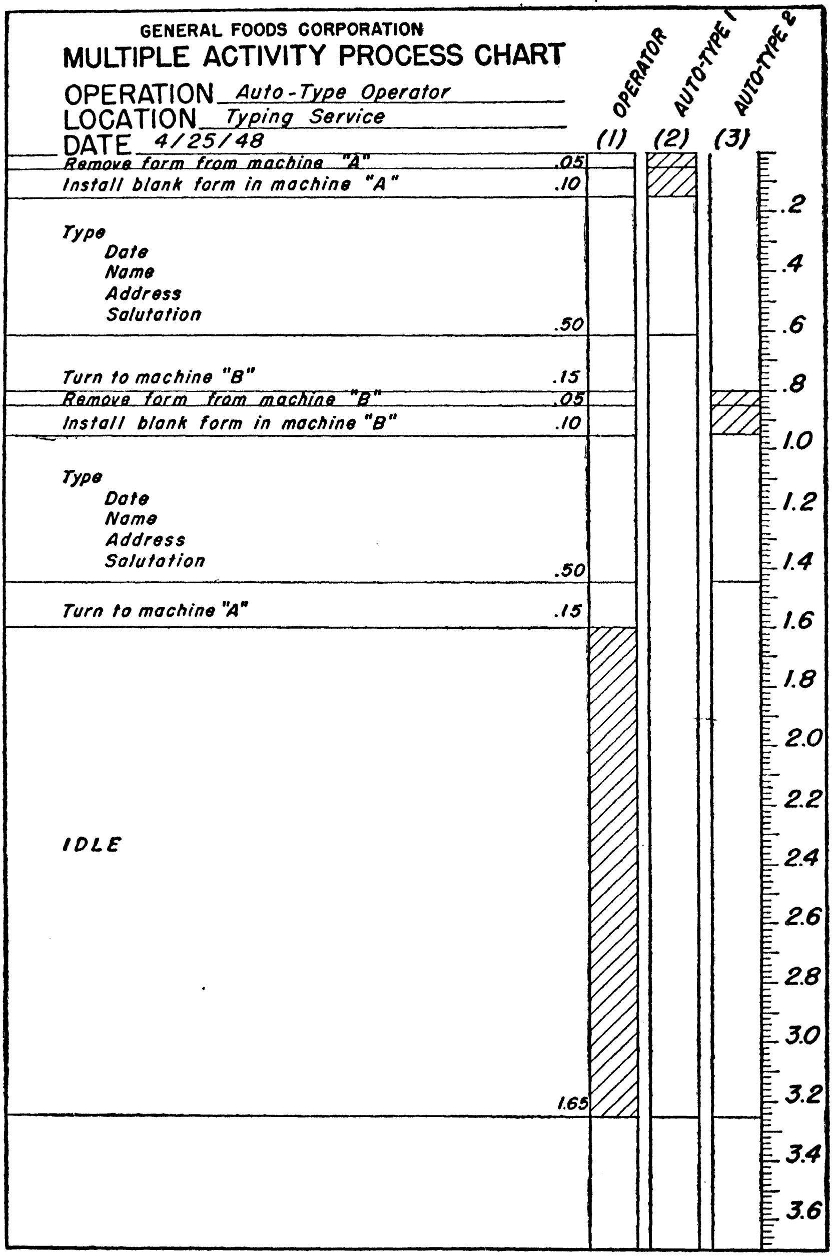
To construct a Multiple Activity Process Chart, it is first necessary to establish the average times for the various details or elements of the personnel and equipment activity. This may be done by observation with a stopwatch, from standard time study data, and/or by determining the operating speeds of the equipment. (See Chapter VII.)

Having determined the sequence and time for all the elements of both persons and machines, the construction of the chart consists of alining the elements of the activity of each person and machine on the basis of time of occurrence.

In Figure 80 is shown a Multiple Activity Chart of one autotype operator and two autotype machines. The autotype machine is briefly described on page 201. The charted job consists of manually typing the date, name, address, and salutation of a form letter, and then leaving the copy in the machine for the body of the letter to be automatically typed. Since a pamphlet is sent under separate cover at the same time that the form letter is mailed, two envelopes must be addressed for each form letter.

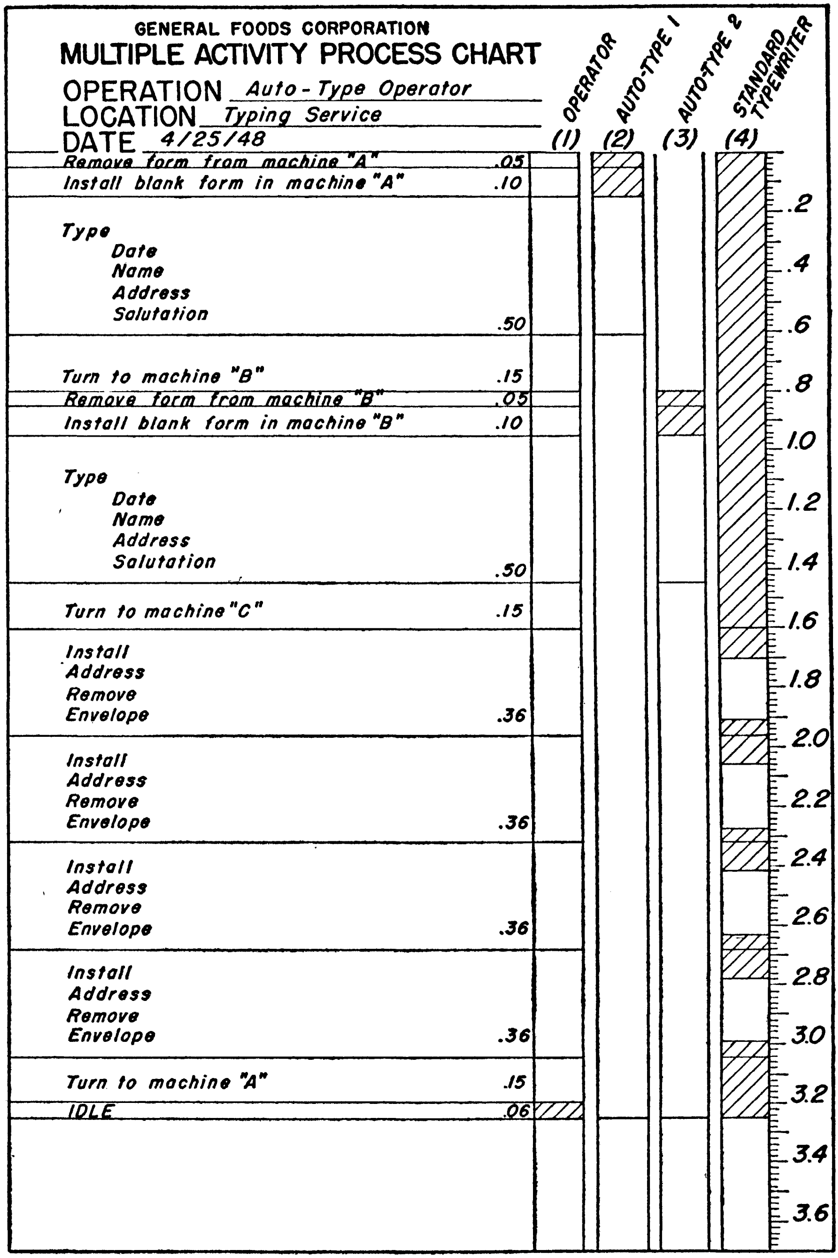
The elements of the activity are indicated in the left-hand portion of the chart. In the first right-hand column (1) is charted the operator's activities; in the second column (2) and the third column (3) are indicated the activities of the respective machines. The graduations of the time scale are placed to the right of the third column (3). When any person or machine is idle, the column is cross-hatched. This chart shows that the operator was working only 49 per cent of the time and was idle 51 per cent of the time. The machines, however, were active 95 per cent of the time, idling only 5 per cent. Since the hourly operator cost is materially greater than the hourly machine cost, this personnel utilization ratio was not good.

To improve this situation, it is necessary to obtain some other activity for the operator while she is waiting for the form letter to be completed automatically. Some other person is presently typing the two envelopes required for each form letter. By assigning a surplus standard typewriter to the operator, she can address all the required



Courtesy General Foods Corporation

Figure 80. Multiple Activity Process Chart—relates graphically the time cycles of the operator and the two autotype machines she operates.



Courtesy General Foods Corporation

Figure 81. By analysis of the operation shown in Figure 80, the new improved synchronization was developed as shown in this chart.

envelopes during her idle time. The low utilization (28 per cent) of the typewriter is not significant because its hourly cost is negligible. The improved procedure is shown in Figure 81.

If two envelopes per form were not required in the example just cited, it might have been advisable to assign two more autotype machines to her. This would also have doubled her productivity.

APPLICATION OF MOTION-ECONOMY PRINCIPLES

In the design and construction of office equipment for the general and special tasks of the office, the principles of motion economy explained in Chapter VII should be applied. Principle No. 6 states that the hands should be relieved of all work which can be performed by other parts of the body. Whenever possible the machines should therefore make use of foot-activated mechanisms or other devices which do not require use of the hands.

Principle No. 5 says that the inherent abilities of the various parts of the human body should be considered. As an example, a well-designed typewriter keyboard would take the inherent abilities of the various fingers of each hand into account. This would be done by:

1. Determining the average relative strengths and capacities of each of the fingers of the right and left hands.
2. Determining the frequencies and sequences of occurrence of the various letters of the alphabet, numerals, punctuation marks, capital letters, etc. in ordinary usage.
3. Assigning positions on the keyboard so that
   a. The relative frequency of striking the keys will correspond to the relative strengths of the fingers.
   b. The most usual sequences of strokes will provide simple, balanced motion patterns.

The Dvorak-Dealey Simplified Typewriter Keyboard was designed with these principles in mind.* Among the advantages claimed for this scientifically designed keyboard are:

1. The keyboard simplifies the finger stroking, makes for better balance between the hands, and aids rhythm and timing. This enables the typist to do the work with greater ease and to increase the amount of work produced.

* August Dvorak and others, *Typewriting Behavior, Psychology Applied to Teaching and Learning Typewriting.* New York, American Book Co., 1936.

2. Fatigue is reduced because more work is done with the stronger right hand and less with the weaker left hand.
3. Student progress on the new keyboard is twice to three times as rapid as on the old keyboard.

ANALYSIS OF FILES AND FILING METHODS

Most systems operations and communications are performed on papers and forms. A good proportion of these are eventually filed. Analyzing the files and filing methods in the office therefore constitutes an important aspect of the work of reducing operating costs.

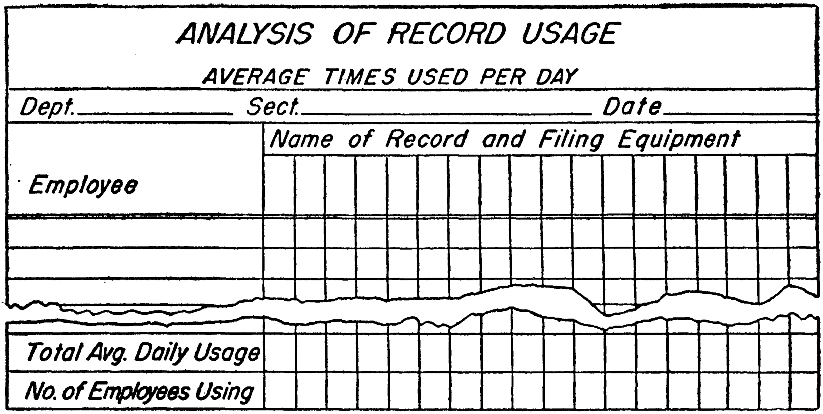


Figure 82. Analysis of Record Usage—provides data for implementing a files analysis program.

If duplicate copies are filed; if active and dead records are intermingled; if old useless records are retained indefinitely; if the indexing systems are incorrect and/or not uniformly followed; if the most suitably designed equipment is not used; if these or other poor filing practices are followed, the enterprise may be burdened with unnecessary expenses.

What are some of the kinds of information required for systematic analysis of filing procedures?

1. Nature of materials filed
2. Purpose of filing the materials
3. Magnitude of advantages from visible indexing
4. Indexing methods
5. Sizes of materials

6. Quantities of materials filed
7. Any fastening methods used
8. Number of references made to materials. A sample form for tabulating this file usage information is suggested in Figure 82.
9. Nature of references, i.e. for posting, obtaining information, etc.
10. Period of active usage of materials
11. Requirements for retaining inactive materials
12. Procedure for removing inactive materials to inactive and/or dead files
13. Persons who have access to file
14. Methods of charging out materials
15. Time spent by various personnel in maintaining files
16. Kinds of equipment used
17. Usage of equipment—proper labeling of drawers, use of guides, balanced distribution of material, etc.

ANALYSIS OF REPRODUCTION EQUIPMENT

Use of the most suitable reproduction methods plays a significant part in the development of successful, low-cost clerical procedures. Thorough and careful analysis of the currently used methods will frequently pay large dividends in savings and improvements. As described later in this chapter, there is a wide range of methods of producing and reproducing systems information. The chart on page 210 suggests some of the more desirable alternatives for the more usual kinds of duplicating work. The following list summarizes the various types of equipment which are mentioned in this chapter.

1. Pencils of varying hardnesses
2. Inks of varying permanence
3. Stamps
4. Typewriter, including electric, automatic, billing, Vari-Type and Teletype.
5. Tape adding and calculating machines
6. Bookkeeping and accounting machines (including punched card)
7. Addressing machines
8. Microfilming equipment
9. Recording or dictating machines
10. Letterpress printing
11. Lithograph or planograph printers (including offset)
12. Rotary relief duplicators such as the Multigraph machine

13. Stencil process duplicators such as the Mimeograph machine
14. Hectograph process machines
15. Contact and projection photocopy machines
16. Facsimile equipment
17. Telautograph machine.

EQUIPMENT-CONTROL PROCEDURE

To promote the proper selection, procurement, standardization, usage, and maintenance of office equipment so as to provide the maximum benefit to the enterprise, an equipment-control procedure should be established. The essential aspects of such a procedure are discussed in a later chapter covering the operation of the systems functions.

SOURCES OF INFORMATION

New developments and inventions in the field of office-machine design and construction are constantly occurring. Many of these innovations will furnish the basis for improving office services at lower costs. To keep up with these developments, the systems analyst should be alert for announcements in the office-management literature which he should read regularly. He should contact the companies manufacturing the kinds of equipment which might prove useful in the enterprise. The office-equipment companies will usually send literature and salesmen to describe their products to any interested person. The analyst should attend the annual business shows which feature displays of the newest refinements in office machinery.

DEMONSTRATIONS

Before purchasing a new machine, it is advisable to have a demonstration of its application to the actual work. In many cases, trial installations can be arranged. In this way, much can be learned about the machine and its possibilities for a particular application in advance of committing large sums of money.

EQUIPMENT DECISION BASED ON ECONOMY STUDIES

It is essential that the decision to install or to reject a piece of office equipment be made only after a detailed systems and economy study. Some of the principles and possible pitfalls inherent in such a study will be outlined in the next chapter. Among the factors to be investigated are the following:

1. Changes in systems and forms which will be required by the machine
2. Required machine capacity
3. Machine speed
4. Machine maintenance costs
5. Machine life
6. Machine purchase costs
7. Material and labor costs using the machine
8. Material and labor costs using the present methods
9. Any alternative machines or methods which might be used.

OFFICE EQUIPMENT

It is impractical and undesirable to attempt to describe here in any detail the large number of different types and makes of office equipment which might be useful to the systems analyst. It would be impossible in one volume to describe completely the myriad types of equipment. Moreover, the detailed descriptions would be incomplete and outdated within a relatively short time because of the constant stream of improvements and new developments. However, an attempt will be made briefly to survey the available types of office equipment, pointing out here and there possible uses and advantages.

DESKS, TABLES, AND CHAIRS

The desk is one of the most common pieces of office equipment. Many special designs of desks for special purposes have been made. Some of these designs have improved the utility and efficiency by a careful consideration of the motion economy of the worker.

The determination of the best type of desk for each enterprise will vary, depending on the nature of the business and the methods of operation. Some generally applicable considerations are mentioned here.

The principal types of standard desks are the double-pedestal executive desk (36 or 38 by 66 inches), which is a larger, more elaborate version of the double-pedestal clerical desk (36 by 60 inches); the single-pedestal clerical desk (30 by 42 inches); the double-pedestal secretarial desk (36 by 60 inches); the double-pedestal (32 by 55 inches) and single-pedestal (30 by 42 inches) typewriter desks.

For clerical work, the double-pedestal or single-pedestal flat-top desk is commonly used. The single-pedestal is preferable when, as is usually the case, the added storage space in the double-pedestal desk is not necessary. The smaller desk allows greater flexibility and work flow in office lay-out planning and conserves floor space. To illustrate the space saving in using single- as against double-pedestal desks, consider that at least 2½ feet must be allowed behind each desk for the chair and worker to move around. The total floor area taken by the double-pedestal desk is thus 27½ (5 by 5½) square feet as compared with 17½ (3½ by 5) square feet by the single-pedestal desk. This saving of 10 square feet per desk can be converted into dollars per year by multiplying by the annual square-foot rental charge.

For the full-time typist, the double- or single-pedestal typist's desk provides a comfortable work place. However, for the person who divides her time between typing and clerical work, such as a private secretary, it is usually convenient to use a secretarial desk in which the typewriter is at the left- or right-hand side of the desk and the entire desk top is available for clerical work.

When drawer storage space is not required, it is preferable to use a table rather than a desk. Tables are cheaper than desks. Lacking large storage capacity, tables discourage the accumulation or hoarding of unrequired material in the drawers. They may thus promote neatness and efficiency. The table sizes should usually correspond with the standard desk sizes.

Chairs of proper height and construction should be provided for all categories of workers. These chairs—executive-type swivel chairs, stenographic chairs, straight-back chairs—should all provide proper body support and comfort. They should promote proper sitting posture to reduce fatigue to a minimum.

In considering whether to use wood or steel furniture, what colors will be selected, what sizes and styles will be established as standards, many factors, such as appearance, durability, utility, maintenance, cost, etc., must be carefully evaluated.

FILES

Files for the office may generally be procured in wood or steel. Steel files have been accepted as generally preferable by a large number of offices and are standard equipment in most companies. Steel files take wear and tear better, are more serviceable, and do not burn. However, because of the insulating quality of wood, a wood file affords greater heat protection to its paper contents in case of a fire which does not reach the cabinet.

Vertical letter- and legal-size files come in one-, two-, three-, four-, and five-drawer units. The four-drawer unit is the most usual standard. The five-drawer type is more economical in so far as first cost and floor space usage are concerned. However, special stools must be used unless only girls of above average height are employed. The three-drawer type can be arranged to serve as a counter and is especially valuable when the filed information is required to answer the queries of persons calling at the office.

Visible-file equipment is made in a very large variety of styles. Only some of these will be mentioned here. Because of extra space and relatively high initial and operating costs which this equipment sometimes requires, careful analysis of the possible alternatives should be made before a decision is reached to convert to visible file equipment. For many applications, involving frequently used records, correctly chosen visible-file equipment will save time and over-all operating expenses.

Drawer-type visible index files are constructed to have the overlapping margins of the cards visible. The visible portion of each card makes for ease in location of the cards as well as providing a means for incorporating a graphic signaling system on the cards. Both sides of a card may be used. Other visible index file systems are made in which the file cards are attached to vertical swinging panels or are filed into specially prepared binders.

Various types of vertical and horizontal rotary files are made. These files have a relatively large capacity and may save time in locating and positioning cards for posting operations. The horizontal variety may prove especially valuable when several persons must work simultaneously with a large volume of records.

MICROFILMING EQUIPMENT

To economize in storage space, many companies have found it desirable to microfilm certain categories of documents, which are then destroyed. Various types of equipment are available for this purpose.

TYPEWRITERS

Standard office typewriters come in various models. The principal sources of variation are the size of the type (elite and pica are usual sizes), size of carriage or bed, manual versus electric-power-driven operation, and cylinder versus flat-bed type.

The size of the carriage or bed determines the maximum size of sheet which can be used. The principal advantage of the electric-driven typewriter over the regular manual variety is the more even pressure, resulting in better copy, reduced typist fatigue, greater number of legible carbons, and higher possible typing speeds. The flat-bed typewriter is valuable when typing on sheets of heavy stock which cannot be bent around a typewriter cylinder.

A special typewriting machine which is well adapted for preparing master copy for reproduction is known as the Vari-Type machine. This machine, having standard letter keyboard, has the following two features which are valuable in the preparation of forms, manuals, instructions, for offset printing as well as many other duplicating methods:

1. A large variety of styles and sizes of type which are very easily changed in a few seconds.
2. Flexible spacing which permits straight margins.

An automatic typewriter (autotype) consists of a standard typewriter which is controlled by an electrical mechanism. The electric mechanism is governed by a perforated roller strip which has been prepared with a standard message or letter. This standard message or letter can then be typed automatically. When portions of the message must be varied, the machine can be stopped, the special portion typed in manually, and then the remaining standard portion completed automatically. An example of the use of the machine is given on page 191.

COMPUTING MACHINES

Computing machines vary all the way from slide rules and reckoning tables to complex electronic computers. In between these two extremes are the adding and subtraction machines and the calculators that are most commonly found of great value in clerical operations.

For multiplication, division, and related operations which do not require extreme accuracy, the slide rule is an inexpensive and very efficient computer. Tables, curves, and nomographs are also very valuable in many applications.*

* Slide rules are nomographs with sliding scales. For a discussion of the construction of all kinds of nomographs, the reader is referred to the following books: Kraitchik, Maurice, *Alignment Charts*, D. Van Nostrand Company, Inc., 1944; Levens, A. S., *Nomography*, John Wiley and Sons, 1948; Douglass, R. D. and Adams, D. P., *Elements of Nomography*, McGraw-Hill Book Co., 1947. Also, *An Index of Nomograms* by Douglas P. Adams, Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York, 1950, is a guide to over 1,700 time-saving and error-reducing published nomographs in 21 fields of science and engineering.

Adding and subtraction machines may be classified with respect to three principal criteria: (1) listing on tape versus non-listing machines, (2) full keyboard versus ten-key arrangement, and (3) hand-lever versus electric-powered machines. Multiplication and division can be performed on adding machines, although not as rapidly as with calculators which have automatic features especially designed for multiplication and division.

DICTATING MACHINES

One of the important problems of efficient office operation is the scheduling and loading of the stenographic and secretarial workers. Dictating machines may prove very effective in increasing typists' output because of the increased scheduling flexibility they permit. There are many varieties of equipment, the three principal types being the

1. Wax or composition cylinder machines
2. Plastic and paper disk machines
3. Wire and tape machines

Most types have separate dictating and transcription or reproduction units. In addition to being used to facilitate the preparation of typed correspondence and other copy, many of these machines are well adapted for recording conferences, discussions, and telephone conversations.

BILLING AND BOOKKEEPING MACHINES

Billing and bookkeeping machines are combinations of various types of calculators and typewriters with properly adjusted stops. A great variety of these machines are available. With the exception of the cash register type of bookkeeping machine, these machines have typewriter keyboards. They are either cylinder or flat-bed type: in the cylinder type, forms are fed around the cylinder as in the standard typewriter; in the flat-bed type, the material being typed is placed in a bed over which the typing portion of the machine moves. When properly applied, billing and bookkeeping machines may reduce labor and errors, and increase posting speeds in many aspects of bookkeeping and accounting work.

MECHANICAL COLLATORS

Various types of mechanical collators are manufactured. The simplest kind would be a vertical arrangement of several bins for hand collating. Others provide for no more than the automatic ejection of the pages from the two or more vertically arranged bins. Still others will completely automatically collate and staple sets of two or more pages.

SORTING EQUIPMENT

Many sorting devices such as pigeonhole racks are available from office-equipment manufacturers. They should be chosen with care to insure that motion-economy principles are followed, especially with regard to normal and maximum work areas.

Manual selecting devices using rods, bars, or other special sorting tools, together with cards which have notches, holes, slots, etc. may provide a means for rapidly separating previously coded information.

PUNCHED-CARD EQUIPMENT

Punched-card equipment uses cards into which holes have been punched in predetermined coded positions to indicate the data. The primary advantages of using punched cards is that these data on the card can be operated upon automatically by different machines, can be analyzed over and over again in different ways for different purposes without recopying the data, can be summarized by machine as frequently and in as many ways as desired. For certain applications having sufficient volume of work, punched-card equipment can be very valuable. This equipment can be arranged to perform many business functions which were formerly reserved for the human brain.*

The punched-card system of the International Business Machines Corporation is typical. A punching machine transcribes alphabetical and numerical information into the cards. To arrange the cards in any desired order for analysis or summary, they are fed through a sorter machine which arranges cards automatically in numerical or alphabetical sequence, according to any classification of information punched

* Professor Norbert Wiener coined the word *cybernetics* to cover the subject of "control and communication in the animal and the machine." In his book *Cybernetics* published by the Technology Press and John Wiley and Sons, Inc., New York, 1948, Dr. Wiener presents a most instructive and refreshingly dramatic discussion of this subject.

into them. Where only certain cards are required for a given analysis, the sorter will select these. A tabulating machine will read the punched and sorted cards and selectively add, subtract, accumulate, and print desired information.

Many additional types of machines supplement those just mentioned. Some will translate and print the punched information; punch the summary information of the tabulator onto summary cards; electronically translate pencil marks on a card into punched holes; duplicate part or all of the information from one group of cards into another; merge two groups of cards arranged in sequence; withdraw or separate one group from the entire deck; match or compare two decks of cards; check the sequence of a deck of cards; multiply, divide, cross-add, and cross-subtract different combinations of data and punch the results in the same cards. Various tape reading and punching machines can convert punched cards into punched teletype tape and also convert punched tape into punched cards. Long distance transmission of punched-card information is thus possible, using standard teletype equipment.

The flow chart on page 264 illustrates the application of punched-card equipment to a payroll procedure.

PRINTING AND DUPLICATING EQUIPMENT *

Letterpress printing machines. Most printing is done by the letterpress (relief, typeset, or type-high) process, although the printing presses that account for the big volume of output are a far cry from the small simple presses from which the process took its name. In the letterpress method, reproduction is accomplished by the transfer of ink from a raised (or relief) image to the paper or other surface on which the copy is desired. The raised image is ordinarily made up of (1) metal type characters locked in a frame (or chase), (2) a zinc or copper photo-engraving (cut), (3) a solid type-metal plate (stereotype) which has been cast from a papier mâché matrix (mat) made from an original typeset or photo-engraved form, or (4) a hard-surfaced casting (electrotype) similar to a stereotype except that it is of harder metal and is electroplated for long wear.

The presses which print from such forms are of widely varying design and size. There are platen presses (both the type form and the

* The material here presented has been adapted from *Appraisal and Control of Duplicating Service,* April 1949, Executive Office of the President, Bureau of the Budget.

impression surface being flat), horizontal and vertical cylinder presses (type form being flat and impression surface cylindrical), rotary presses (both type plate and impression surface being cylindrical), and numerous special adaptations of these basic designs. These machines range from letter-size platen presses to the giant rotary web and web-perfecting presses on which metropolitan newspapers are produced. In between these extremes, the great volume of printing is done on flat-bed cylinder presses, the smallest common size of which (a pony press) prints a sheet 17 by 22 inches—an area four times the ordinary letter-size sheet most frequently turned out in duplicating shops.

Obviously, however, the typesetting and casting machinery (Linotype, Intertype, or Linograph composing machines, Monotype and logotype casters, stereotype casting equipment, and so on) are as important a part of the letterpress method as the presses themselves.

Lithographic or planographic printing machines (including offset variation). In the lithographic method the transfer of ink is from an image that is neither raised nor recessed but is part of an almost perfectly plane surface. Hence the term "planograph." The method is based simply on the affinity of oil for oil and the lack of affinity of oil for water. Traditionally the image transfer was accomplished by (1) drawing a negative (reverse) image with a greasy lithographic crayon upon a flat, porous limestone surface, (2) applying water, which adhered to all except the greasy crayoned areas of the surface, (3) applying an oil-base ink, which then adhered only to the grease image, and finally (4) impressing a sheet of paper (or other material) upon the stone surface, so that the sheet received a positive copy of the inked image.

Essentially this method of direct lithography is still used for some classes of work (notably large billboard posters and long runs of multicolor labels).

However, it was the development of the offset variation—along with cheap, pliable, and workable substitutes for the stone printing surface, and photochemical and other simple means of imaging the substitute surfaces—that permitted fully mechanized presses to bring lithography down to everyday printing needs. Sheets of zinc (or aluminum) were grained to give them some of the porosity of limestone. Being thin and pliable, they could be readily curved for use on a fast-traveling cylindrical roller. Although zinc plates are still the most common surface for photo-offset lithography, various heavy, coated papers have been developed as still lower-cost substitutes for the lithographic stone.

Two main types of masters are available for offset reproduction:

(1) the direct-image plate (usually paper or plastic) and (2) the photographic plate (metal, plastic, or paper). The process of reproduction is identical for both direct-image and photographic plate after the plates have been prepared.

In direct-image offset work copy to be reproduced may be typed, printed, drawn, or traced on any white paper by standard black typewriter ribbon or any black ink (though a carbon-paper ribbon or black India ink is preferable). Either line or half-tone illustrations may be cut and pasted on the same sheet with the typed or hand-drawn copy in whatever arrangement may be desired. In fact, nearly any previously printed or reproduced pages, forms, charts, tables, maps, or illustrations may be used (with or without change) as originals for photographic offset plates. The original copy is photographed in the same, enlarged, or reduced size, depending upon the desired size of the finished copy.

The photographic negative is placed over the surface of a plate (usually a thin sheet of grained zinc, but may be plastic-coated or other specially prepared paper) which has been treated with a photosensitive, grease-attracting chemical. The plate, thus covered by the negative film, is exposed to an arc lamp. Light passes through the transparent areas of the negative, tending to fix the grease-receptive chemical on the exposed areas of the plate. The sensitizer is then washed off the remaining areas, leaving the plate with an image which will repel water and attract oily ink.

The offset press employs three cylinders—a plate or form cylinder, a rubber-blanket or offset cylinder, and an impression cylinder. The offset plate is clamped to the plate cylinder. This cylinder, as it revolves, rolls under a set of water and ink rollers. The image on the plate, which repels the water and accepts the grease-base ink, is transferred to the blanket cylinder (offset from plate to blanket). The blanket cylinder, in turn, impresses the image upon sheets of paper as they pass between the impression cylinder and the blanket cylinder. The plate image is positive, the blanket image is negative, and the final image on the paper again positive. Work in two or more colors can be produced by means of a separate plate and separate press run for each color. The number of copies that can be run from one plate (from a few thousand to more than 25,000) depends upon the kind and quality of plate used. While most paper plates (either direct-image or photographic) are capable only of relatively short runs, at least one make of photograph paper plate—coated with a fine granular plastic—is intended to compete with metal plates in long-run work. A similar plastic plate is available for direct-image work but does not equal the photographic plate in length of run.

Office rotary-relief process machines. More popular before the development of small, economical offset presses than at present, rotary-relief office duplicators (such as the Multigraph) are still feasible for certain kinds of work—such as imprinting local identification on previously printed general materials, printing ready-made envelopes, printing postal cards that require only a few lines of type, adding a few lines of necessary color printing to work run in standard black ink by another process, or printing small cards or forms that need to be scored or perforated—provided, of course, the demand for such work is frequent enough to justify the machine. For general work, however, the process is relatively inflexible; and although press operating speed is high and efficient, the printing normally is done from type which has to be set by hand, a step long outmoded for commercial grades of text matter in the printing industry. Although the handsetting process in this instance is considerably simplified by the T-shaped base of the type and the slotted type-holding construction of the printing cylinder, it nevertheless is a time-consuming method and one which limits the flexibility of type arrangement.

Stencil process machines. The master copy for the stencil-duplicating process (such as Mimeograph) is the stencil itself—a thin fibrous sheet covered on one side by a pliable, waxy coating through which ink will not pass. A typewriter, a hand stylus, or a die may be used to impress letters or other images upon the stencil with just sufficient force to penetrate the coating, so that ink may pass through.

The stencil is placed on the outside of a perforated and padded ink drum. As this cylinder is rotated, paper is fed between it and an impression roller. The resulting pressure squeezes the ink from the pad, through the openings of the stencil, and onto the paper, reproducing the desired image. A high-grade stencil, properly prepared, should be good for 5,000 or more serviceable impressions. If maximum use is not made of the stencil at one time, it may be cleaned and stored for future use. Work in two or more colors can be produced either by means of a separate stencil and separate press run for each color or by tedious spot-inking of the ink pad by hand. However, the costs and inconveniences of color work by this process make it rarely feasible.

Hectograph process machines. There are two different types of hectograph process: (1) the gelatin process and (2) the liquid or spirit process. The newer liquid process, being more efficient for general use, is rapidly replacing the gelatin.

In the gelatin process, the master copy is generally prepared by using a special typewriter ribbon or carbon paper impregnated with a strong aniline dye. Hand-drawing or lettering may be done, however, with special inks or pencils. The image to be reproduced appears in positive form on the face of the master copy, just as it is to appear on duplicated copies. The character of the ink accounts for the simplicity of the process; but it also accounts for some fading of the reproduced image, especially upon excessive exposure to sunlight.

The inked side of the master copy is impressed upon the gelatin surface of the duplicator. The gelatin absorbs ink from the master in the form of a reverse (or negative) image. Positive copies are obtained by impressing blank paper against the gelatin, which transfers the image to the paper by releasing a little ink each time a new sheet of paper is impressed. Single inking is the reason for the gradual lightening of copies on runs of more than 50. Ink not taken off by the copies gradually sinks into the gelatin, leaving the surface clear after an hour or so. The gelatin surface thus can be used over and over again.

For the liquid (or spirit) process the master copy is prepared by typing or drawing upon paper which is backed by a face-up hectograph carbon sheet. The carbon transfers an image in reverse (or negative) to the back of the paper. The paper and carbon for preparing the original generally come in sets ready for insertion in the typewriter.

After preparation, the master copy is placed securely on a metal cylinder, with the inked image outward. Sheets of paper are fed under a moistening roller (so they will attract dye from the master) and thence over or under the revolving master cylinder, from which the inked image is transferred (in positive). The fluid used is an alcoholic mixture, whence the term "spirit process." Each sheet of paper coming in contact with the master removes some of the carbon deposit, or dye, until the copies become too light to be legible. If the number of copies run at one time does not remove all the dye, the master can be saved and rerun at a future time. Ordinarily not more than about 150 clear, legible impressions are expected from one master, including any reruns made from it (although some manufacturers now are marketing hectograph carbon paper said to be good for three or four times that number of legible copies).

By either the gelatin or the liquid process, work in two or more colors can be reproduced in a single operation, simply by using various colors of ink, ribbon, pencil, or carbon paper in preparing the master copy. For general work, however, purple is used almost exclusively because that dye will produce a larger number of legible copies than others.

Contact photocopy machines. There are many variations of the familiar blueprint method of reproduction whereby an image on a transparent or translucent sheet is transferred to a chemically sensitized sheet by placing the two sheets together, exposing to light (or other radiant energy), and then developing either in a chemical bath (wet process) or a chemical vapor (dry process). If vapor development is used (as in the ozalid process) the separate drying step is eliminated and curling of the finish prints avoided. Blueprints or other blue-line prints, brownprints or brown-line prints (sepia or vandyke prints), black-and-white prints, and red-line prints are a few of the varieties of finished products possible by these processes. Ordinarily the same equipment, with changes of chemicals or of chemically treated paper, can be used to get various results. The equipment most commonly available for ordinary use, however, has been made more or less automatic at the expense of wide variability in the results.

Copy to be reproduced by these processes may be written, drawn, or typed, so long as it is in sharp black on a transparent or translucent ground. Since the image is transferred by direct-contact exposure rather than by projection through a lens, no enlargement or reduction is possible; the image of the finished print is the same size as that of the original.

Projection photocopy machines. There are several varieties of projection photocopying machines, ranging from small portable models to large stationary installations. The basic process is about the same in each of them. The master copy can be any document, drawing, book, or other object containing writing, lines, or pictures in any color or combination of colors, in any size up to the maximum of the equipment available.

The Photostat machine, a widely used make of photocopying equipment, consists chiefly of a camera with a magazine for holding a roll of sensitized paper. This assembly is mounted on a frame, to the front of which is attached a movable subject-holder. The holder is charted with guide lines and numbers to aid in scaling the copy. The machine is equipped for mechanical focusing to the desired size of finished work, which may be enlarged, reduced, or processed in the original size. The subject is photographed through a prism lens. The prism provides a means whereby the image, normally reversed by the lens, is again reversed and carried to the sensitized paper in its original position. The sensitized paper, after exposure, is processed through developing, fixing, and washing solutions, and run through a drying machine. In some models this entire process is done within the machine, while for other models a darkroom is necessary for hand development. The first copy—though not a negative in the true sense of the word—is a reverse print; the image is white on a black ground. This "negative" is then photographed if normal black-on-white copies are wanted.

GENERAL GUIDE TO REPRODUCTION METHODS

Number of Copies	Type of Original		
	TEXT AND TABLES	DRAWINGS, CHARTS, FORMS, ETC., WITH OR WITHOUT TEXT	PHOTOGRAPHS, WITH OR WITHOUT TEXT AND DRAWINGS
1 - 10	Typewrite with carbons Photostat	Photostat Ozalid**	Photostat**** Photograph
11 - 50	Typewrite with carbons if practicable Hectograph*** Mimeograph* Photostat Ozalid**	Photostat Ozalid** Hectograph*** Mimeograph*	Photostat**** Ozalid** Photograph
51 - 150	Hectograph*** Mimeograph* Multilith (offset)	Hectograph*** Mimeograph* Multilith (offset)	Multilith (offset) Printing (letter-press halftone)
151 - 3500	Mimeograph* Multilith (offset) Multigraph	Mimeograph* Multilith (offset)	Multilith (offset) Printing (letter-press halftone)
More than 3500	Multigraph Multilith (offset) Printing (letter-press)	Multilith (offset) Printing (letter-press from line cut)	Multilith (offset) Printing (letter-press halftone)

* poor writing quality of paper
** if copy is opaque, transparency must be made
*** colors feasible
**** poor tonal gradations

Figure 83. A rough guide in the choice of duplicating processes.

Addressing machines. Although originally and primarily designed for addressing envelopes and other material, the machines have been modified by attachments to perform many varied duplicating activities. Among these functions are the preparation of production orders, process cards, etc.; the imprinting of short messages on cards; the writing of pay checks; the preparation of regularly recurring invoices, such as telephone bills. There are two principal types of equipment: one type uses stencils which are prepared in a typewriter; the other uses embossed metal plates with inked ribbon.

GUIDE TO REPRODUCTION METHODS

As a general guide to the use of various types of duplicating and printing processes, the chart of Figure 83 is presented. It indicates which duplication processes are generally preferable depending on the type of material to be reproduced and the number of required copies.

AUTOMATIC LOCKING FORMS REGISTERS

Various types of registers utilizing multicopy continuous forms are conveniently used when exact protected copies are required. One copy of the form, which is completed in the register, refolds in a locked compartment when the other copies are removed.

PLANNING BOARDS AND MECHANICAL GRAPHS

Various types of clip, hook, pocket, grooved, strip, bar, tape, string, and peg boards are manufactured for use in graphically presenting and controlling various aspects of the enterprise's operations. These boards are sometimes well adapted for providing visual summaries of production, personnel, scheduling, work loading, sales, all kinds of performance and other operating data. Some examples of this equipment are:

1. Spring-clip panel boards
2. Hook bulletin boards
3. Multipocket racks
4. Grooved strip boards
5. Mechanical bar charts using colored bar cards
6. Boards using movable tapes or strips for recording progress or visual bars
7. Colored signal pegs are frequently introduced on the tape and string boards just described.

ELECTRIC STAPLERS

Electric staplers operate automatically upon insertion of paper into the stapler. Eliminates hitting operation.

FOLDING MACHINES

High-speed power-driven machines are available which will automatically fold letters, statements, advertising literature, etc.

FILLING OR INSERTING MACHINES

These relatively expensive machines insert prefolded sheets of paper in envelopes at high speed.

ENVELOPE SEALING MACHINES

These machines vary from simple manual types to the fully automatic motor-driven varieties.

OTHER EQUIPMENT

- Paperwork conveying systems, such as pneumatic tubes, basket conveyors, etc.
- Communication equipment, such as telephone, teletype, Temporator, Telautograph, facsimile, television, etc.
- Time recorders and stamps
- Check writers, endorsers, signers, cancelers, etc.
- Postage-affixing machines
- Postal scales
- Envelope-openers, including motor-driven type
- Counters
- Equipment for paper-cutting, punching, perforating, binding, etc.

MODERN TECHNOLOGY IN THE OFFICE

It has not been practical to attempt to describe here in great detail the large variety of ingenious and valuable equipment that has been and is being developed. However, our survey has indicated how engineers and inventors are constantly improving existing machines and designing new ones. Every year sees new developments which are facilitating better systems. The New York *Times,* commenting editorially in its October 23, 1949 issue on the National Business Show, had this to say about modern technology in the office:

"What with typewriters, phonographs that take the place of stenographers, duplicating machines of a dozen different kinds, adding machines, stamplickers, stapling machines and a score or so of gadgets, it can't be said that the inventors have ignored the white-collar worker in offices. The promotors of the National Business Show, which opens today, think otherwise. They are sure that 'if business were as slow in adapting new methods and equipment to the factory as it is to the office, we would still be in a horse-and-buggy age.' Whatever may be said for this argument there is no doubt that the inventors have been doing their best to reduce office costs with contrivances that were never dreamed of when clerks wore celluloid sleeve protectors.

"Here, for example, is a new typewriter ribbon that makes it easy to erase mistakes without leaving a smudge. Just paint away the wrong word or letter with a special eradicator. No rubber particles fall into the machine. Then there's a push-button secretary that fools even the most skeptical into accepting a chatty form letter as an original that must have been specially composed. Flip a switch and slip a light card into place and tailor-made replies to complaints and inquiries are selected from sixty form paragraphs. Another machine gathers pages into sets—just sucks them up on the vacuum principle one by one and transfers them to a moving belt in the right order. If a delivery arm fails to work the vacuum is broken and the incomplete set of papers is returned to be picked up again."

Part III

EVALUATION, SELLING, AND INSTALLATION OF PROCEDURES

X

SELECTING AND SELLING THE SYSTEM

SELECTING THE BEST available alternative and selling this alternative first to the supervisory and then to the operating personnel is the pivotal part of the systems project. The same fundamental analyses, calculations, and reasoning processes are used in both cases. The approaches and difficulties vary, of course. Selecting the best system means selling yourself on the system. Selling others should follow from this first selection process with varying degrees of difficulty, depending upon a number of factors:

1. How good is the proposal?
2. How well is the proposal analyzed and presented?
3. How well can the analyst handle and influence people?
4. What are the personal characteristics and personal interests of these other people?

Each of these questions will be considered in this chapter.

In determining the relative economy of alternative proposals, simple, logical cost analyses must frequently be made. It is essential that all applicable costs be considered in the analysis and that the cost estimates be sufficiently accurate. In particular, the changeover and installation costs must not be overlooked. The detail procedures for making economy analyses are described in a number of texts on engineering economy. The essential basis for these analyses is always a comparison of alternative costs. Many types of fallacious reasoning may creep into an economy analysis if the basic alternatives are not kept clearly in mind. To help give a clearer understanding of the process of making cost comparisons and to illustrate some of the kinds of errors which should be avoided, seven commonly occurring types of errors were described by the writer in a recent article: * the assumption of different levels of efficiency, the average interest error, the book-value error, the capitalization of book-value loss, the inaccurate assumption of future requirements, the incorrect use of overhead ratio, and the improper interest rate. Although the examples here described were adopted from actual situations, they have all been changed.

ASSUMPTION OF DIFFERENT LEVELS OF EFFICIENCY

The Doe Manufacturing Company's production-control system is functioning poorly. The president engages an engineer to survey the operations and recommend any required steps to improve the services and efficiency. The engineer investigates and analyzes the present operations and requirements. He then submits a report to the president recommending a change to a newly designed system which he has developed. The engineer's cost analysis shows that his proposed system will provide the required production-control service at a total annual cost of $168,000 as compared with the $203,000 annual cost of the present system.

The president is greatly impressed with the engineer's proposal and it is adopted by the company. The engineer supervises the installation of the new system and is then hired to head the production-control department. During the first year of operation under the new system, the total annual cost of production control activities amounted to $185,000. Although this is greater than the estimate of $168,000, it is still a substantial saving over previous costs and the company management is satisfied.

After five successful years, this engineer leaves the Doe Manufacturing Company and is replaced by a man of considerable production-control experience. After becoming acquainted with the company's operations, the new production-control head submits to the president

* Barish, "Don't Be Fooled by Erroneous Cost Studies," *Mill and Factory*, December 1949.

a plan for improving the system he has inherited from his predecessor. The improved system which he proposes would, according to his estimates, reduce the cost of the production-control services to $150,000.

Upon examining the details of the proposal, the president of the company is surprised to notice that it is almost identical to the system used by the company five years ago. He quite naturally asks why the first system will now be cheaper than the present one, whereas five years ago it was shown to be more expensive.

The new department head is given the detailed cost analysis of five years ago and makes a study of the comparative cost figures used by his predecessor. He discovers that his predecessor had compared the current operating costs of the then existing system with the cost of operations of his proposed system at a very high level of efficiency. The fallacy of his predecessor's cost comparison was twofold:

1. The level of efficiency which his predecessor had assumed would be obtained under the new system was too high. For this reason, only $18,000 of the expected $35,000 annual savings were actually realized.

2. The level of efficiency at which the costs of operations of the then existing system were computed was unconsciously too low. The old system seemed more expensive than the new only because the old system was operated and managed very inefficiently. If the cost analysis had been based on the original and the new system being operated at the same level of efficiency of the personnel, then the cost analysis would have disclosed that the then existing system was essentially better than the proposed and adopted one.

What was originally needed in this case was an improvement in management of the department to raise the level of performance of the personnel, not a change of system, as had been proposed by the engineer and adopted by the company five years ago.

AVERAGE INTEREST ERROR

The systems analyst for a metal-parts manufacturer had developed what he considered an improved material-control recording procedure. The new procedure required the investment of funds in office equipment which would cost $40,000. Time study analysis showed that as a result of this investment, the annual cost of clerical labor would be reduced from $40,000 to $27,000. Making the assumption that a 10 percent return was desired on an investment of this kind and depreciating the equipment on a five-year basis, the analyst came up with the following comparison of annual cost:

Present System

Clerical labor	\$40,000.00
Total	\$40,000.00

(Other costs unchanged and therefore not considered in this analysis.)

Proposed System

Clerical labor	\$27,000.00
Depreciation of new equipment $\frac{40{,}000}{5}$	8,000.00
Interest on investment in new equipment (Ten percent of \$40,000)	4,000.00
Total	\$39,000.00

There appears to be little saving to be obtained by adoption of the proposed system. It was therefore not used.

If correctly calculated, the annual saving was more than 3½ times as great as the \$1,000 saving shown above. Annual interest was computed on the \$40,000 original investment, despite the fact that the investment was being reduced each year by the depreciation charge of \$8,000 per year. Actually, \$4,000 is the valid interest charge for the first year only, \$3,200 (10 percent of the \$32,000 book value of the equipment during the second year) being the correct charge for the second year, \$2,400 for the third year, \$1,600 for the fourth year, and \$800 for the fifth year. The average annual interest cost is thus the average of this decreasing arithmetic progression, the first term of which is \$4,000 and the last of which is \$800. The average interest over the five-year period is then $\frac{4{,}000 + 800}{2} =$ \$2,400. Expressed in general terms, if C represents the original cost, N the number of years, and R the interest rate, then $\frac{1}{2}\left(CR + \frac{CR}{N}\right)$ or $CR\left(\frac{N+1}{2N}\right)$ is the average interest cost per year.

The annual costs of the proposed system should therefore have read:

Clerical labor	\$27,000
Depreciation, $\frac{40{,}000}{5}$	8,000
Interest, $40{,}000 \times 0.10 \times \frac{6}{10}$	2,400
Total	\$37,400

This correct analysis now shows a distinct saving for the proposed system.

BOOK-VALUE ERROR

The foreman in a furniture factory proposes the substitution of an automatic shaper costing $9,000 for the two hand shapers presently used. The one automatic shaper will be able to handle the volume of work presently performed by the two hand machines and will reduce the direct labor cost from $5,000 to $2,000 annually. However, the shapers were purchased six years ago at a cost of $4,000 each and were being depreciated $800 per year on the basis of straight-line depreciation for an estimated life of ten years. The book value of each of the hand shapers was thus $1,600. It is a company policy that all new installations must pay for themselves in 4 years with interest at 10 percent.

The foreman made the following comparison of annual costs, assuming no salvage value for any of the machines at the end of their estimated lives:

Hand Shapers

Depreciation, $\frac{8{,}000}{10}$	$ 800.00
Interest, $8{,}000 \times 0.10 \times \frac{11}{20}$	440.00
Direct labor	5,000.00
Maintenance, repairs, power, supplies, insurance, etc.	1,000.00
Total	$7,240.00

Automatic Shaper

Depreciation, $\frac{9{,}000}{4}$	$2,250.00
Interest, $9{,}000 \times 0.10 \times \frac{5}{8}$	562.50
Direct labor	2,000.00
Maintenance, repairs, power, supplies, insurance, etc.	2,000.00
Total	$6,812.50

On the basis of this analysis, the foreman notes an annual savings of more than $400 if the automatic shaper is used and recommends its adoption to the company.

In analyzing the annual costs if the hand shapers are kept, the foreman should have considered only those depreciation and interest costs which would be avoided if the automatic shaper were bought, just as the depreciation and interest costs for the automatic shaper would be avoided if the hand shaper were kept. Thus the company is forgoing the present salvage value of the hand shaper if it does not adopt the automatic shapers. This forgoing of the present salvage value is the equivalent of investing this sum of money in hand shapers and, to be strictly logical, the company policy that new installments must pay for themselves in 4 years should also apply here. These shapers could now be sold for only $250 each or $500 total. In analyzing the annual costs of keeping the hand shapers, the foreman should therefore depreciate this $500 investment over a period of 4 years or the remaining expected life of the hand shapers, whichever is less. In this case, the remaining expected life is at least 4 years. Accordingly, the annual costs, keeping the hand shapers, are:

Depreciation, $\frac{500}{4}$	$ 125.00
Interest, $500 \times .010 \times \frac{5}{8}$	31.25
Direct labor	5,000.00
Maintenance, repairs, power, supplies, insurance, etc.	1,000.00
Total	$6,156.25

The true annual cost of operations on the basis of continuing use of the hand shapers thus turns out to be more than $600 lower than if the change is made to the labor-saving automatic shaper.

CAPITALIZATION OF BOOK-VALUE LOSS

An engineer for a chemical manufacturer has come across some new type of equipment which would apparently lower unit costs considerably. In accordance with his detailed estimates of material, labor, supplies, etc., the engineer computes that operating costs will be reduced from $30,000 to $10,000. This new equipment will cost $125,000 and will replace facilities which were purchased just two years ago at a cost of $150,000. The present facilities were being depreciated on the books of the company on a straight-line basis over a ten-year life, giving them a book value of $120,000. Their resale value, if the new facilities were purchased, is only $40,000. Using an 8 percent rate of return on investment, the engineer made the following comparison of annual costs based on a ten-year life for the new equipment and eight years of remaining life for the old facilities:

Present Equipment

Depreciation, $\frac{40{,}000}{8}$	\$ 5,000.00
Interest, $40{,}000 \times 0.08 \times \frac{9}{16}$	1,800.00
Operating costs	30,000.00
Total	\$36,800.00

New Equipment

Depreciation, $\frac{(120{,}000 - 40{,}000) + 125{,}000}{10}$	\$20,500.00
Interest, $205{,}000 \times 0.08 \times \frac{11}{20}$	9,020.00
Operating costs	10,000.00
Total	\$39,520.00

Depreciation of the new equipment was calculated on the basis that the cost of the new equipment equals \$125,000 plus the loss involved in selling the present equipment for \$40,000 when it has a depreciated book value of \$120,000.

This analysis has convinced the engineer that his proposal is uneconomical and he therefore drops the whole matter.

Actually, this is a very good proposal and, if analyzed correctly, a very substantial reduction in annual costs can be shown. The \$80,000 book loss involved in selling the old equipment for \$40,000 is a cost which is not pertinent to the present problem. This \$80,000 represents the difference between the actual reduction in the resale value of the equipment and the amount of this reduction which the accountants have charged and recovered as production expense in previous years. The economic advisability of making this replacement is independent of whether past production costs were overstated or understated, although this factor might affect financial ability to make the replacement. We are here concerned solely with determining the relative advisability of two alternative courses of action by comparison of the annual cost increments which each alternative will cause. Past happenings are only significant as guides to the future costs.

One of the alternatives is to invest \$125,000 in new equipment which will be used up in 10 years. If this alternative is chosen, then the manufacturer can sell the present equipment for $40,000. The other alternative is to keep the present equipment, which involves the investment of $40,000 in a depreciating asset in the sense that the manufacturer forgoes the $40,000 which he can get by selling the equipment now, but will not be able to get 8 years from now.

The manufacturer is thus essentially investing $40,000 in a depreciating asset if he chooses to continue with his present facilities and $125,000 if he decides to install the improved equipment.

Correct analysis of the annual costs using the new equipment, therefore, reveals the following estimate:

Depreciation, $\frac{125,000}{10}$	$12,500.00
Interest, $125,000 \times 0.08 \times \frac{11}{20}$	5,500.00
Operating costs	10,000.00
Total	$28,000.00

Installation of the new equipment will thus result in a substantial reduction in annual operating costs—saving almost $9,000 per year.

INACCURATE ASSUMPTION OF FUTURE REQUIREMENTS

A company is setting up a separate plant to manufacture a newly developed product. A special nut, required in this product, can be made on an engine lathe costing $4,000 or a turret lathe costing $15,000. The turret lathe will have lower material wastage, decreasing material cost from $0.160 to $0.155 per unit. Operating rate using the turret lathe is 30 pieces per hour; using the engine lathe the rate is 10 pieces per hour. Three engine lathes will thus be required to equal the capacity of one turret lathe. The operator of the engine lathe would make $2.00 per hour; the turret lathe operator $1.60 per hour. Repairs, power costs, tools, and all indirect expenses for each of the engine lathes add up to an average of $1,800 per year. Set-up, repair, power costs, tools, and other indirect expenses for the turret lathe add up to an average of $9,600 per year. Estimating a life of ten years for the engine lathe and 6 years for the turret lathe, assuming no salvage values, and using a return of 6 percent on investment, the following unit cost comparison was made on the basis of a 2,000-hour work year (50 weeks times 40 hours):

Engine Lathe

Direct labor, $\frac{2.00}{10}$	\$ 0.200
Direct material	0.160
Repairs, power, tools, other indirect expenses	
$\frac{1{,}800}{10 \times 2{,}000} = \frac{1{,}800}{20{,}000}$	0.090
Depreciation, $\frac{4{,}000}{10} \times \frac{1}{20{,}000}$	0.020
Interest, $4{,}000 \times 0.06 \times \frac{11}{20} \times \frac{1}{20{,}000}$	0.007
Total cost per nut	\$ 0.477

Turret Lathe

Direct labor, $\frac{1.60}{30}$	\$ 0.053
Direct material	0.155
Repairs, power, tools, other indirect expenses	
$\frac{9{,}600}{30 \times 2{,}000} = \frac{9{,}600}{60{,}000}$	0.160
Depreciation, $\frac{15{,}000}{6} \times \frac{1}{60{,}000}$	0.042
Interest, $15{,}000 \times 0.06 \times \frac{7}{12} \times \frac{1}{60{,}000}$	0.009
Total cost per nut	\$ 0.419

Since the analysis shows a saving of almost six cents per nut using the turret lathe, the methods man included the turret lathe in his recommendation for new equipment. He neglected to consider one crucial aspect: how many of these special nuts will be required each year? If 60,000 will be needed, then the turret lathe is the more economical machine and the cost comparison is valid. If, however, the new plant is expected to produce 20,000 units of this new equipment per year and only one of these special nuts is used in each equipment, then a correct analysis of unit costs will disclose that the engine lathe is more economical.

The expected requirement for the nuts in this case was actually only 20,000. Therefore, the unit costs of production using the one engine lathe that will be required are the same as those previously calculated —totaling \$0.477. The unit costs using the turret lathe, however, are much higher than those calculated because of the excess machine capacity which will not be required:

Direct labor, $\frac{1.60}{30}$	\$ 0.053
Direct material	0.155
Set-up, repairs, power, tools, other indirect expenses, etc., $\frac{9,600}{20,000}$	0.480
Depreciation, $\frac{15,000}{6} \times \frac{1}{20,000}$	0.125
Interest, $15,000 \times 0.06 \times \frac{7}{12} \times \frac{1}{20,000}$	0.026
Total cost per nut	\$ 0.839

Unless it were anticipated that requirements would increase or that the excess capacity of the turret lathe would be otherwise utilized, the methods man should have recommended the engine lathe rather than the turret lathe.

INCORRECT USE OF OVERHEAD RATIO

A machinist submits a proposal under the Employee Suggestion Plan in operation in a large manufacturing company. He suggests using a fixture which he has designed to reduce the labor required in the assembly of a sub-unit which is used in the company's products. To show the worth of his suggestion and to provide the basis for the determination of the amount of the suggestion award, the following analysis of cost savings is submitted:

Item	*Amount*
1. Direct labor required per assembly sub-unit: Present method	8.725 min.
2. Direct labor required per assembly sub-unit: Proposed method	6.307 min.
3. Direct-labor savings per assembly sub-unit (Item 1 — Item 2)	2.418 min.
4. Average direct-labor cost	\$1.20 per hour
5. Number of sub-units manufactured and used per year	40,000
6. Total direct-labor savings $\frac{(\text{Item 3} \times \text{Item 4} \times \text{Item 5})}{60}$	\$1,934.40 per year
7. Departmental overhead rate	50% of direct-labor dollars

8. Overhead cost savings (Item 6 × Item 7)	$ 967.20 per year
9. Total savings (Item 6 + Item 8)	2,901.60 per year

(The cost of the fixture was negligible and therefore omitted from the analysis.)

The error in this calculation is in the assumption that a reduction in the direct-labor cost required in the assembly of the sub-unit would necessarily produce a 50 percent reduction in the overhead costs because the overhead costs for the department average 50 percent of direct labor. Actually, there might be no overhead cost savings as a result of the adoption of this suggestion; or there might be some savings, but less than 50 percent of the direct-labor savings; or there might perhaps be an overhead savings greater than 50 percent of the direct-labor savings. There might even be an increase in the overhead costs as a result of the adoption of this suggestion. It is necessary to determine by direct analysis the overhead costs, if any, which will be reduced as a result of the adoption of this suggestion.

In the case of the proposal just mentioned, investigation disclosed that practically no reduction in overhead costs would occur as a result of the adoption of this suggestion. Therefore, the correct analysis would show total prospective savings of $1,934.40 rather than $2,901.60.

IMPROPER INTEREST RATE

The manager of a plant is considering the replacement of a certain machine with a model of improved design which cuts operation costs to less than one third. He asks two of his methods engineers to make independent surveys and determine whether the replacement is desirable. When he receives the reports, he notes that Engineer A's analysis indicates that the replacement should be made and Engineer B's analysis indicates that the old machine tool should be retained. The two analyses are reproduced below:

Engineer A:

Present Machine

Depreciation, $\frac{1{,}500}{4}$	$ 375.00
Interest, $1{,}500 \times 0.035 \times \frac{5}{8}$	32.81
Operating costs	4,000.00
Total	$4,407.81

New Improved Machine

Depreciation, $\frac{20{,}000}{8}$	\$2,500.00
Interest, $20{,}000 \times 0.035 \times \frac{9}{16}$	394.00
Operating costs	1,200.00
Total	\$4,094.00

On the basis of the analysis shown above, annual costs will be lowered more than \$300 if the present machine is replaced. Engineer A therefore recommends purchase of the new improved machine.

ENGINEER B:

Present Machine

Depreciation, $\frac{1{,}600}{4}$	\$ 400.00
Interest, $1{,}600 \times 0.08 \times \frac{5}{8}$	80.00
Operating costs	4,000.00
Total	\$4,480.00

New Improved Machine

Depreciation, $\frac{20{,}000}{8}$	\$2,500.00
Interest, $20{,}000 \times 0.08 \times \frac{9}{16}$	900.00
Operating costs	1,200.00
Total	\$4,600.00

On the basis of Engineer B's analysis, the total annual costs would be higher if the new improved design were adopted at the present time. Engineer B therefore recommends that the present machine be retained.

Both engineers estimated almost the same costs and salvage values. (Engineer A estimated salvage of \$1,500 for old machine; Engineer B estimated a \$1,600 salvage value.) The principal differences are caused by the rate of return which each engineer estimated was required on the money investment.

This rate of return should indicate two components: one element would be the return which conservatively invested money can earn; the second element would be an additional return to compensate for the risks involved in the investment. The greater the risks and possibilities of loss of money because of business fluctuations and changing economic conditions, because of technological changes and the highly competitive nature of the business, and because of lack of a sound basis for estimating expenses, etc., the greater this second element should be.

On reviewing the two analyses presented by his engineers, the plant manager decided that Engineer A neglected to make sufficient allowance in his estimated rate of return for this second element. A 3½ percent return barely covered the cost of a conservative well-protected loan and certainly made no allowance for the risks involved in the investment.

UNDERSTANDING OF ALTERNATIVES AND ASSUMPTIONS

In evaluating the reliability of any economy analyses, it is necessary to consider the validity of the underlying assumptions. All of the calculations may be correct, but if the basis for the calculations is false, or is not suited to the situation being studied, the answer may be worthless.

Many errors are made in economy and cost analyses because of a failure to think clearly in terms of the alternative costs involved. To avoid errors, it is important that only actual alternative costs be considered; that the interest rate which is used be reasonable and adequate for the risks involved in the investment; and that interest charges be computed only on money which is actually invested and which is unavailable for other productive use because of the adoption of the alternative. Estimates of overhead cost savings should be based on actual analysis of the effects of a proposal on these costs rather than on the overhead ratio of the department or plant. An economy analysis will give a biased result if the estimator, consciously or unconsciously, compares the cost of one method or system operating with good management and efficiency, with another one operating with poorer management at a lower level of efficiency. In addition, all annual cost comparisons must be based on a reasonably accurate estimate of anticipated production volume or the analysis may give a fallacious result.

Besides pointing out errors which should be avoided, these examples show that, correctly to interpret a cost analysis, it is necessary to understand the basic assumptions, financial requirements, and risks involved in the alternative. It is not simply a matter of adding up two columns of annual costs and noting which column gives the lower total. Correctly to evaluate the real significance of the saving which is indicated by the cost comparison, one must also evaluate the adequacy of the assumptions and estimation methods used.

EVALUATION OF INTANGIBLE ELEMENTS

Many of the advantages and disadvantages of alternative systems proposals cannot be conveniently evaluated on a dollars-and-cents basis. These intangible elements of varying individual importance may sometimes be of greater importance than those factors which have been quantitatively evaluated into dollars and cents.

ELEMENTS	Importance	ALTERNATIVE METHODS									
		Present method		Alternative 1		Alternative 2		Alternative 3		Alternative 4	
		Rating		Rating		Rating		Rating		Rating	
(1)	(2)	(3)	(4)	(3)	(4)	(3)	(4)	(3)	(4)	(3)	(4)
TANGIBLE ELEMENT 1. COMPARATIVE COSTS INTANGIBLE ELEMENTS 2. 3. 4											
Total	100	xxxxxx		xxxxx		xxxxx		xxxxx		xxxxx	

Figure 84. Systems Evaluation Worksheet, useful in promoting clearer reasoning in arriving at a systems decision.

To promote clarity in his own thinking as well as to provide a method of demonstrating to others, an analysis of the relative merits of two or more alternatives using a Systems Evaluation Worksheet such as shown in Figure 84 may prove very convenient.

Each of the intangible elements which are of importance in the comparison of the alternatives is listed in the left-hand column. The comparative importance of the tangible cost analysis and of each of these intangible factors in the promotion of efficient operations is then estimated. These relative importance values are assigned so that they total 100. Each element is then given a rating from 0 to 10 in Column

(3) under each alternative proposal. For example, the manufacturing time cycle might be one intangible element. Alternative 1 may have a very short time cycle, alternative 2 a very long one, and the present method an average one. Alternative 1 might then receive a good rating of 9, alternative 2 a rating of 0, and the present method a rating of 5 or 6. The rated value for each element is determined by multiplying the importance and the rating, placing the product in Column (4). The total rated value for each alternative method can then be obtained by addition of the rated values for each significant element.

When agreement is difficult to obtain on a rather involved system, this method of analysis may be of value in clarifying the thinking of the various people on the relative merits and demerits of various proposals. By promoting the organization of thoughts on the essential elements, it will help bring agreement or will aid in disclosing the basic items of disagreement.

THE REPORT

Having determined the relative worth of the alternative proposals, it is desirable to work up an analytic statement which will present the proposal in detail to management and the supervision. How elaborate the report should be will depend on the nature and scope of the survey, the size of the investigation, and the amount of selling on details that is required. The next chapter is devoted to an outline of essentials of good systems report preparation. The charts, graphs, tables, and textual material of the report are all selling devices which should be used to maximum advantage. Many of the charts presented earlier in this book are effective means of comparing the old system with the proposed improvements.

SELLING A NEW SYSTEM

The ability to sell a proposal, to handle and influence people depends to a great extent on an understanding of their motivations. What do the managers and employees of the enterprise want from their companies and their jobs? How do they react to the various stimuli created by the activities and proposals of the systems analyst? A firm understanding of these questions will provide the basis for effectively selling improvements.

There are no fixed and definite rules for selling a new system either to the management of a company or to the employees who are to operate and work under the system. However, both of these tasks are very important. Unless management is sold on the desirability of a proposal, it will not be adopted; and unless the persons who will supervise and operate the system are sold on its desirability and correctness, it will usually not be successful.

A competent systems man does not make the mistake of considering his selling job done when he has obtained management approval of his plans. In fact, the selling of top management may frequently be the easier part of the job and the systems report is one of the principal aids in this task.

Although the personal approach and attitude of the systems analyst is important in both of these selling tasks, it is of predominant importance in selling the operating personnel. The job of selling these persons begins the first time the systems man meets them, before he even knows what scheme he desires to sell. A poor start in building up a cordial relationship is very hard to overcome.

EMPLOYEE MOTIVATIONS

In developing the best approaches in dealing with people, the systems analyst will be greatly aided by a consideration of their more common motivations and attitudes.

People resist change; they fear change; they cling to customs, especially those of long standing. Suggestions of changes in methods of long standing are bound to meet resistance unless they are carefully presented. It is because of this natural resistance to change that most progress is evolutionary rather than by leaps and bounds. It is because of this natural resistance that most persons are suspicious and fearful of all proposals to change the status quo.

It is necessary, therefore, for the systems analyst to overcome this natural fear and distrust by appealing to the self-interest of the personnel and to their underlying motives and drives, such as the desire for recognition of one's work and the craving to be above other persons (the power motive). People desire that attention be paid to their thoughts and action. They are unhappy unless they feel reasonably secure in their jobs.

Everett R. Smith lists six basic things which the worker wants from his employer: *

* "What the Wage Earner Thinks," *Production Series, Number 187.* New York, American Management Association.

1. Fair pay and a chance to really earn it.
2. Self-respect—the opportunity to feel that he is really part of the company and not just a cog in a machine.
3. Security in the job, and reasonable welfare plans.
4. Opportunity for advancement.
5. Fair play—the elimination of favoritism and a straightforward dealing between management and workers, with prompt and definite response to complaints.
6. A management which is capable and efficient in handling its operations.

Good systems promote all of these basic desires of the worker. If they do not, then they are not good systems. By keeping these aspects of the systems goal in the forefront at all times, the systems analyst can do a better and more effective job at all levels of the organization.

The systems analyst should always be on the alert to show that he has carefully considered employee interests; to show how his proposals will benefit the worker and supervisor by:

Eliminating overtime
Improving working conditions
Reducing pressure and amount of work
Providing higher job ratings
Increasing job security through a more competitive position for the firm when costs are decreased
Providing funds for possible pay increases
Increasing promotion opportunities
Enabling greater creative expression of the worker.

As pointed out in Chapter XIII, it is advisable to establish a definite policy to protect the status and tenure of employees whose positions are affected by systems changes.

SUGGESTIONS FOR EFFECTIVE SELLING

Some specific suggestions of what to do and not to do might prove helpful. Most of these will undoubtedly seem self-evident. Nevertheless, this obvious quality has not always given them the universal application which it would seem they deserve. No attempt has been made to group these suggestions by importance or to make an exhaustive presentation. Some additional considerations in the handling of people were presented in the discussion of the methods of obtaining systems data in Chapter IV.

Volumes can be devoted to the subject of handling and influencing people. Thousands of rules can be listed to promote more effective selling. But they will all boil down to two basic principles: understand the motivations of the persons you are trying to sell; always be tactful and observe good manners.

The systems analyst should always pay attention to persons while they are talking. And let them talk as much and as long as they desire. There are a number of advantages to letting the other fellow talk first and as much as he desires:

1. He tells you what his position and possible objections are and thus gives you valuable information for planning your strategy to win him over to your side.
2. In talking out his objections, he may sell himself on the logic of your suggestion before you have even attempted to appeal to his reason.
3. If you hold forth while he has some objections which he desires to expound, he will be turning these objections over in his mind instead of listening carefully to your exposition. As you talk on with only a semblance of attention on his part, his objections will be amplified by his irritation at being unable to express them.

Never tell anybody directly that he is wrong. It is practically always unnecessary and represents a negative approach. Concentrate on your proposals and how things can be improved, which is a constructive, positive approach. The simplest, surest way to make an enemy is to say, "You are wrong." It is a foolproof method.

By a questioning rather than a declaratory approach, it is frequently possible to get the operating or supervisory personnel to say what is wrong with the present system. By carefully planting ideas, it is often feasible to get these people to suggest your solution even when it was not originally their own. Both of these are very desirable because everybody likes ideas which he considers his own.

Never argue. If you cannot gain your point except by argument, it is usually better to concede the point for the time being and, if it is important, return some time in the future when you can discuss the matter from a better perspective. As Dr. Samuel Johnson wisely remarked: "Every man will dispute with great good humor only upon a subject in which he is not interested."

Be careful not to induce an argumentative attitude by unconsciously raising your voice or allowing a cynical attitude or expression to enter into a discussion.

When discussing a proposal to which a person objects, first show your objector that you understand his objection by restating it. Even expand a little on some of the good points of his objections to show that you appreciate his viewpoint. It is very important for him to know that you thoroughly understand his position and consider it sensible even though he may not have considered everything.

Before chancing a rebuff in order to gain a point in a discussion, remember that it takes a lot of ingratiating to overcome just one little slip which induced dislike. Again quoting Dr. Johnson: "Men hate more steadily than they love. If I have said something to hurt a man once, I shall not get the better of this by saying many things to please him."

Always give credit where credit is due and, if it will help your public relations, even sometimes where it is not due. Do not allow yourself to get the reputation of being an idea stealer.

It may sometimes be helpful in obtaining the cooperation of supervisory personnel to submit a joint report with the signatures of the operating personnel appearing on the recommendations. This may be a powerful means of overcoming hostility, because most people are not quite as scared of changes when they have had a part in suggesting them and will receive due credit.

One of the important aspects of selling and influencing people is to know the characteristics of the persons with whom one is dealing. With this knowledge and a little finesse in human relations, much can be accomplished. Three examples of how prior knowledge of personal characteristics proved very effective in selling are presented here:

I. It was the habit of George Roberts, president of the Pennsylvania Railroad, to show his subordinates that he was fully aware of their doings by adding to or taking away something from the projects they submitted to him. One of Mr. Roberts' division superintendents, D. M. Caldwell—later a president himself—had obtained permission to build a new station, in which he was deeply interested. Caldwell designed a station according to his own ideas, and to prevent Roberts from making any essential changes he added an unnecessary bay window to the waiting room. Roberts carefully examined the plans and said, "Remove the bay window and you have my approval." Caldwell had what he wanted.*

II. One of my recurrent difficulties in stage designing was caused by a certain actor who seemed invariably to dislike the clothes intended

* Chauncey M. Depew, *My Memories of Eighty Years.* New York, Scribners, popular ed., 1924. (Adapted.)

for him, and to hanker after those of his fellow-players. In one piece it was absolutely necessary for the balance of my picture that he should wear a certain costume. I felt sure he would object to it, so I had it made carefully to his measure and allotted it to a minor character, who at once became an obtrusively conspicuous figure. Soon—as I had foreseen—the leading man drew me aside.

"This costume of mine, you know," he began. "It's fine, of course. But that costume there—right in the corner—oughtn't it to be nearer the center?"

I agreed it certainly should.

"I suppose," he went on, "that it wouldn't do for me to wear it instead of this?"

I admitted that it would look very well. He vanished, and soon returned, attired as I had hoped to see him. "It's a most extraordinary thing," he exclaimed. "It fits me exactly." *

III. Liszt, as an old man, very rarely played. Count Hatzfeldt, then German ambassador to England and a great friend of Liszt's, when consulted by a hostess as to how she could induce Liszt to play, had answered: "Put the piano in the darkest corner of the room, and pile all sorts of things on it. Then he won't think you have asked him in the hope of hearing him play, and perhaps we can persuade him."

All the music was hidden away, and the instrument covered with photographs, vases of flowers, heavy books. After luncheon Hatzfeldt began talking to Liszt about Offenbach's melodies—particularly one song he had improvised for the Empress—he couldn't quite remember it. If there were a piano—he looked about. "Oh, yes, in a corner, but so many things upon it, it was evidently never meant to be opened." He moved toward it, Liszt asking the hostess if it could be opened. Hatzfeldt played a few bars in rather a halting fashion. After a moment Liszt said: "No, no, it is not quite like that." Hatzfeldt got up, and Liszt seated himself, played two or three bits of songs, then, always talking to Hatzfeldt, by degrees broke into a nocturne and a wild Hungarian march. His touch was that of an old man—but a master. When he got up, he said: "Oh, well, I didn't think the old fingers had any music left in them." †

* W. Graham Robertson, *Life Was Worth Living.* New York, Harpers, 1931.
† Mary King Waddington, *My First Years as a Frenchwoman.* New York, Scribner's, 1914. (Adapted.)

XI

WRITING SYSTEMS REPORTS AND PROCEDURES

THE PRESENTATION of systems recommendations and reports is usually done in writing, and procedures are written to make the systems known to the enterprise's personnel. The success or failure of the systems analyst's work may often hinge on his effectiveness at these tasks. Reports which concisely and graphically present the important points in easily understood language will have the most sales appeal. We will therefore consider in this chapter what subject matter should be included in systems reports and in written procedures; and how this material should be presented to promote maximum understandability and effectiveness.

ELEMENTS OF THE SYSTEMS REPORT

There are many variations in arrangement and content of a systems report, depending on the subject and scope of the investigation, the length of the report, and the audience for which the report is written.

Some of the elements discussed below are required in every report; some are optional.

Title. Every report should have a title or subject heading, providing a concise description of the material being presented. Any identifying project number should also appear on the title page.

Signature. The name or names of the person or persons responsible for the report and the investigation should appear either at the beginning or end of the report.

Date. Every report should be carefully dated. The date of the report should usually be the date of submission. All materials, facts, charts, and data should be individually dated to indicate the time at which the analyst can attest to their being the true state of affairs.

Table of contents. Most reports of any size should contain a table of contents or index of some sort to inform the reader of the arrangement and contents of the report.

Purposes and scope. All reports should include a statement of the purpose or purposes of the investigation and report, including who requested that it be made, as well as its scope. Acknowledgments of cooperation and assistance received from various personnel should be included at this point.

If warranted by its length and complexity, the statement of the objectives or purposes may comprise a separate section from the outline of the scope of the investigation and report. The section on scope should include any necessary explanations of the limitations of the survey data, the information, and the conclusions obtained in the conduct of the investigation.

Summary. It is frequently desirable in the case of long reports to have a short summary in the beginning. This summary enables the busy top executive, who does not have the time to read the entire report, to gain an over-all picture of the investigation. The summary should provide a brief résumé of the salient points covered in the analytical sections of the report as well as a short statement of the conclusions and recommendations.

Definitions. In some cases, several of the terms used in the report may be subject to various interpretations. To prevent misinterpretations, a section defining these terms should be included in the report.

Analytic sections. The analytic sections of the report will first present the facts disclosed by the investigations. A historical presentation of past occurrences may sometimes be valuable to provide a background for the current analysis. Some of these facts on the presently used systems might be clarified by the various systems-charting techniques described in earlier chapters. These facts are then analyzed in the report in terms of the principles developed in the earlier sections of this book. Possible alternatives may be presented and, in turn, analyzed. A section of the report may be devoted to detailed presentation and analysis (including charts, photographs, etc.) of the proposed alternative which appears most desirable. An economic comparison and evaluation is very valuable whenever it is possible.

Conclusions and recommendations. The sections on the conclusions and recommendations of the investigation may be separate or combined into one. The conclusions which stem from the preceding analysis are explained in logical sequence. Then the recommendations for implementing these conclusions are presented. How should the proposals be given effect? When should the installation of new procedures begin and what is the correct timetable for its completion? How should the affected persons be sold on the new methods? What instructional aids and/or training programs should be utilized? How much systems staff time will be required to implement the conclusions and recommendations? What important related problems could not be studied because of lack of time or limitations of scope? Which of these should be studied in the future when more time is available?

Appendix. The appendix to the report should contain statistical tabulations, lists of references and persons supplying various parts of the information and data, charts which do not properly fit into the body of the analysis, any visual aids and written instructions for the installation of the proposal, blueprints, photographic details, worksheets, etc.

Required and optional sections. Formal reports should have a distinctive title and, if assigned, a project number; the name of the person or persons responsible for the report; one or more dates; a statement of purpose; a presentation and analysis of facts; and, unless it is the result of a purely informational survey, some conclusions should be reached. All material and data in all sections of the report should be meticulously labeled to indicate the sources from which they were obtained.

Depending on the size, nature, and purposes of the investigation and report, it may be desirable in some cases to include an index or table of contents; to outline carefully the scope and the limitations of the survey; to include a separate section summarizing the analysis, conclusions, and recommendations; to define any possibly ambiguous terms; to provide recommendations for implementing the conclusions; and to include an appendix.

ELEMENTS OF THE PROCEDURE

Just as there are no definite rules applicable to all situations on the content and arrangement of systems reports, so there are no fixed rules on the content, arrangement, and format of procedures.

All procedures should contain the information on dates, titles, numbers, distribution, forms, associated procedures, etc., as outlined in the final chapter on the systems department's operations.

Some of the elements described in the discussion of systems reports are equally applicable to procedures.

1. An initial statement of the scope of the procedure, what it covers and the limits of its coverage, is always desirable in a procedure. This statement should clearly define the area within which the procedure is effective.
2. A statement of the importance of the system being established to the proper functioning of the enterprise is frequently desirable. What is the purpose of the function? What will the procedure accomplish? Why is the paperwork or the report needed?
3. A summary of the procedure or an index may be very helpful when a long or complex system is being presented.
4. If some organizational unit has an unusual and major responsibility in the operation of the system, this fact might be emphasized in a separate introductory section of the procedure.
5. If any of the terms or concepts used in the procedure are subject to misinterpretations, a section defining these terms might be included in the early part of the procedure. It is advisable to be certain that all new items or relationships with which the reader is unfamiliar be clearly explained.

The procedural material should be organized in a logical and readily understandable fashion. A number of different logical approaches are usually possible, but usually only one of these will provide maximum understanding. The analyst must examine all possibilities to provide the simplest and clearest organization of the material.

Procedural material may be effectively presented in chronological sequence. This organization is the best for ease of understanding the operation of the entire procedure. It is therefore well suited to relatively short procedures or those in which few sections of the company are involved. However, when numerous departments are involved in a relatively long procedure, the chronological organization is more difficult for the operating personnel to follow than one in which the operations of each department are grouped together.

In this departmental organization of the material, the activities of each department are explained in a sequence as nearly chronological as possible. The personnel of each department concerned need read carefully only its own section of the procedure. However, to a person desiring an over-all picture of all the operations, this departmental break-down is harder to follow. To provide this over-all picture in a long departmentalized procedure, a chronological summary can be included.

When the departmental break-down is called for in a long and complicated procedure, the writer has successfully resorted to a procedural design which cross-references the systems flows in a uniform fashion. An example of this "Information Received, Source, Action Taken" form is shown below:

> "VI. *Procurement Department*
> INFORMATION RECEIVED: Purchase Requisition Change
> SOURCE: Material Ordering Section (see section III-B)
> ACTION TAKEN: issue new purchase order for revised requirements."

In writing a procedure, reflect the point of view of the user of the procedure. It is desirable to consider its comprehensibility to the dullest persons who will be required to understand it. While avoiding the appearance of writing down, direct the material to the lowest level of comprehension of your anticipated audience.

To provide a complete explanation, the procedure should explicitly indicate the source of all information and forms referred to therein, what action is taken on receipt of the information or forms, and the entire distribution of information, forms, and material.

Specific, concrete examples are generally preferable to long generalizations in clarifying a system. Also, pictures, samples of actual forms and how they are used, specimen reports, statistical tables, etc., will frequently give a clearer picture of the situation than many pages of explanation.

The possibilities of clarifying procedural explanations through the use of the many charting and lay-out techniques presented in the various chapters of this book should not be overlooked. They should be included in the procedures wherever they will aid understanding.

Procedures should not refer to personal names, but should use organizational titles. The procedure is thus not made obsolete whenever the organizational assignment is changed.

In the Appendix to this Chapter is shown an example of the written procedures used at the RCA Victor Camden Plant. Other examples are shown in the Appendices to Chapter XIII.

CLARITY AND EFFECTIVENESS OF STYLE

We want to consider here methods of improving the clarity of reports and procedures. By improving the clarity is meant increasing the effectiveness of the communication provided by the written sequences of words. The efficiency of communication can be measured by the amount of space or time required to complete transmission of information, as well as by the accuracy of the transmission.

Of the various guides to more effective methods of expression which can be offered, many are related to custom and traditional practice, such as rules for punctuation. This is to be expected, because punctuation marks convey a meaning which is determined by its past usages and present practices, just as the meanings of words are dependent on past and present usage.

It almost goes without saying that the more familiar the words used in the report, the easier will be the communication. Therefore, it is desirable to use words which have the most general usage to the prospective readers. The same words are not always the familiar ones to different groups. There is, however, a common group of words which are familiar to most literate Americans.

Brevity

Not only should familiar words be used, but there should not be too many of them. Brevity is the soul of wit and no one likes to read fifty words when twenty-five will convey the same meaning.

For example, a procedure was written some time ago containing the following paragraph:

> "*Critical items which are of the most urgent nature, and which must be expedited as soon as possible:* In cases such as these it will be necessary for the expediters (for the stockroom) to make either telephone contact, or personal contact with the delivery group. They will discuss the situation (verbal contact is required as indicated above) and will determine which of the following types of vendor expediting should be performed and the extent to which it should be done.

1. Governmental action
2. Field service action
3. Vendor follow-up action."

This paragraph of 88 words can be reduced to a much shorter paragraph of 36 words, as shown below, without losing any of the original meanings. This results in improved style and clarity:

"*Extremely critical items requiring immediate expediting.* The stockroom expediter will contact the delivery group personally or by telephone. Discussion will determine the extent of vendor expediting required (governmental, field service, or vendor follow-up action)."

Active voice

When language is alive, packed with action, it is easier to read and is more effective. One aid to getting action in your sentences is to use the active voice of the verb rather than the passive voice. To illustrate:

"The report will be prepared by the group supervisor," is written in the passive voice.

"The group supervisor will prepare the report," is written in the active voice.

Other things being equal, the active voice is to be preferred to the passive voice. However, the active voice puts the emphasis on the performer whereas the passive voice places the emphasis on the recipient of the action or the thing being acted upon. Therefore, if it is desired to emphasize the thing being acted upon or the recipient of the action, the passive voice should be used.

The passive voice is frequently used to create impersonality in reports and procedures. Since excessive use of the passive voice creates a weak composition, this practice should be avoided.

Short declarative sentences

Short declarative sentences read easily and are easy to understand. They are preferable to long sentences with many modifying phrases and clauses which tend to weary and confuse the reader. Compound and complex sentences should be avoided when simple ones will convey the same meaning.

For instance, read the following one-sentence paragraph:

"Although the production-control department has been having difficulty releasing its parts fabrication orders on schedule because of the inability of several vendors to meet promised delivery dates and because of the recent overload of the facilities of the incoming inspection department, the situation has been improved in the past two weeks by the institution of a new expediting procedure and by redistributing the responsibilities of the various departments of the inspection division."

Now read it as revised below:

> "The production-control department has been having difficulty releasing its parts fabrication orders on schedule. This has been caused by the inability of the several vendors to meet promised delivery dates as well as the recent overload of the facilities of the incoming inspection department. Instituting a new expediting procedure and redistributing the responsibilities of the various departments of the inspection division have improved the situation these past two weeks."

Although the revised version is still not composed entirely of short declarative sentences, it is decidedly more readable than the original.

Itemizing the clauses

At times it is impractical to use many simple sentences in place of a compound one. Consider the following :

> "The section supervisor will check the calculations on the Data Sheet, fill out a Piecework Card, clip the Piecework Card to the Data Sheet, record the rate on the Payroll Record Card, and initial the Labor Voucher."

Rather than attempt to break this one-sentence paragraph into five simple sentences, the efficiency of the paragraph can be improved by itemizing the actions:

> "The section supervisor will:
> 1. Check the calculations on the Data Sheet.
> 2. Fill out a Piecework Card.
> 3. Clip the Piecework Card to the Data Sheet.
> 4. Record the rate on the Payroll Record Card.
> 5. Initial the Labor Voucher."

Parallel sentence structure

Clarity is promoted by the use of parallel sentence structure and words to express ideas which are parallel in nature. Let us consider several examples of this principle.

> "The Washington Sales Office will issue F O P forms when estimates are requested whereas K O P forms will be issued by the Chicago Sales Office when estimates are requested."

If the important elements in this sentence are the different forms, then parallel structure and the proper emphasis are given by the following revised version: "F O P forms will be issued by the Washington Sales Office when estimates are requested whereas K O P forms will be issued by the Chicago Sales Office when estimates are requested."

> "The systems department will determine the requirements for additional office space and whether air-conditioning should be installed."

An obvious improvement to give parallelism is: "The systems department will determine the requirements for additional office space and the necessity for air-conditioning."

> "The receiving department will stamp the move ticket and it will then be forwarded to the accounting department."

This is easily transposed to a sentence with parallel construction: "The receiving department will stamp the move ticket and will forward it to the accounting department."

The sentence, "Inventory control has and continues to be a critical function," not only violates the principle of parallelism, but is incorrect. The verb *has* is incomplete. The sentence should read: "Inventory control has been and continues to be a critical function."

Independent clauses

When using a complex sentence, the independent clause gets most of the emphasis and should therefore transmit the more important ideas. Let us consider the following sentence:

"The plant manager conferred with his department chairmen on the quality-control problem, resulting in agreement on a new system for insuring adequate control."

The independent clause is underlined by a solid line and the subordinate clause by a dashed line. Since the agreement on a control system is the principal idea in the sentence, it would read better as:

"As the result of a conference of the plant manager with his department chairmen on the quality-control problem, agreement was reached on a new system for insuring adequate control."

Or, better still, substituting a simple sentence for a complex one:

"Agreement was reached on a new system for solving the quality-control problem at a conference of the plant manager with his department chairmen."

Logical placing of clauses and phrases

Clarity in the written word requires conformance to the logical relationships of the language. When the customary relationships are violated, a mental disturbance is created in the reader which is not conducive to the rapid transmission of ideas. In addition, many misinterpretations may result from non-conformance to established usage.

To illustrate some of the hazards involved in the violation of the logical conventions of the language, the following two samples of more common deviations from correct usage are presented.

"Having completed the testing cycle, the equipment was released for shipment by the inspector." Although the clause, "having completed the testing cycle," modifies "inspector," it is placed adjacent to "equipment." It would be clearer to say, "Having completed the testing cycle, the inspector released the equipment for shipment."

"Before signing move tickets, it is required that each supervisor carefully read the tickets and check the stock record." What word does the clause "before signing move tickets" modify? It modifies "supervisor" but is placed adjacent to "it." A better arrangement would be: "Before signing move tickets, each supervisor is required to read the tickets carefully and check the stock record."

Punctuation and capitalization

The conformance to standard punctuation and capitalization practice in procedures and reports is considered desirable because it aids comprehension. Some standard recognized authority should be followed. In all cases, consistency should be maintained. If a word is capitalized in one place, it should be capitalized throughout the report or procedure.

The writer has attempted in these last several pages to signal for the reader's attention some considerations which may help to promote the clarity and understandability of his reports and procedures. Many additional aspects which might be discussed with profit are being omitted for the sake of brevity.

MEASURING THE EFFECTIVENESS OF WRITING

Mr. Rudolf Flesch, in his very interesting treatises on effective writing,* succinctly states his recipe for understandability: "Talk about people in short sentences with many root words." Mr. Flesch's yardstick

* Rudolph Flesch, *The Art of Plain Talk*, Harper, 1946; *The Art of Readable Writing*, Harper, 1949; and "A New Readability Yardstick," *Journal of Applied Psychology*, Vol. 32, No. 3, June 1948.

for measuring readability or comprehension difficulty is based on the three elements in this recipe:

1. How short are the sentences?
2. How many prefixes, suffixes, and inflectional endings have been added to the roots of the words used in the sentences? What is the average number of syllables per word of text?
3. How many personal references—nouns with natural gender, personal pronouns except those that refer to things and not to people?

This third yardstick measures human interest more than readability. However, the human interest will increase the reader's attention and his motivation to continue reading. Mr. Flesch later adds a fourth human interest yardstick to test conversational quality or story interest: How many personal sentences? How many spoken sentences marked by quotation marks or otherwise? How many questions, commands, requests, and other sentences directly addressed to the reader? How many exclamations and grammatically incomplete sentences whose meaning has to be inferred from the context?

POTENTIAL EFFICIENCY OF A REPORT

A written procedure or a systems report can only be as good as the proposed system it presents. If the procedure or report performs its function perfectly—with 100 percent efficiency—then it is exactly as good as the proposal itself. If the proposal will accomplish only 50 percent of what it should, then the perfectly written report rates only 50 percent.

Although the report can be only as good as the proposed system, this maximum may not be obtained. Thus, if a perfect proposal which should be rated 100 percent is written and presented poorly so that only 50 percent efficiency of communication results, the report will rate only 50 percent.

Which is the greater tragedy: a good system poorly presented or a poor system well presented?

The answer to this question might be debated for many hours. The important point to remember in systems work, as in all activities, is that the best ideas are of no consequence unless they are accurately transmitted. If they are inaccurately transmitted, these same ideas may prove very harmful.

APPENDIX

CAMDEN PLANT PROCEDURE

Issued by: SYSTEMS GROUP
INDUSTRIAL ENGINEERING DEPARTMENT

No. 1450-02
Page 1 of 7

Date 4-14-45 Effective 4-14-45 Supersedes 12-18-44

Classification Cost Estimating

Subject COST ESTIMATE: REQUEST, PREPARATION, AND DISTRIBUTION

Scope:

This Procedure outlines the flow of cost estimating information. It establishes the method for:

1. Requesting a Cost Estimate from the Cost Estimating and Standards Section
2. Obtaining cost information for estimating purposes
3. Distributing the Cost Estimate.

The provisions of this Procedure are not applicable to Record Manufacturing.

I. DEFINITIONS

A Cost Estimate is a determination of the cost of a production part, subassembly or complete equipment, regardless of whether used for sales quotation, billing, or planning purposes.

II. RESPONSIBILITY

The Cost Estimating and Standards Section of the Plant Accounting Department is responsible for making all authorized estimates of production costs in the Camden Plant. Estimates compiled by other sections for any purpose must be approved by the Cost Estimating and Standards Section prior to submission to any person, department, or agency.

III. INITIATION OF REQUEST FOR COST ESTIMATE FORM

The following groups are authorized to initiate a Request for Cost Estimate in accordance with the procedure herein established. All requests must carry a proposition number assigned by initiator, in accordance with Camden Plant Procedure #1450-01, "Proposition Numbers".

A. Commercial Organization

1. The Engineering Products Department may initiate Requests for Cost Estimate to obtain costs on parts and/or equipment to be manufactured at or subcontracted from the Camden Plant, for quotation to outside agencies and to obtain estimates of maximum expenditures on a Letter of Intent.

   The Request will be sent to Product Manager involved. When no Product Manager has been assigned to the type of equipment involved, the Request will be sent to the Supervisor of the Cost Estimating and Standards Section.

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Date 4-14-45 Effective ______ Supersedes ______

Classification ______

Subject ______

2. Industrial and Sound Department (same as A-1).

3. Radio, Phonograph, and Television Department (same as A-1).

4. The Spare and Replacement Parts Section of Tubes and Equipment Department may initiate a Request for Cost Estimate for costs on spare or replacement parts for quotation to outside agencies.

   A Request for Cost Estimate on complete Master Items (MI's) will be sent to the Product Manager. A Request for Cost Estimate for parts or assemblies (except complete MI's or equipments) will be sent direct to Cost Estimating and Standards Section.

   Special Replacement Parts Procedure - When replacement parts are ordered on a Direct-to-Works Requisition Sheet, usually to be produced at the same time as the entire equipment, a special estimating procedure will be followed, as outlined in Section VII of this Procedure.

B. International Activities (same as A-1).

C. The Subcontracting Section of the Procurement Department may initiate a Request for Cost Estimate to obtain costs for billing purposes on parts and/or equipment shipped to a subcontractor from the Camden Plant. The Request will be sent to the Product Manager.

D. The Accounting Department may obtain estimates on parts and assemblies for billing and other purposes by following the special procedure outlined in Section VIII of this Procedure.

E. The Product Manager may initiate a Request for Cost Estimate:

   1. For costs on parts supplied by Camden to other RCA Victor Division Plants.

   2. To obtain costs requested by any department of Camden Plant for planning and comparison purposes.

   In all these cases, requests will be sent to Cost Estimating and Standards Section.

IV. ENGINEERING DEPARTMENT COPY OF COST ESTIMATE REQUEST

One copy of each Request for Cost Estimate (except those originating in Subcontracting Department) will be sent to the proper Engineering Department by the person who sends the Request to the Cost Estimating and Standards Section.

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V. ESTIMATING PROCEDURE

A. Product Manager

1. Upon receipt of a request from a department of the Camden Plant to initiate a Request for Cost Estimate for planning purposes, the Product Manager will first ascertain that the cost information desired is actually required. He will then initiate a Request for Cost Estimate and send to the Cost Estimating and Standards Section, and to the proper Engineering Department, with any additional information which will be of value in estimating.

2. Upon receipt of a Request for Cost Estimate from the Commercial Organization or the Subcontracting Section of the Procurement Department, the Product Manager will review the item requested to make sure that it is practical from a manufacturing and load standpoint and in accord with RCA manufacturing policy. He will indicate whether equipment is to be manufactured at the Camden Plant or subcontracted. If it is to be manufactured, the section in which it is planned to assemble the equipment will be indicated, if possible. If it is to be subcontracted, one copy of the Request for Cost Estimate will be sent to the Subcontracting Section. The Product Manager will send the Request for Cost Estimate to the Cost Estimating and Standards Section with any additional information which will be of value in estimating. A copy will also be sent to the proper Engineering Department and to the Equipment Planning and Scheduling Section.

3. Upon receipt of the subcontracting cost data (Section V-A-2) from the Subcontracting Section, the Product Manager will forward this data to the Cost Estimating and Standards Section.

4. Upon receipt of three copies of a Request for Cost Information on crystal units in an equipment from the Equipment Estimating Group (Section V-B-1), the Crystal Product Manager will send one copy to the Engineering Department and one copy to the Crystal Cost Estimating Group.

5. The Crystal Product Manager will receive four copies of the Crystal Cost Estimate (Section V-B-3). After approving the Cost Estimate, the Product Manager will forward a copy to each of the following groups:

   a. Equipment Cost Estimating Group
   b. Commercial Organization
   c. Engineering Department

B. Cost Estimating and Standards Section

1. Upon receipt of Request for Cost Estimate from an authorized source, the Cost Estimating and Standards Section will request cost information from other departments of the Camden Plant in following manner:

   a. Procurement Department - send a Request for Purchased Parts

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to the Procurement Department for costs of purchased parts.

b. All other departments - send a Request for Cost Information to all other departments from which cost information is required.

When the equipment contains crystal units, the Equipment Cost Estimating Group will send three copies of a Request for Cost Information to the Crystal Product Manager and one copy to the Commercial Organization.

2. If parts are to be obtained from other RCAVD plants, a Request for Costs will be prepared and sent to the Product Manager of the plant involved. If no Product Manager has been assigned to the type of equipment involved, the Request for Costs will be sent direct to the Cost Estimating Section of that Plant.

3. Upon receipt of a Request for Cost Information from the Crystal Product Manager and engineering cost information from the Engineering Department, the Crystal Cost Estimating Group will prepare a Cost Estimate for the crystal units and forward four copies to the Crystal Product Manager.

4. Upon receipt of the cost information requested, the Cost Estimating and Standards Section will:

a. Prepare a cost estimate on Cost Estimate form, except estimates of expenditures on Letters of Intent, which will be prepared on Standard Letter Form. Distribute as outlined in Section VI of this Procedure.

b. Prepare a Price Analysis Summary for all cost estimates except estimates of expenditures on Letter of Intent. Distribute as outlined in Section VI of this Procedure.

When crystal units are contained in an equipment, they will appear as a separate item on both the Cost Estimate and Price Analysis Summary.

C. Engineering Departments

1. Upon receipt of copy of Request for Cost Estimate, the Engineering Department involved will:

a. Prepare adequate engineering information for estimating cost of the equipment and/or parts involved and forward to the Cost Estimating and Standards Section and to the Assembly Planning and Scheduling Section.

b. Prepare engineering cost information on Engineering and Drafting Estimate form. The cost and quantity of instruction books and engineering facilities, together with list of tube complements must be included with the estimate. Send to the Cost Estimating and Standards Section and to the Assembly

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Planning and Scheduling Section.

c. If equipment is to be subcontracted, send adequate engineering information for obtaining quotations on equipment to the Subcontracting Section.

2. Upon receipt of a Request for Cost Information on crystal units in an equipment from the Crystal Product Manager (See Section V-A-4), the Engineering Department will send engineering cost information for both the crystal and crystal holder to the Crystal Cost Estimating Group.

D. Subcontracting Section of Procurement Department

Upon receipt of a Request for Cost Estimate from the Product Manager, the Subcontracting Section will obtain one or more quotations for the items from subcontractors, plus any additional information required by the Cost Estimating and Standards Section. This information will be sent to the Product Manager.

E. Procurement Department

Upon receipt of a Request for Purchased Parts from the Cost Estimating and Standards Section, the Procurement Department will prepare the required cost information and return one copy to the Cost Estimating and Standards Section.

F. All Other Departments of Camden Plant

Upon receipt of a Request for Cost Information from the Cost Estimating and Standards Section, the section receiving the request will prepare the cost information required and send it to the Cost Estimating and Standards Section and to the Equipment Planning and Scheduling Section.

VI. DISTRIBUTION OF ESTIMATES

A. Estimate Requested by Commercial Organization

1. All except estimates of expenditures on Letter of Intent:

a. The Cost Estimating and Standards Section will send one copy of the Cost Estimate, one copy of the Price Analysis Summary (Price Analysis Summary not required for replacement parts), and an Approval Card to the Product Manager.

b. Upon return of the signed Approval Card and Price Analysis Summary from Product Manager, the Cost Estimating and Standards Section will:

(1) Send three copies of Price Analysis Summary and Commercial Organization copy of Cost Estimate to Price Accounting Group of General Accounting Department.

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(2) Send a copy of the Cost Estimate to one of the following sets of departments, depending on the nature of the proposition:

(a) Non-restricted, restricted, or confidential
(1) Equipment Planning and Scheduling Section
(2) Engineering Department
(3) Plant Accounting Department
(4) General Accounting Department

(b) Secret
(1) Engineering Department
(2) Plant Accounting Department

2. Estimates of maximum expenditures of Letter of Intent:

a. The Cost Estimating and Standards Section will send three copies of the Standard Letter to the Price Accounting Group, who will distribute a copy to the Commercial Organization and to the Divisional General Counsel.

b. The Cost Estimating and Standards Section will send a copy of the Standard Letter to one of the following sets of departments, depending upon the nature of the Letter of Intent:

(1) Non-restricted, restricted, or confidential

(a) Equipment Planning and Scheduling Section
(b) Engineering Department
(c) Plant Accounting Department
(d) General Accounting Department
(e) Commercial Organization
(f) Plant Manager
(g) Product Manager

(2) Secret

(a) Engineering Department
(b) Plant Accounting Department
(c) Commercial Organization

B. <u>Estimates Requested by Subcontracting Section of Procurement Department</u>

The Cost Estimating and Standards Section will send four copies of the Cost Estimate to the Subcontracting Section and one copy to the Product Manager and to the Plant Accounting Department.

C. <u>Estimate Requested by Product Manager</u>

The Cost Estimating and Standards Section will send two copies of the Cost Estimate to the Product Manager, and one copy to the

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Plant Accounting Department, and one copy to the Engineering Department.

VII. SPECIAL REPLACEMENT PARTS ESTIMATING PROCEDURES

The following procedure will be followed for estimating the costs of replacement parts ordered on a Direct-to-Works Requisition (DTW).

A. Three copies of the DTW issued by the Replacement Parts Section will be sent to the Cost Estimating and Standards Section.

B. The Cost Estimating and Standards Section will estimate the costs of the parts ordered on the DTW.

C. The cost estimates will be typed on the DTW in line with the part description. One copy will then be sent to Replacement Parts Section and one copy to Plant Accounting Department.

VIII. SPECIAL PROCEDURE FOR COSTS REQUIRED BY THE PLANT ACCOUNTING DEPARTMENT

When a section of Plant Accounting Department requires cost on parts and assemblies for billing and other purposes, it will request these costs from the Cost Estimating and Standards Section in writing. The Cost Estimating and Standards Section will supply the requested information in writing.

IX. COST ESTIMATE FOLLOW-UP

Upon receipt of a DTW from the Equipment Planning and Scheduling Section, the Cost Estimating and Standards Section will check it against the applicable cost estimate. If the quantities or contents on the DTW do not agree with those used in the cost estimate, a new estimate will be made. The estimated costs will then be placed on Cost Comparison Card and one copy sent to the Cost Accounting Section of the Plant Accounting Department.

DISTRIBUTION

All holders of Camden Plant Procedures Manuals plus:

H. S. Hemingway	8-5	2057	Central Planning
F. J. Herrmann	4-5	2069	Equipment Assembly
H. Hannum	10-R	2292	Plant Accounting
F. J. Holmes	8-5	919	Plant Accounting
T. R. Sykes	10-2	802	Plant Accounting
F. W. Watkinson	8-5	449	Plant Accounting
N. Barish	8-5	427	Industrial Engineering

FORMS INVOLVED

Request for Cost Estimate	- #12859
Request for Purchased Parts	- #11B94
Request for Cost Information	- #B257T
Request for Costs	- #12812
Engineering & Drafting Estimate	- #19885 and #25913-2
Cost Estimate	- #18262
Price Analysis; Summary	- #10859 and B214T or 2C4& 2C5
D.T.W.	- #11B95
Purchase Order	- #B11D5
Cost Comparison Card	- #10749

ASSOCIATED PROCEDURES

PROPOSITION NUMBERS, BLOCK ASSIGNMENT OF #1450-01

INDEXING

This Procedure is to be indexed as follows:

COST ESTIMATE: REQUEST, PREPARATION AND DISTRIBUTION

ESTIMATE (COST): REQUEST, PREPARATION AND DISTRIBUTION

Please post to your index for easy reference.

XII

INSTALLING THE SYSTEM

THE EXISTING SYSTEM has been thoroughly and systematically examined; the best alternative has been determined and the detailed procedure designed; a report of the entire investigation has been prepared; management has approved the new system and the supervisory and operating personnel have been sold on the new procedures. The next step is the installation of the improved system.

The methods and thoroughness of installing the system may determine the success of the improvement, especially in the early stages of operations under the new system. If the groundwork for the new system has not been properly prepared; if the personnel have not been properly trained; if the installation timetable is poorly arranged; if understandable and concise instructions have not been issued; if the period of overlap between the old and the new has not been provided for; then the best improvement will fail.

The installation should therefore be logically planned well in advance of the changeover. The timetable and the installation methods should be outlined in detail to insure complete and effective results.

METHODS OF INSTALLATION

There are four principal approaches in installing a new, improved system:

1. Install critical parts of the system on a tentative trial basis to test its effectiveness.
2. Install the entire system on a tentative basis and at the same time retain the old system running concurrently.
3. Install the entire system in one small unit of the company as a pilot plant, replacing the old system only in this company unit.
4. Install the new system to replace the old system in its entirety. The timetable to accomplish this installation covers as short a period of time as is possible without disturbing normal operations too severely.

Each of these methods has advantages and disadvantages and is best suited to varying situations. The first three approaches involve a trial approach to reveal and eliminate any minor kinks in the new system before it is fully applied. If it is necessary and desirable, the testing of critical aspects of the system on a trial basis should generally be done prior to the decision to adopt. It is essentially a part of the systems investigation in most cases. Installing the new system to run parallel to the existing one may provide a good basis for comparison of the systems. However, it is a costly procedure and may pose a personnel problem because of the two sets of employees required, one of which will be eliminated eventually.

The pilot-plant installation system may be very valuable where applicable. In the vast majority of cases, similar, independent units are not available for pilot-plant installation and, even if available, are not always necessary. However, they can provide valuable experience for refining the details of a complicated system when the opportunity for such an installation procedure is present.

Direct installation of the new system is the most usual and most logical procedure in most cases. Various segments of the system may be installed in succession or simultaneously, depending upon the circumstances. The installation timetable should make allowance for the training and learning time required for adapting the workers to the new routines.

TRANSCRIBING TO NEW RECORDS

It is sometimes necessary to transcribe some historical information from the old record-keeping system to the new record. This task may be relatively time-consuming and arduous. It will not usually be practical to expect the regular record keepers to transcribe this backlog as well as keep up with the current volume unless the change can be made during a period of low volume of work.

If the volume of work is not too great, it might be advisable and most economical to have this setting-up work done by the same employees on an overtime basis.

If this is not feasible because of the large amount of overtime which would be required and the length of time which the task would take, then it might be possible to borrow some personnel from other departments for a short period of time. This would be especially practicable if the installation could be timed to coincide with the period of unseasonal activity in the other departments.

Another source of aid in this installation work is an outside clerical agency. A number of enterprises have been established in recent years which will provide a staff of clerical workers to handle peak-load operations such as this. A competent clerical crew provided by a reliable agency may sometimes be the answer.

Of course, if the nature of the installation is such that the changeover will cover a relatively long period of time, it may prove most practical to employ one or more persons on a temporary basis to perform the task.

TRAINING PRINCIPLES

The methods of training the worker will vary widely. Different types of work and the varying abilities and aptitudes of the workers will dictate differing methods. Some general principles of teaching and learning are nevertheless applicable to all training methods.

The tasks should be divided into logical entities and then each of these should be taught as one complete unit, rather than break these entities into smaller parts. It is easier to learn a whole motion pattern rather than learn each part of the pattern separately and then integrate the parts into the whole pattern. It is generally more effective to teach the entire operation of a clerical task as a whole rather than attempt to obtain facility with each segment separately and then integrate the segments into the entire operation.

Training is made more effective when the worker's interest is aroused. The best methods of arousing the worker's interest and stimulating his attention will vary in each circumstance.

The learning process is greatly facilitated when associations from past skills and knowledge can be used. The memory is assisted when the old innate reactions or procedures can be transferred, with necessary changes, to the new task.

The analyst should never talk down to the worker or give evidence of any kind of irritation or boredom to those who may be slow in learning. Any such actions are bound to create undesirable reactions in the worker which may make the learning rate even slower.

Patience should always be shown to all the workers in learning the new procedures. Indications of impatience will usually tend to rattle the worker and defeat the instructional purposes.

It is generally preferable to concentrate on accuracy first and allow the speed to develop as the skill increases. If speed is initially attained at the expense of accuracy, it is usually exceedingly difficult to eliminate the early habits of inaccuracy.

As many of the organs of sensory perception should be brought into play as possible. The worker should hear how it should be done; see how the expert demonstrates it; and, under supervision, feel how he is supposed to do it himself. As much as possible, the instruction should train and use the senses.

It is important that the worker be observed closely in his initial performances of the new procedures to insure that he follows the desired methods. Errors or bad habits are best discovered early if they are to be rapidly corrected.

The instructional sessions are usually more effective if they are relatively short and numerous rather than one or several long, continuous periods. Breaking up the training periods into short sessions gives the worker a chance mentally to digest the material as well as to recuperate psychologically from the struggle of learning. It enables the learner to be in a refreshed state of mind more frequently. Distributing the teaching and practice has been found generally to promote more rapid learning.

TRAINING TECHNIQUES

Utilizing these learning principles, the employees may be trained, using various combinations of industrial training techniques. The correct emphasis will be dependent on the nature of the work and personnel. Mr. W. H. Leffingwell explains six phases in the training of clerical workers to perform their duties correctly: *

* From *Handbook of Business Administration,* edited by W. J. Donald. Copyright 1931. Courtesy of McGraw-Hill Book Co.

1. The actual work to be done must be explained to the worker in a manner that will thoroughly impress him with (a) the purpose of the work; (b) the relation of the operation to other work; (c) the relative importance of the various details of the job; and (d) the manner in which it is to be done. This is the beginning of all training, and there are perhaps more companies who take this step than will be found taking the rest of them. But it is only the beginning, and nothing remarkable can be accomplished by stopping there.

2. The best arrangement of the work and the work place should be taught. If every job is carefully studied, it will be found that there is always one particular way of arranging the work and the work place that is far superior to the others. But this is a matter which can only be determined by deliberate study; one cannot "just naturally" pick it up, and if left to his own devices the clerk will usually adopt a clumsy arrangement. Many managers, though observing this, hesitate to suggest a change, on the assumption that a person will work better with his own arrangement than with any other, which is of course an unfounded idea.

3. The best motions constitute the next step, and they can only be found by the most careful analysis of the work to be accomplished, the nature of the motion required, the element of fatigue, and so forth. Occasionally a worker will, of his own accord, develop a superior way of performing a certain motion, but rarely indeed does one worker develop all of the best motions in an operation. A study of the various methods used at present by different workers will be found suggestive, but ordinarily the observer will be compelled to use his own ingenuity.

4. The next step to be taught is the correct sequence of the motions at a standard rate of speed. Gilbreth has shown that fast motions are different from slow ones, and if one is definitely to learn the right motions, he must at the same time learn to perform them at a standard rate of speed.

5. While the fourth step is being learned, the habit of speed must be developed. For it is strictly a habit. Some people acquire it more readily than others, but all must learn it.

6. Accuracy must also accompany the last two steps, but its final development may be completed after the habit of performing the right motions in the right sequence, and at a standard rate of speed, has been acquired. The worker must be taught the points at which accuracy is of the greatest importance, and also where extreme accuracy is not required. The meticulous clerk is often more of a liability than an asset.

Some formal classroom or conference instruction may be desirable to acquaint the workers and the supervisors with the new procedures. These classes will normally be held during working hours. If classes meet after hours, supplementary employee compensation may be desirable. The first step is to write down in detail the material and skills to

INSTRUCTIONS FOR POSTING SHOP ORDER STATUS RECORDS

THIS KIND OF PAPERWORK MEANS THAT	THIS TRANSACTION HAS OCCURRED, AND	THE SHOP ORDER STATUS RECORD SHOULD BE POSTED LIKE THIS: Column to be Posted	Color of Ink	Add or Subtract
Accumulation Sheet	Accumulation stockroom has sent parts to Assembly for installation in equipment	Disbursements	Black	Add
Credit Memo *C.M.	1. Assembly has returned purchased parts to P.M.I. to be reinspected or to be returned to the Vendor.	Receipts and Disbursements	Red (both columns)	Subtract (both columns)
	or			
	2. Assembly has returned parts to the Accumulation stockroom.	Disbursements	Red	Subtract
	or			
	3. P.M.I. has returned to the Accumulation stockroom parts which were sent to be reinspected or returned to vendor.	Receipts	Black	Add
Material Diversion Ticket D.T.	1. Parts have been received on a diversion from another shop order.	Receipts (Note in red in Diversion column)	Black	Add
	or			
	2. Parts have been received from borrower as repay of a previous diversion loan.	Receipts (Note in black in Diversions column)	Black	Add
	or			
	3. Parts have been disbursed on a diversion to another shop order.	Receipts (Note in black in Diversions column	Red	Subtract
	or			
	4. Parts have been disbursed as repay of a previous diversion loan.	Receipts (Note in black in Diversions column)	Red	Subtract
Material Forwarding Ticket *F.T.	1. Accumulation stockroom has received fabricated or Component parts from Parts Fabrication or Component Parts Department.	Receipts	Black	Add
	or			
	2. Assembly section has sent parts to a manufacturing department for repair.	Receipts and Disbursements	Red (both columns)	Subtract (both columns)
Material Requisition Ticket *M.R.	1. The Accumulation stockroom has received parts from the Warehouse (also received on copy of M.O.C.).	Receipts	Black	Add
	or			
	2. The Accumulation stockroom has sent parts to Assembly to cover shortages.	Disbursements	Black	Add
	or			
	3. Accumulation stockroom has sent parts to subassembly, which will return them under a subassembly number.	Disbursements	Black	Add
	or			
	4. Accumulation stockroom has returned purchased parts to P.M.I. to be reinspected or returned to vendor.	Receipts	Red	Subtract
	or			
	5. Accumulation stockroom has returned parts to a manufacturing section to be repaired.	Receipts	Red	Subtract
	or			
	6. Accumulation stockroom has returned parts which it received by mistake.	Receipts	Red	Subtract
Receiving Sheet	Accumulation stockroom has received purchase parts from P.M.I.	Receipts	Black	Add
Report of Reject Material Scrapped R.M.S.	Assembly section has scrapped parts.	Receipts and Disbursements	Red (both columns)	Subtract (both columns)
P.O.C.	The Accumulation stockroom has received parts from the Warehouse (also received on Material Requisition Ticket).	Receipts	Black	Add

* REJECTS
When parts are rejected on a Credit Memo, a Material Forwarding Ticket, or a Material Requisition Ticket, add "R" to the regular ticket symbol entered in the ticket number column.

Examples:
CMR 89175 Parts rejected on Credit Memo #89175
FTR 32450 " " " Mat'l. Forwarding Ticket #32450
MRR 79282 " " " Mat'l. Requisition Ticket #79262

TABS
The following tabs will be used to show the status of different kinds of parts:

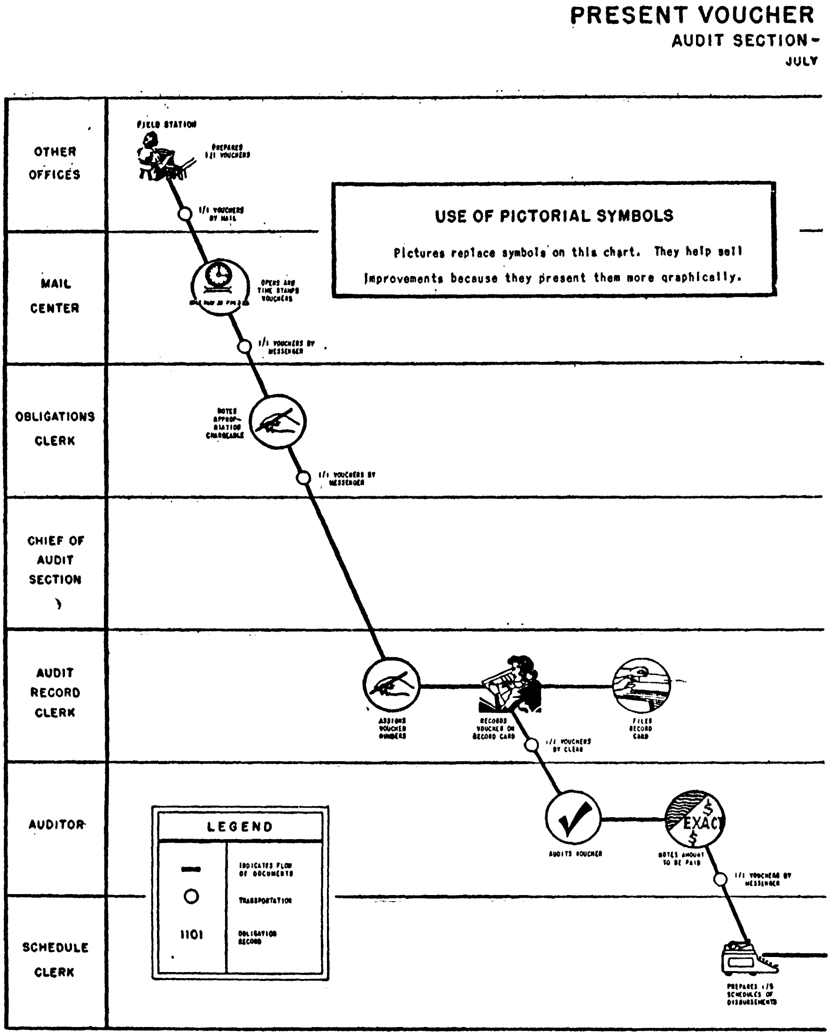
1. Blue tab purchased parts
2. Red tab manufactured parts
3. Black tab component parts

In addition, a yellow tab will be placed on a card whenever a diversion of that part has been made and repayment has been promised. The yellow tab will remain on the card until the repayment is made.

SYSTEMS GROUP
INDUSTRIAL ENGINEERING DEPT.
8-17-44

Courtesy RCA Victor

Figure 85. Instruction Chart—summarizes the routine duties of the posting clerk using the shop order status record of Figure 63.

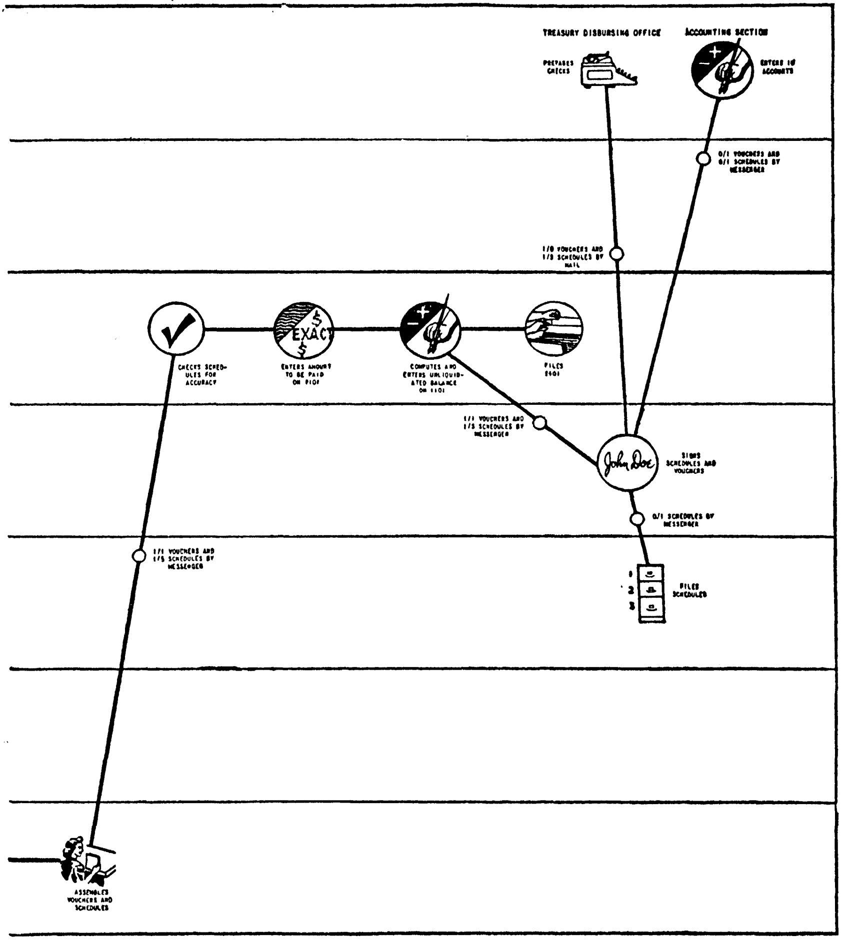


U. S. Bureau of the Budget Management

Figure 86. Organizational Flow

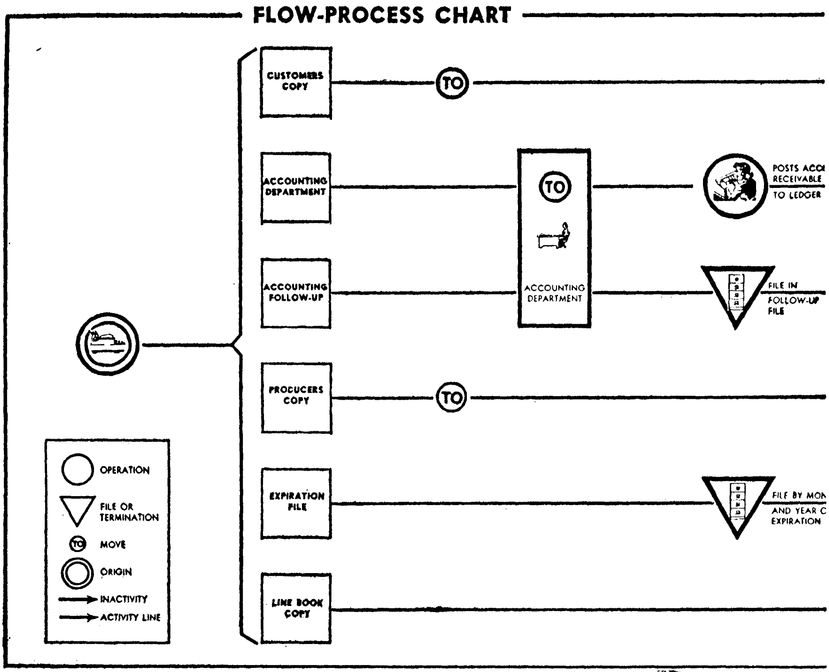
be taught in the classes. If all the material can be covered in one short session—which sometimes might very well be the case with the supervisors—then a timetable of sessions is not required. Otherwise, a timetable of relatively short periods (about one hour each) should be prepared and the material to be covered allocated the required amounts of time in these sessions.

AUDITING PROCEDURE
FINANCE DIVISION
1945



Bulletin "Process Charting"
Chart with pictorial elements.

Unless it has been demonstrated definitely that the workers are familiar with certain practices or skills, it is advisable to assume that they know absolutely nothing. Otherwise, two undesirable conditions may develop if some of the workers do not come up to the assumed level of knowledge or skill: some of the trainees will not be able to follow the instruction and will flounder helplessly; or the instructor



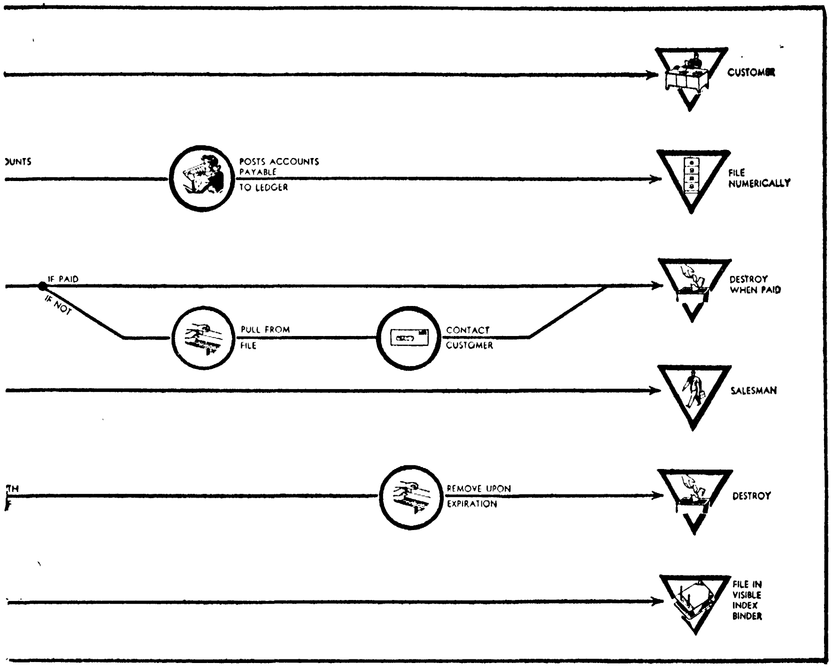
Courtesy Standard Register

Figure 87. Pictorial Forms Distribution Chart. The pictorial elements drama

will have to take unplanned stopgap measures to attempt to bring the less trained workers up to the assumed level of competence. Better results will usually be obtained if careful extra training is given at the start.

The lectures should make use of visual aids and demonstration techniques as much as possible. Everything should be prepared in advance so that there will be a minimum of distracting occurrences during the periods. Supervised practice sessions are desirable to give the workers actual practice in the new routines. Pertinent questions should always be encouraged. An examination may be given to determine how effectively the material has been mastered and what additional training is desirable.

Much of the training will be done most effectively at the workplace. The use of instructional charts, activity analysis charts, process charts, and operator charts are all helpful in supplementing written and oral instructions. Process charts, right- and left-hand charts, departmental flow charts, etc., should be distributed wherever they can increase the



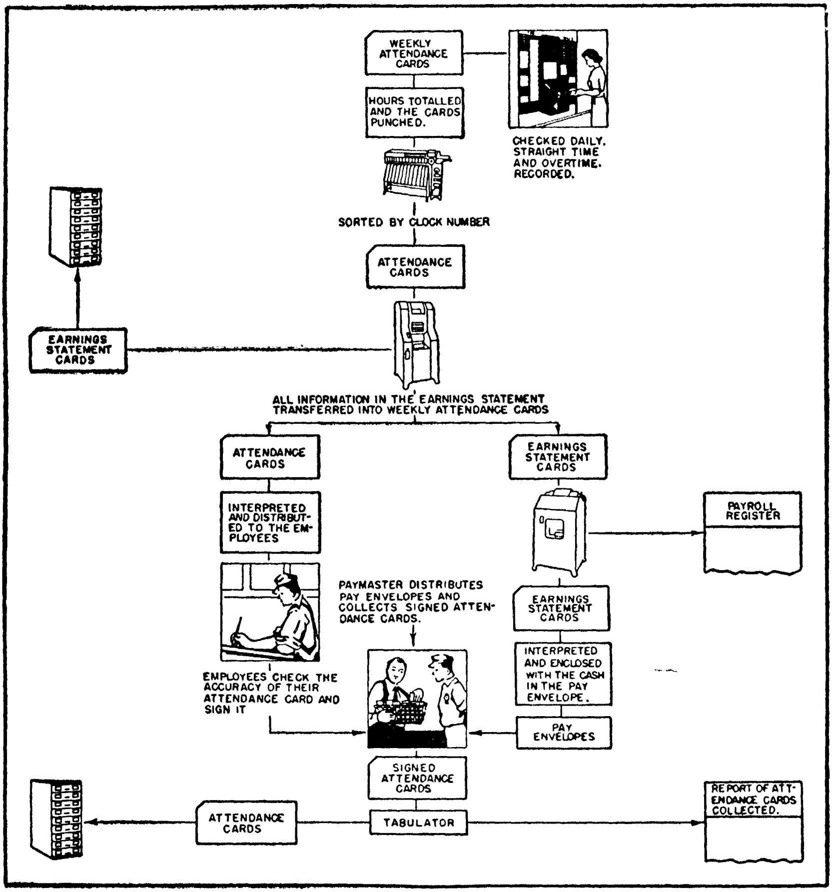
Company of Dayton, Ohio

tize vividly the procedure symbols shown at lower left in the chart.

effectiveness of the instruction. The chart shown in Figure 86 of a voucher-auditing procedure is an example of an Organizational Flow Chart adapted for instructional purposes. Figure 85 shows an instructional chart used in the installation of a new production-control record. The use of a pictorial flow chart is shown in Figure 88. The pictorial forms chart of Figure 87 has analytical as well as instructional value. Continual checking on the performance of the work is desirable in the early stages of a systems installation to insure that the personnel are working correctly and to give individual aid and instruction where required.

The Training within Industry Service of the Bureau of Training of the War Manpower Commission developed a very excellent program during World War II. Its outline of the desired essentials of job instruction training is very valuable for indicating how to go about training workers in a new system.*

* "The Training within Industry Report," War Manpower Commission, Washington, D. C., 1945, pp. 33–34.



Courtesy Remington Rand, Inc.

Figure 88. Pictorial Flow Chart representation of a punched-card procedure.

How to Get Ready to Instruct

Have a Timetable

How much skill you expect him to have, by what date.

Break Down the Job

List important steps.

Pick out the key points (safety is always a key point).

Have Everything Ready

The right equipment, materials, and supplies.

Have the Workplace Properly Arranged

Just as the worker will be expected to keep it.

HOW TO INSTRUCT

STEP 1—*Prepare the Worker*

Put him at ease.

State the job and find out what he already knows about it.

Get him interested in learning job.

Place in correct position.

STEP 2—*Present the Operation*

Tell, show, and illustrate one *Important Step* at a time.

Stress each *Key Point.*

Instruct clearly, completely, and patiently, but no more than he can master.

STEP 3—*Try Out Performance*

Have him do the job—correct errors.

Have him explain each *Key Point* to you as he does the job again.

Make sure he understands.

Continue until *You* know *He* knows.

STEP 4—*Follow Up*

Put him on his own. Designate to whom he goes for help.

Check frequently. Encourage questions.

Taper off extra coaching and close follow-up.

If Worker Hasn't Learned, the Instructor Hasn't Taught.

Part IV

MANAGEMENT OF THE SYSTEMS TECHNIQUE

XIII

THE SYSTEMS-CONTROL FUNCTIONS— ORGANIZING A SYSTEMS DEPARTMENT

WE HAVE CONSIDERED in some detail in the previous chapters the principles and methods used in systems and procedures analysis. But we have not spoken about the persons who perform this important function. Where should the systems functions be located in the organization? How should they be performed? How should a systems department be organized and operated? What are the desirable qualifications for systems work?

The purpose of the systems functions is to promote the use of the best systems in the operations of the organization: to enable the organization to achieve its objective with the greatest efficacy, at the lowest cost, and in the shortest possible time. To achieve this objective, a number of related systems activities are performed. These activities in the systems department are designed to facilitate systems investigations; to provide mechanisms for controlling and coordinating the enterprise's systems; and to promote better performance and evaluation of the systems functions.

ORGANIZATIONAL LOCATION

There is much disagreement about the best place in the organizational structure to locate the systems function. There is also considerable controversy as to whether the systems function should be centralized or decentralized.

Historically, the accountants were the first group interested in systems and the first written procedures were accounting instructions. These accounting instructions usually established the account and department numbers and usually prescribed the paperwork routine necessary for accumulating the desired cost information. However, it was the industrial engineers rather than the accountants who developed many of the analytic techniques used in systems work. But until comparatively recent years, the industrial engineers had concentrated their talents on the direct manufacturing operations. It was in connection with this methods work that they developed process charts, principles of motion economy, etc.

Today, the systems function has much broader objectives than it did years ago and its techniques have been expanded and sharpened. The organizational arrangement and position of the systems function is of considerable importance in determining the success of its performance.

Should each product line or division have its own systems department? To whom should the function report? Present practice of the companies having separate units for performing systems functions varies considerably. Centralized, decentralized, and combinations of both types of functional allocations are used. These systems units frequently report to the accounts and finance director, to the chief engineer, or to the head of the industrial engineering department.

For effective performance of the systems function, there is much logic in having the systems department as a staff unit reporting to the top executive of the company. Since the systems function provides the vehicle for effectuating managerial policy, it should be as close as possible to the sources of the managerial directives if it is to interpret them correctly and quickly insure that they are carried out. The systems function should be as independent as possible of pressure from particular groups in the enterprise. These pressures will be fewer and less violent the higher up in the organization the function is placed.

The systems functions require the analysis and integration of the relationships between all parts of the enterprise. If these functions are performed at too low a level in the organization, one of the following situations may occur:

1. The systems functions are decentralized, each group having authority within its own area only, as shown in Figure 89.

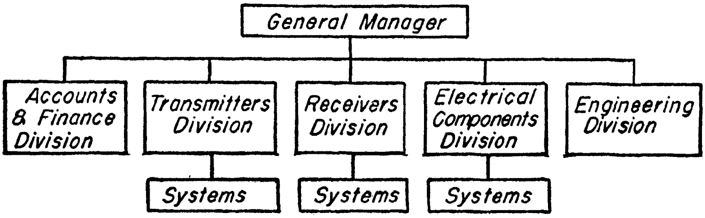


Figure 89. Although the three product divisions each have separate systems departments, coordination is difficult in this arrangement and some divisions have no systems department.

In this arrangement, the problem of coordinating those activities which cross division lines is difficult. Also there are some divisions with no systems units. The low placed systems department may have trouble coordinating functions having interdivisional flows.

2. The systems functions are centralized in one division which services all the other divisions as well (Figure 90). In this arrangement, the

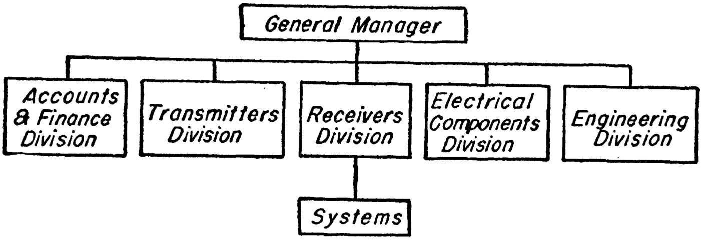


Figure 90. The systems department services all divisions of the enterprise although it reports to the receivers division.

problem of coordination of the activities of the systems departments of the various divisions is solved. However, the ability of the systems unit to function in the other division may be impaired because it reports to the head of one division who may unduly influence its operating policies.

Neither of these alternatives is ideal. If the systems functions cannot report to the top man of the enterprise, then placing them in the accounts and finance division is frequently the next best solution.

In a very large enterprise, it may be logical to give each major division its own systems unit to deal with local problems in addition to providing a centralized systems unit reporting to the top operating executive. The centralized unit, close to the sources of managerial directives and having access to the policy-making individuals of the enterprise, will coordinate the activities of the local systems units and provide the general framework for their operations. This central unit will also be directly responsible for the over-all systems activities which cross divisional lines. The divisional systems units will be able to give specialized attention to systems problems in all departments and at all levels in its division. If properly applied, this plan may supply most of the benefits of decentralization without sacrificing the major advantages of centralized controls.

IMPOSITION OF DECISIONS

Although the systems department should have the authority to impose its decisions when approved by top management, this authority must never be exercised over the objections of any of the operating executives. Systems activities are performed as a service to those executives who have the primary responsibility for the successful operation of their respective departments. The systems department should aid the executives in carrying out these responsibilities. When an operating executive disagrees with the systems analyst, agreement must be reached by logical, good humored, patient analysis and selling. A system should never be imposed over an executive's objection: the enterprise, the systems department, and the operating department will usually all suffer as a result of the bad feeling. In addition, the operating executive will have been deprived of some of the authority to which he is entitled if he is to be held completely responsible for his department's performance.

PERSONNEL ADJUSTMENTS RESULTING FROM SYSTEMS CHANGES

It should be the policy of the company that persons will not be fired or laid off because of improved efficiency resulting from systems improvements. If any position is eliminated, the person should be transferred to another activity for which he is qualified. If no such transfer is possible, some special assignment should be found for the person until an opening develops. To promote cooperation of the operating personnel, it is desirable that the workers in the enterprise do not feel that their positions are jeopardized by systems analysis.

SUPERVISOR TRAINING IN SYSTEMS ANALYSIS

The application of systems analysis for improving operating routines should not be restricted to the personnel of the systems department. Not only should systems analysis have the support and cooperation of all employees, but special training programs should be organized to train supervisors in handling day-to-day systems problems—to apply the principles of work simplification to their daily activities and those of their subordinates.

A training program for supervisors should, among other things, train the supervisor to apply the systems-charting techniques in solving his problems and simplifying clerical routines. Since most supervisors know more about the work and the jobs in their respective departments, they are one of the best sources of ideas for increased productivity. When they suggest, install, and receive credit for the improvements, the supervisors' incentives in promoting good systems are very great. Because there are a large number of supervisors in the enterprise in comparison with the possible number of systems analysts, the cumulative effect of possible improvements working through the supervisors may be quite imposing.

The organization of a systems-training program for supervisors follows the principles outlined in Chapter XII. The principles and methods of a program to train supervisors in the use of systems-analysis techniques are the same as those for instructing the worker in how to operate a new system.

Prepare for the program by first obtaining the support of all key personnel. Explain the purpose of the program and discuss all questions. Schedule the program: which departments will be tacked first and how much time will be allotted to each group. Then, follow the job-training outlines. Get ready to instruct by having a timetable for the acquisition of the skills, by breaking down the job, by having everything ready and all material properly arranged. Then, instruct by first preparing the supervisor—selling him on the values of the techniques, presenting the systems techniques one step at a time, having conference problem analyses under supervision, having him make his own sample analyses which are checked and discussed.

CONTROLLING THE SYSTEMS FUNCTIONS

The systems functions are in some ways analogous to the highways of our land—the roads of the nation provide the avenues for the flow of vehicles, persons, etc., and the systems in a company provide the avenues for the flow of the procedural information, forms, etc., required for operating the enterprise. Both systems and highways are subject to the effects of obsolescence and require constant attention to insure that they are adequate for serving current needs.

A new highway provides a new path for the flow of traffic. To ascertain how effectively this new highway is functioning, the traffic police patrol the highway and observe the character and amount of usage. To ascertain how effectively a new system is functioning, the systems follow-up function is performed by the systems department.

To outline the directions and length and breadth of the highways, road maps are prepared and distributed. To outline the direction of the systems paths in the organizational structure, its length and its breadth, organization manuals and organization charts are used.

To control the operations of the traffic patrols, various assignment sheets, time cards, accident reports, activity reports, etc., must be maintained by the highway police department. To control the activities of the analysts in the systems department, various project controls and project status and summary records must be maintained by the systems department.

To define the manner in which the highways may be used, a driver's manual distributed to all drivers will prescribe acceptable practice. To define the manner of performance of systems, a procedures manual distributed to the proper persons will prescribe standard practice.

The highway department has several key indicators for controlling operations on the highway. When a serious accident occurs, it must be reported in a specified manner; when a person or organization believes that the road needs a change in width, the highway department must be petitioned to study the problem and determine the best solution. The systems department also has several key devices for controlling procedural operations. These will be described later: forms control, lay-out control, and equipment control.

SYSTEMS FOLLOW-UP

The follow-up function of the systems department is so important to the success of the department's activities that it is hard to conceive of its being overlooked. Yet time and time again, this lack of effective follow-up results in a lack of complete effectiveness on the part of the systems department.

Follow-up on the completed projects of the department serves many valuable purposes. It enables the department to determine if its procedures and recommendations are being followed. If these changes are not functioning properly, the department may then determine why they are not being applied. Is it because the supervisor is lax in regulating the work of his group? Is it because the new system was not sold correctly or sufficiently to the operating personnel? Is it because insufficient instructions were issued in installing the system? Has the timing of the installation caused difficulties? Are there misinterpretations or misunderstandings of the system? Has a new situation developed which could not be foreseen?

The follow-up also enables the department to evaluate its work. Have the changes produced the anticipated results? Are operations proceeding as expected? How much personnel have actually been reduced? How greatly has the volume of work handled been increased?

Responsibility for the follow-up activity in the systems department should be independent of all other activities to insure that it is not subordinated to the seemingly more productive activities of the department and to insure completeness and impartiality in the follow-up survey. The person or persons engaged in the follow-up activity should generally have no functions other than the checking on the results of the department's projects, procedures, forms, recommendations, etc.

To provide a systematic basis for the follow-up activities, a follow-up card should be prepared for each project as it is completed. Based on the follow-up policy of the department, a follow-up date is recorded on the card and the card is filed under this date. Each week, the cards scheduled for follow-up are pulled. The procedures, recommendations, or projects listed thereon are investigated to determine whether the recommendations are being followed, whether the procedures are working, whether changes are required. Every aspect of the procedure and all the recommendations are checked by contacting the persons involved and by direct observation.

Upon completion of each follow-up survey, a short report form is prepared indicating:

1. Any aspects of the recommendations or procedures which are not being followed.

2. Any aspects of the recommendations or procedures which are not functioning as desired.
3. The actual savings resulting from the adoption of the project recommendations as compared with the estimate.
4. Any improvement recommendations regarding the project, including a statement as to whether further systems action is required.

Copies of the follow-up report are then made available to the systems analyst who was in charge of the project as well as the departmental supervisor. If the report discloses the need for extensive additional systems work, the project may have to be reentered and rescheduled on the project register.

When the follow-up report has been submitted, a date for the next follow-up is entered on the follow-up card for the project and the card is refiled under the new date.

THE ORGANIZATION MANUAL

"The man who is best able to accomplish his job thoroughly and successfully, and the one who gains the most inward satisfaction, is the man who has a clear understanding and knowledge of the requirements, the limitations, and the relationships of that job, and of its relative position in the whole organization of which it is a part. To provide all members of our management with this essential knowledge and understanding, we of Standard of California have developed over the past twelve years what we call Management Guides.

"These Management Guides define the functions, responsibilities, and principal relationships of management positions at all levels. They are in daily use and are relied upon throughout the Company."

Thus writes Mr. H. L. Pallier, chairman of the Board of Directors of Standard Oil Company of California in *The Management Guide,* developed and used by Standard Oil Company of California as the Organization Manual of the company. *The Management Guide* shows the organizational structure of the company and indicates "the primary phases of management for which the individual in the position is always accountable." The responsibilities of each position are also stated, giving the specific aspects or duties of each organizational position. Moreover, the principal relationships of the position with other organizational positions on the same, higher, and lower levels are explained as well as the nature of the accountability to a superior position.

To illustrate the kind of descriptions used by *The Management Guide*, the following description of the function, responsibilities and

MANAGEMENT GUIDE

CHIEF ENGINEER, ENGINEERING SECTION, MANUFACTURING DIVISION

I. FUNCTION

As a staff member of management, the Chief Engineer of the Engineering Section of the Manufacturing Division is charged with advising the General Manager of the Division, with furnishing functional guidance to the Plant Superintendents, and with providing services in connection with engineering, maintenance, plant and process design, technical service, and plant and warehouse construction.

II. RESPONSIBILITIES AND AUTHORITY

Within the limits of Company policies and control procedures, and the approved program and policies of the Division, the Chief Engineer of the Engineering Section of the Manufacturing Division is responsible for, and has commensurate authority to accomplish the fulfillment of the duties set forth below. He may delegate to members of his section appropriate portions of his responsibilities together with proportionate authority for their fulfillment, but he may not delegate or relinquish his over-all responsibility for results nor any portion of his accountability.

1. He will assist the General Manager of the Division in formulating, or receiving and recommending for approval, proposals for policies on engineering, maintenance, plant and process design, technical service, and plant and warehouse construction.
2. As directed, he will provide services in connection with engineering, maintenance, plant and process design, technical service, and plant and warehouse construction.
3. He will prepare drawings and approve construction, installation, or alteration of proposals covered by the annual budget, any capital or extraordinary expenditure program, or any appropriation, for plants, plant facilities, mills, manufacturing equipment, warehousing, and manufacturing processes.
4. As directed, he will supervise construction of plants and warehouses.
5. As requested, he will serve as technical consultant in any engineering or construction undertaken by the Company
6. He will recommend selection of individuals or firms as consulting engineers.
7. He will pass upon the qualifications of candidates for engineering positions within the Company.
8. As requested, he will advise and assist the General Managers of the Divisions in the preparation of recommendations for new or altered products or for the discontinuance of products.
9. As requested, he will advise and assist the President on matters pertaining to public relations.

III. RELATIONSHIPS

The Chief Engineer of the Engineering Section of the Manufacturing Division will observe and conduct the following relationships He may delegate portions of the conduct of such relationships to members of his Section, but may not delegate his over-all responsibility or accountability for their proper conduct.

A. **General Manager, Manufacturing Division**

1. He is accountable to the General Manager of the Manufacturing Division for the fulfillment of his function, responsibilities and authority, and relationships, and for their proper interpretation.
2. He will relieve the General Manager of administrative detail as outlined in this Guide or as directed by the General Manager.

B. **General Manager, Marketing Division and Managers of Staff Departments**

1. As directed or requested, he will advise and assist the General Manager of the Marketing Division and the Managers of the staff departments in the fulfillment of their functions in matters within his province, but in so doing he will not assume, nor will he be delegated, any function, responsibility, authority or relationship belonging to any other member of management.

C. **Retained Engineering Consultants**

1. He will conduct such relationships with retained engineering consultants as are necessary to the accomplishment of his function.

D. **The Public**

1. He will conduct such relationships with members of the public as are necessary to the accomplishment of his function, but in such cases he will act only as a representative of the General Manager of the Manufacturing Division.

Courtesy Department on Organization,
Standard Oil Company of California.

Figure 91. A page from the Standard Oil Management Guide illustrates the delegation of responsibility and authority and the establishment of organizational relationships.

authority, and relationships of the Chief Engineer, Engineering Section, Manufacturing Division, of a hypothetical company manufacturing and selling electronic devices is presented in Figure 91.

In addition to the uses mentioned by Mr. Pallier, the preparation, distribution, and maintenance of an Organization Manual which outlines the basic functions, responsibilities, and authorities of all the principal units of the organization serves several systems purposes. It forces the systems department and the top management of the enterprise to make the basic analyses and definite decisions on the objectives and responsibilities of the various units of the enterprise. By reducing the responsibility, authority, and functional allocations to writing, it makes possible a much clearer analysis of their logic and advisability by all concerned persons. It fixes responsibilities for definite aspects of the enterprise's work much more definitely than verbal instructions or miscellaneous memoranda. Finally, it makes the basic organizational policy of the enterprise available, in consolidated and convenient form, to those who require such knowledge for effective prosecution of their duties.

The Organization Manual establishes the fundamental bases for the operations of the entire enterprise. Since these basic plans change rather infrequently, revisions are made relatively seldom. When required, the affected sheets of the Manual may be reissued and inserted in the looseleaf manual in place of the obsolete ones. All sheets of the manual should therefore be dated and superseded dates should be indicated. If a radical change in the organization of the enterprise is adopted, it is sometimes more practical to reissue the entire Manual.

ORGANIZATION CHARTS

To enable the personnel of the organization to identify the organizational position of each person, it is desirable to issue organization charts, which indicate the organizational lines of authority. This reduces confusion and is especially valuable in an organization in which personnel transfers and changes occur rather frequently.

The chart should be very simple and should do little more than list the title and names. Rather than draw elaborate and costly charts which take time and use up considerable space, a simple listing with indentions, such as shown in Table IV, is usually desirable. The separate sheets of these charts should be reissued as required by personnel changes.

TABLE IV

TYPICAL ORGANIZATION CHART
"X" Department

Name	*Title*	*Function*	***No. of Employees***		
Aller, A. A.	Division Manager	Industrial Equipment	789		
Baller, B. B.	Department Manager	Receivers		206	
Caller, C. C.	Section Supervisor	Domestic			46
Daller, D. D.	Section Supervisor	Industrial			89
Ealler, E. E.	Section Supervisor	Export			24
Faller, F. F.	Section Supervisor	Marine			47
Galler, G. G.	Department Manager	Transmitters		473	
Haller, H. H.	Section Supervisor	Industrial			102
Jaller, J. J.	Section Supervisor	Communication			167
Kaller, K. K.	Section Supervisor	Low Power			48
Laller, L. L.	Section Supervisor	Broadcast			74
Maller, M. M.	Section Supervisor	High Power			82
Naller, N. N.	Department Manager	Components		110	
Paller, P. P.	Section Supervisor	Transformers			51
Raller, R. R.	Section Supervisor	Coils			35
Saller, S. S.	Section Supervisor	Capacitors			**24**
			789	789	789

Date: *5/18/48*
Supersedes: *4/16/47*

PROJECT CONTROL

Just as the production department requires a simple but effective system for controlling the issuance of material to the manufacturing floor from the storerooms, so the systems department needs a system for controlling systems investigations. Although the need for this control in the systems department is as great as in the production department, it is much more complicated because of the complexity of the work, the wide divergences of opinion on many systems problems, and the inability to resolve many aspects of the work to a quanitative basis.

A systems investigation project may be instigated as the result of a written request from one or more responsible department heads or it may originate in a written request from one or more members of the systems department. In either case, it is well to request that letters asking for investigations should contain the sources of available information on the subject and should indicate:

1. The scope of the problem to be investigated, with definitive boundaries.
2. The efforts which have already been made to solve the problem.
3. The groups and personnel which are involved.

Upon receipt of such a request, the systems department will usually make a very short preliminary investigation to determine what the project involves, whether it can be accepted, and the approximate number of man-hours which will be required. If the project is accepted, it is numbered and entered on a project register, such as shown in Figure 92, and an approximate starting date is scheduled and tentative assignment to a systems analyst is made. Because of the many intangible factors which are difficult to forecast, it is not usually practicable to schedule the completion date at this time.

When the project is started, the actual starting date and the engineer in charge are indicated. When the investigation has been completed a report or proposal is usually made. The date is indicated on the register.

The proposals in the report may encompass new forms, new procedures, new lay-outs, revised allocations of organizational responsibilities, new equipments or new work methods, or any combination of these. It may be in the form of a twenty-five page written report, a one-page memorandum, or a three-page proposed standard procedure. In all of these cases, certain people must be sold on the proposal before it can be adopted. These persons will vary, depending on the organizational structure of the company, the nature of the proposal,

Date	Project Number	Name	Estimated Man Hours	Assignment	Dates: Scheduled Starting	Dates: Actual Starting	Dates: Report or Proposal	Dates: Issued-Installation in Process	Dates: Project Completed	Remarks

NOTE: NAME IN ASSIGNMENT COLUMN IS INDICATED IN PENCIL TENTATIVELY UNTIL WORK IS ACTUALLY STARTED. THEN, AN INK ENTRY IS MADE.

Figure 92. Project Register, a chronological record of accepted projects.

and the systems department sales policies. After the recommendations have been sold, they are installed. The installation date is then entered on the register. When the new system has been completely installed, and a final report on the project has been completed, the project is closed out and the date indicated on the register.

WORKLOAD SHEETS

To enable the systems department supervisor properly to schedule forthcoming work, it is usually valuable for him to keep a simple workload sheet for each of his analysts, on which are indicated the tentatively assigned project hours as well as the estimated hours required for completion of the current projects.

PROJECT STATUS AND SUMMARY RECORDS

To control the operations of the systems investigations, provide information on the status of each project, and summarize the costs and accomplishments of each, it is frequently desirable to keep some sort of project status and summary record. This card record may contain the following information on each project undertaken by the department:

1. Project number
2. Name
3. Origination
4. Scope and purpose
5. Date received
6. Estimated man-days and spaces for revisions of the estimate

7. The scheduled and actual dates for
   a. Start of investigation
   b. Completion of investigation
   c. Completion of report, recommendations, newly designed forms, new procedures, charts, etc.
   d. Completion of selling
   e. Completion of installation

   (Spaces should be allowed for revisions of the schedules as the work progresses)
8. Record of time spent on the project
9. Brief summary of the accomplishments of the project upon completion, including analysis of cost savings
10. Analysis of the costs of the project, including the costs of
    a. The systems analyst's time
    b. The estimated time of other personnel in the organization whose time was taken by interviews, questionnaires, etc.
    c. The supervision and clerical costs in the systems department as well as other overhead items of the department
    d. Other special expenditures required in conducting and concluding the investigation and installation.

Completed project cards should be filed separately from the current ones. These cards are very useful for loading the systems personnel, for preparing activity and accomplishment reports, and for answering numerous general questions about the status of any given investigation.

PROJECT FOLDERS

In the chapter on obtaining systems data, the importance of a systematic and neat procedure for gathering and recording information was emphasized. These worksheets, arranged in a systematic manner, are fastened together in the project folder at the conclusion of the project. When properly indexed and filed, they provide a valuable source of systems information for future use as well as a means of answering any questions which may be raised about the investigation.

FINAL PROJECT REPORTS

After installation has been completed, the project status records, the project folder, and the previously prepared report on the results of the investigation will be the basis for the final report on the project.

This report will explain how the recommendations of the previously prepared report have been implemented, what immediate tangible and intangible results have been accomplished, and what potential advantages are expected to accrue in the future. To make this final report complete, it is frequently desirable to include any written procedures and instructions which have been issued to implement the system.

PROCEDURES CONTROL

In the previous chapters we have discussed the principles and methods for determining systems policies, for ascertaining correct procedures, for determining the best methods of performing the required functions of the enterprise. Having determined the best systems, however, they are valueless to the enterprise if they are not known to the personnel. A basic medium for announcing and for making these detailed systems known to the personnel is the written instruction. These written instructions are usually known as procedures or standard practice instructions.

The best methods of organizing procedures manuals will depend on the character of the enterprise—its organization, size, complexity, and manner of controlling operations. The most effective means of handling the formalities of issuing procedures will also vary from company to company. In Appendix A to this chapter is shown a written procedure or standard practice instruction of a well-known enterprise which describes the rather elaborate system of manuals used in the company. In Appendix B is shown a standard practice instruction of the American Machine and Foundry Company describing how the written procedures of the company are developed, approved, classified, and issued.

It is usually desirable to establish a procedures manual which will contain the written procedures in readily available form. Durable looseleaf binders of simple construction should be used to allow ready insertion of new material. However, it is not usually necessary for all recipients of procedures to have a procedures manual. It is desirable for each department to have a procedures manual available for reference. The manual will usually be issued to the supervisor for his own as well as staff use.

For written procedures to be effective, they must be placed in the hands of all persons who are concerned with the functions covered. Wide-spread distribution amongst all persons concerned is therefore desirable. These persons, however, do not require a manual since they only receive those procedures which directly affect their own activities.

The distribution of individual procedures is determined on the basis of both organizational level and functional responsibilities. Thus, top management policy procedures would go only to top officials of the company. A procedure covering the ordering of replacement parts would be sent to all holders of procedure manuals (department supervisors and higher levels) as well as all section supervisors in the production-planning department and all other persons directly connected with the performance of the ordering function.

To control the distribution of the procedures, standard distribution lists are established. Distribution A includes all top management officials in each department. Distribution B includes all persons of department supervisor level or higher, with the exception of those included in list A. Distribution C includes all persons of section supervisor level in each department. Thus, the top management policy procedure goes to Distribution A only. The procedure covering the ordering of replacement parts would go to Distribution A (all departments), Distribution B (all departments), Distribution C (production-planning department) plus the list of persons operating directly under the procedure. (The analyst who developed the procedure determines those who are directly concerned.)

The names of persons on each distribution list are kept up to date by keying these persons' names and positions on the master copy of the Organization Chart. Whenever any of these keyed names or positions change, this fact is brought to the attention of the person maintaining the distribution lists. A file card is maintained for each procedure, on which is indicated the distribution of each issue and revisions. When revised procedures are issued, there is a danger that the superseded procedure will not be removed from the manual. It is therefore the practice in some companies to require that the superseded procedure be returned to the systems department with the transmittal sheet of the revision. The obsolete procedures are then destroyed by the systems department. Some systems departments have found it desirable to go so far as periodically to inspect the procedure manuals to insure that they are being kept up to date.

As pointed out in an early chapter describing the general subject of systems work, the systems of an enterprise require continual revision. These revisions mean changes in the written procedures. Shall these changes be made (1) by reissuing the entire procedure, (2) by reissuing only the affected pages, or (3) by issuing addenda and errata sheets? The latter two methods are a bit cheaper than reissuing the entire procedure. However, they suffer from the defect that all copies of the procedure may not be clipped with the errata sheet and that all changed pages may not be substituted in the procedure because of negligence on the part of the recipient. This risk of having obsolete procedures in use is smaller when entire procedures are reissued because it is simpler to substitute the entire procedure and because the systems department can require the return of the old procedures. Also, subnumbering of pages is not required when the complete reissue method is used. The necessity of revisions is an added reason for keeping the size and scope of individual procedures relatively small, so that only small units have to be reissued at any one time.

To provide for maximum ease in locating desired procedures, the procedures in the manual should be arranged in accordance with a systematic numbering system. The R.C.A. Victor Company at Camden, New Jersey, evolved a system of functional classifications, a section of which is shown in Figure 93. In this scheme, all the principal classifications and subclassifications of functions are arranged in logical fashion and blocks of numbers assigned to each. Each procedure is then numbered in accordance with this break-down. Thus a procedure on stock records would be numbered 2025–12, because its subject is part of the inventory-control function. The 12 after the dash distinguishes this procedure from all others on this function. This system allows sufficient room for the addition of new functions as the needs develop. In addition to systematic numbering, the procedures should be indexed, with much cross-referencing to provide speedy location of desired material.

The procedures should be issued in standardized format and the first sheet of each procedure should have a simple but impressive heading, identifying the procedure, the company, and the group in the company responsible for its issuance. Space should be provided in this heading for:

1. Procedure number
2. Page ______ of ______
3. Date of issuance
4. Date effective
5. Date of issue superseded (if revision)
6. Functional classification of the procedure
7. Title of the procedure

At some place in the procedure—the back of the last page is convenient—the following reference information should be indicated:

FUNCTIONAL CLASSIFICATION

CAMDEN PLANT PROCEDURES AND BULLETINS
Issued by: Systems Section
Industrial Engineering Department

Date: 6-2-45 Supersedes: Initial Issue (no date)

All Camden Plant Procedures and Bulletins are numbered according to the functional classifications listed below. When a Procedure or Bulletin involves more than a single function, the number of the function most involved is used. This functional classification may be used as a guide to the location of instructions when the exact title or number is not known.

ACCOUNTING
1000-Accounting (Plant), General
1010-Accounting - Cost
1020-Accounting - Fixed Asset
1030-Accounting - Stores
1040-Accounts Payable
1050-Billing Direct
1060-Billings to Home Office
1080-Payroll
1090-Tabulating
1150-Timekeeping

ADMINISTRATION
1200-Administration, General
1210-Sales Contact
1230-Government Liaison
1270-Systems
1276-Organization Control

COST CONTROL
1430-Expense Control
1435-Departmental Budgeting
1450-Preparation of Cost Stds. & Est.
1470-Timestudy Coordination
1475-Timestudy

PLANT SERVICES
1600-Plant Services, General
1615-Facilities & Equipment
1625-Receptionist & Escort Service
1630-Mail Service & Intra-Plant Comm.
1635-Janitor Service
1640-Plant Layout
1650-Maintenance
1660-Guard Service
1670-Power Plant Services
1690-Fire Protection
1700-Clerical Services

ENGINEERING (PRODUCT)
1800-Engineering, General
1810-Design & Development (Eng. Releases, ECN's, Packing Design)
1815-Model Building
1820-Drafting
1825-Blueprint Issuance
1830-Engineering Estimating
1840-Breakdown
1845-Preparation of the UBM
1850-Chemical Engineering
1860-Standardizing
1880-Photographing
1885-Engineering Publications
1890-Measuring Equipment Designing

MATERIAL CONTROL
(See also Production Control)
2000-Material Control, General
2010-Material Moving
2020-Reject Control
2025-Inventory Control
2030-Miscellaneous Material Storing (Maint., Office, & Factory Supplies; Terminated Mat'l.)
2040-Raw Material & Hardware Storing
2050-Accumulation of Parts
2060-Receiving
2070-Stock Expediting
2080-Tool Crib Operation
2090-Hold Rooms

Figure 93. Portion of a functional classification system,

1. Associated procedures. Related procedures which affect the systems in the subject procedure should be listed by title and number.
2. Forms involved. The names and numbers of all forms used or mentioned in the procedure should be listed.
3. Distribution. The distribution of the procedure will be indicated by the code previously explained. When the procedure is distributed to non-supervisory employees, such as the clerks in the inventory-control section, this fact will be indicated not by listing the names

FUNCTIONAL CLASSIFICATION

Date: 6-2-45 Page: 2 of 2

PERSONNEL RELATIONS
2400-Personnel Relations, General
2410-Wage and Salary Administration
2420-Interviewing and Hiring
2430-Labor Relations
2435-Personnel Records,Selective Serv
2440-Employee Training & Education
2450-Employee Services
(A.A., News, Sound System)
2455-Cafeteria Operation
2460-Employee Sales
2470-Suggestions & Assignments
2480-Safety and Health
(Beneficial, Dispensaries)

PRODUCTION
2640-Processing
2660-Tool Designing
2800-Manufacturing General
2805-Factory Development
2810-Manufacturing Research
2815-Assembly
2820-Department 82
2825-Factory Expediting
2830-Product Expediting
(Project Eng. Prod. Mgr.)
2840-Crystals
2849-Chemical Preparations
2850-Components, General
2851-Transformers
2852-Capacitors
2853-Coils
2854-Plastics
2856-Fabrication
2870-Tool Control
2875-Tool Construction
2880-Phonograph Records
2890-Packaging (Spare Pts. Records)
2900-Packaging Material Construction
2910-Measuring Equipment Construction
2930-Packing Finished Goods

PRODUCTION CONTROL
(See also Material Control)
3000-Production Control, General
3010-Authorization to Manufacture
3011-Terminations
3020-Sourcing
3030-Machine Loading
3040-Ordering
3050-Pre-Production Scheduling
3055-Scheduling
3060-Material Release
3070-Dispatching
3080-Plant Loading
3090-Production Performance Reports

PROCUREMENT
3200-Procurement, General
3220-Subcontracting
3230-Buying
3240-Vendor Expediting
3250-Verifying Vendor Charges
3260-Vendor Claims
3350-Priorities

QUALITY CONTROL
3440-Test and Inspection
3445-Quality Standards
3450-Purchased Material Inspection
3460-Measuring Equipment Testing
& Inspecting
3470-Tool Inspecting
3480-Reject Analysis

WAREHOUSING
3840-Shipping
3850-Trucking and Transportation
3860-Domestic and Export Traffic
3870-Finished Goods Storing

INTER-PLANT AND HOME OFFICE
5010-Inter-Plant Engineering Comparisons
5020-Inter-Plant Communications
5030-Replacement Parts
5040-Insurance

Courtesy RCA Victor

showing code numbers used in classifying procedures.

of these clerks, but by the notation "all inventory clerks (16) in section 42."

Prior to the issuance of a new or revised procedure, it is very desirable to have the agreement of all persons concerned with its operations. The practice of circulating a draft copy of the procedure amongst the persons for comments is usually very time-consuming. This agreement can usually be best obtained by duplicating the proposed procedure and sending a copy to each person requesting that he indicate thereon his comments and agreement or disagreement, and return by a certain date. (To avoid delay in getting agreement, some systems departments set up the rule that all copies not returned by a given date are considered approved.) After all comments have been received, it is sometimes found desirable to call a meeting of several of the persons to iron out minor differences of opinion.

FORMS CONTROL

Because most systems involve clerical activity which must be performed on forms, control of the design and distribution of forms provides a pivotal means of controlling the systems. Forms design and control, therefore, constitute vital parts of the systems-control program of the systems department.

The principles of forms design have already been discussed at some length in a previous chapter. In order to obtain full benefit from good forms design, it is necessary properly to control the issuance, ordering, distribution, and use of these forms. This function is called forms control.

Effective forms control will provide the framework for accomplishing the following:

1. All forms eventually designed properly.
2. Coordination between the systems and the forms used in the systems.
3. Ease of identification of forms referred to in procedures.
4. Availability of forms as required by the systems.
5. A means of enforcing and following up on the operation of systems because most changes in a system will affect forms. These changes will be brought to the attention of the systems department when new forms are requested.
6. Systematic elimination of useless and conflicting forms, and creation of new well-designed forms as required.
7. A central source of valuable systems information provided by a forms file containing every form in use in the organization arranged in a logical fashion and cross-indexed by systems usage.
8. An efficient system for ordering, stocking, and issuing the correct quantities of each form to its authorized users.

FORMS-INVENTORY CONTROL

To accomplish these objectives, the systems department must institute certain procedures. Physical control of the stocking and issuing of all printed forms should be established in a central stockroom. This centralized physical control will provide a means of restricting the supply of forms to authorized users. Quantities withdrawn for use can be limited to reasonable amounts in accord with requirements: this enables the systems department to discourage the hoarding of forms which complicate changes in forms design and causes fictitious usage figures.

By maintaining an adequate minimum stock-recording system, the department can insure that forms are always on hand to meet systems requirements. The minimum stock point should always be set high enough to allow sufficient time for thoroughly reviewing the forms design prior to reordering. When forms designs are changed, the department can remove from stock and call in all the obsolete ones which have been issued, since all the users will be known.

When no copies of a form have been requisitioned from the stockroom for more than a given period—say one year—an obsolescence investigation slip is sent to the forms-control unit in the systems department. The forms-control unit determines whether the questioned form is still being used and informs the stockroom of any disposal action which may be necessary to avoid the accumulation of obsolete forms.

The forms inventory-control record provides a history of the printing dates and quantities, the distribution of the form, revisions, etc. Together with the forms file, discussed later, it summarizes a complete history of the form.

FORMS-NUMBERING PROCEDURES

All forms should be numbered in accordance with some procedure, which may be nothing more than a simple numerical numbering of each form for identification purposes. The kind of numbering system is not as important as the consistent application of the system. For illustration purposes, three possible systems are presented here. If a reasonable system is in use, it is not generally worthwhile to change it.

NUMBERING SYSTEM A:

Each form is given a number one unit higher than the previously numbered one, regardless of the nature of the form. When the form is revised, an R 1 is placed after this number for the first revision, and R 2 for the second revision, and so on. Example: 168 R 3 is the third revision of form 168.

NUMBERING SYSTEM B:

A functional numbering classification is established, such as

1000 – 1999	Engineering
2000 – 2999	Production
3000 – 3999	Accounting
4000 – 4999	Personnel

Forms are arranged numerically in each of the above categories depending on the functions in which they serve. Forms used in more than one function are placed in the one of primary usage. Preparatory to establishing a functional numbering system, a functional analysis of all forms on a chart such as Figure 94 must be made to show the functions which make use of each form. This analysis will also serve as the basis for the functional cross-indexing file mentioned later.

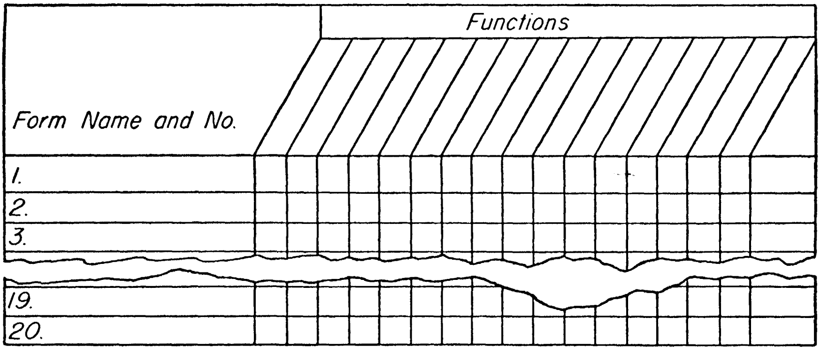


Figure 94. Forms Functional Analysis Chart, especially useful for inventorying and analyzing all forms in the initial phases of a forms program.

NUMBERING SYSTEM C:

The functional classification is abbreviated, then a numerical number in the functional classification series, then the quantity last printed, and then the date of the printing is added to construct the form number. Thus PR49 – 5M – 749 indicates that it is a form used for a production function, number 49 in this series, and 5,000 copies were ordered in July 1949.

The possible variations in numbering systems are limitless. Generally, the simpler the system, the better it is. In all cases, a Forms

Number Ledger must be kept for assigning the numbers in sequence. This ledger should contain columns for:

1. Number of form
2. Title
3. Date initiated
4. Date superseded or discontinued
5. Reason for discontinuance and/or the superseding form number.

FORMS FILE

A forms file containing two copies of every form used in the organization is required. (The extra copy of each form is required because one copy may be sent to the printer when the form is reordered.) A folder is established for each form and is filed by form number. In addition to having two copies of each form, the folder would contain information on (1) what departments are authorized to use the form, (2) what procedures require the use of the form, and (3) any notes on future desired changes to be considered before reordering.

CROSS-INDEXING FILE

It is usually desirable to have a cross-indexing file, relating form titles to form numbers. It is also sometimes considered desirable to have a functional cross-indexing file to be able to locate all forms connected with each function. This facilitates the combination and elimination of unnecessary forms.

ORDERING PROCEDURE

All requests for new forms or revisions of old forms must be routed to the systems department for evaluation in accordance with sound systems considerations. If a new form is to be adopted, its design will be carefully planned, as outlined in a previous chapter. The paper, printing, and quantity specifications will be established in accordance with the department's standards. In addition, the authorized users will be specified.

Whenever the stock of a form reaches the minimum point, the systems department is alerted by the stock clerk. Any suggested changes are noted from the Forms File folder; all procedures using the form are

1181 **REQUEST - FORMS**

Prepare in *duplicate* and submit with sample of form. *Section A* to be answered by originator of new or revised form and forwarded to Industrial Eng'g. *Sections B* and *C* to be completed by Industrial Eng'g. and submitted to Procedures Coordination Department. For the reordering of existing forms stockroom will fill in *Section C* and forward with sample to Industrial Eng'g. for transmission to Procedures Coordination Department for ordering. For Home Office forms, functions of Industrial Eng'g. will be performed by Procedures Coordination Department.

FORM NO. ______
☐ NEW ☐ REVISED ☐ REPRINT
PLANT ______

SECTION A

TITLE OF FORM ______ SIZE ______ X ______

2. TO BE PREPARED BY: ______ Section Group of ______ DEPT.

3. PURPOSE OF FORM: ______

4. TO BE PREPARED	Daily	8. FILING EQUIPMENT TO BE USED.	Card - Size X	12. IF CARBON IS TO BE INCLUDED WITH FORM, CHECK THE SUGGESTED TYPE.	Snap-out		
	Weekly		Letter		Carbonized Back		
	Monthly		Legal		Interleaved Padded		
	Quarterly		Other (explain)		Fanfold-Continuous		
	As required				Other (explain)		
5. TO BE PREPARED WITH	Pencil	BINDER	No. rings or posts				
	Pen	☐ Ring ☐ Post	Dia. rings or posts	13. SER. NUMBRO.	☐ Yes ☐ No		
	Typewriter	☐ Top ☐ Side	C. to C. Spacings	TO BEGIN WITH	No.		
	Bkking. Machine	9. RETAINED IN FILE	Months	14. SUGGESTED COPY DESIGNATION FOR DISTRIBUTION	Silhouette Numbers		
	Tabulating		Years		Printed Addresses		
	Other (explain)	10. ESTIMATED USAGE	3 Months		Colored Paper		
			6 Months	15. WILL SUPERSEDE ☐ PARTIALLY ☐ COMPLETELY FORM(S)	No.		
6. FROM DETAILS ON FORM(S)	No.		One Year		No.		
	No.	11. SUGGESTED METHOD OF REPRODUCTION	Mimeograph Copies		No.		
	No.		Hectograph Copies	16. WILL BE REVIEWED FOR POSSIBLE REVISION IN ______ MONTHS.			
7. POSTED TO FORM (S)	No.		Printed				
	No.		Other (explain)	17. ANTICIPATED NUMBER OF COPIES REQUIRED ______			
	No.						

REQUESTED BY: ______ DEPARTMENT APPROVAL: ______ DATE: ______

SECTION B (18) APPROVED DISTRIBUTION

Copy	Distributed To	Copy	Distributed To
1		6	
2		7	
3		8	
4		9	
5		10	

19. QUANTITY OF OLD FORMS NOW AVAILABLE

20. SUPPLY WILL BE DEPLETED BEFORE NEW FORM IS PUT INTO USE ☐ Yes ☐ No

21. IF ANSWER TO ITEM 20 IS "No", WHAT DISPOSITION IS TO BE MADE OF OBSOLETE FORMS? ☐ Destroy ☐ Scratch Pads Hold for ______ months

22. TOTAL COST OF FORMS MADE OBSOLETE $

23. APPROVED REPRODUCTION: ☐ Multigraph ☐ Hecto. Neg. Master ☐ Snap-out ☐ Interleaved Carbon ☐ Fanfold ☐ Continuous ☐ Offset ☐ Letterpress

24. ORDERING SPECIFICATIONS	Copy #1	Copy #2	Copy #3	Copy #4	Copy #5	Copy #6	Copy #7	Copy #8	Copy #9	Copy #10	PAD
Size of Form											☐ Top
Grade of Paper											☐ Bot.
Weight of Paper											☐ Left
Color of Paper											☐ Right
Color of Ink											
Same type or plate #1 to 10											PER PAD
Printed 1 or 2 Sides											☐ Wrap
Tumble or Leaf Turn											☐ Band
Numbered Serially											
Silhouette Numbers											
Perforations											PER PKG.
Punchings											

SECTION C (25)

Deliver To ______ Bldg. ______ Floor ______ Date Required ______

Charge to ______ Notify Upon Receipt ______ Quan. Now on Hand ______

Estimated Use: 3 mos. 6 mos. 1 yr. Quan. to be Ordered ______

Approved by: ______
Industrial Engineering Department

Date: ______

Courtesy RCA Victor

Figure 95. Form for requesting a new or revised form and for reordering an old one.

HAMMERMILL FORM ORDER SHEET • PART 1

Printing Specifications

To ______________ NAME OF PRINTER ______________ ADDRESS ______________ Date ______________ 19____

From ______________ COMPANY ______________ ADDRESS ______________

Quantity ______________ Name or Form No. ______________

Trimmed Size: width ______________ height ______________ Start numbering at ______________

To fit Envelope: size ______________ ☐ Plain ☐ Outlook ☐ Hold type form ☐ Have form plated

PAPER STOCK				☐ USE HAMMERMILL	COLORS OF INK		
COPY #	COLOR	WEIGHT	FINISH	GRADE	FRONT	BACK	NUMBERS
1							
2							
3							
4							
5							
6							
7							
8							

BINDING

- ☐ RULE
- ☐ FOLD ______ SHEETS
- ☐ PAD ______ SETS
- ☐ STITCH
- ☐ STRING
- ☐ WIRE
- ☐ GUM STRIP
- ☐ CARBON SHEET

PUNCHING, ETC.

- ☐ SCORE
- ☐ PERFORATE (Pin, Slot)
- ☐ PUNCH ______ IN. HOLES
- # ______ ON ______ IN. CENTERS
- ☐ DIE CUT
- ☐ RULE CUT
- ☐ ROUND CORNER
- ☐ SPECIAL SLOTTING

HOW USED

- ☐ CARD FILE
- ☐ VISIBLE FILE
- ☐ LETTER FILE
- ☐ VISIBLE BOOK
- ☐ POST BINDER
- ☐ RING BINDER
- ☐ SPECIAL BINDER
- ☐ CLIP BOARD

HOW FILLED IN

- ☐ PEN
- ☐ PENCIL
- ☐ PICA TYPEWRITER
- ☐ ELITE TYPEWRITER
- ☐ SPIRIT DUPLICATOR
- ☐ GELATIN DUPLICATOR
- ☐ STENCIL DUPLICATOR
- ☐ OTHER METHODS

Misc.:

☐ Quote price Show proofs to ______________ not later than ______________ 19____

Deliver to ______________ Attention of ______________

On or before ______________ 19____ ☐ Wrap ☐ Band ☐ Carton ☐ Case ______ Sets ______ Single Forms to Package

Special Instructions:

Department ______________

Signed ______________ NAME OF BUYER

Printed on Canary Hammermill Bond Substance 16 Bond finish

Courtesy Hammermill Paper Company. Reproduced by permission

Figure 96. Printing Specifications Form for insuring that all reproduction aspects are considered and specified.

checked; all users are contacted for suggested improvements; and a complete forms-design analysis, using previously presented principles, is made.

For both reorders and new forms, an ordering form, such as shown in Figure 95 or a printing specifications form, such as shown in Figure 96, is used to insure that all production aspects have been carefully considered and specified.

POSSIBLE SAVINGS FROM FORMS CONTROL

"What savings can be expected from an effective forms control program?" asks Herman Krauss, Planning Supervisor, Mutual Life Insurance Company of New York.* He then continues:

"Here are some of the results of the program in my company, where a staff of three works on forms control; when the program started, there existed 3,208 forms in the organization. Five years later this number had been decreased to 1,987 forms. Procurement or initial cost savings average $27,000 per year, or $135,000 for five years. Cost of the forms-control personnel was $9,000 per year, or $45,000 for five years.

"In one procedure alone the company originally used 27 different forms; 10,350,000 of these forms were used per year. After revision there were seven forms with 4,800,000 copies used per year. That reduced the number of copies handled to 47 per cent of the previous figure. Operations on each form were reduced from an average of 34 to an average of 18, or to 53 per cent of the original operations required. Savings in clerical costs amounted to $160,000 a year.

"Bear in mind, however, that such a program is ineffective if allowed to wither on the vine and die of neglect. It must be kept alive by constant revisions. In short, a forms standardization and control program that produces not more forms, but simpler, more efficient forms, designed and supervised by a man who knows his stuff, is a major contributing factor to lower office costs."

LAY-OUT CONTROL

The office lay-out-control function of the systems department involves three principal aspects:

1. Development of standards for office lay-outs.
2. Maintenance of an up-to-date record of the office lay-outs of the enterprise.

* Herman Krauss, "Standardizing Forms Control," *Office Management, Series Number 122.* New York, American Management Association, p. 30.

3. Control of rearrangements of offices so that none are made without prior consideration of the systems department.

The development of standards of good lay-out practice and policies for such office lay-out problems as the private office, amount of space for persons of various rank, etc., are discussed in Chapter VI. The control of office rearrangements and the enforcement of lay-out standards is maintained by requiring that all proposals for lay-out changes be submitted to the systems department.

EQUIPMENT CONTROL

The equipment-control program of the systems department is, of course, closely correlated with all the other activities of the department. Its functions may be divided into five principal phases:

1. Maintenance of a current source of information on the office equipment used in the enterprise.
2. Establishment, in conjunction with the other sections of the systems department, of such office equipment standards as are deemed advisable in accordance with the considerations outlined in Chapter IX.
3. Control of the purchase and use of equipment to insure that:
   a. Equipment standards are observed.
   b. Standard procedures are not violated.
   c. Existing equipment cannot perform the work with greater over-all economy.
4. Development and administration of sound equipment, maintenance, and replacement policies.
5. Serve as a source of expert technical information on the operations and application possibilities of the various types of presently used equipment as well as the newly developed equipments which are constantly appearing on the market in increasing variety.

EQUIPMENT FILE

The first phase of this equipment-control activity, maintaining an office equipment usage information source, is essentially an inventory-control function. What equipment does the company own and where is it used? The usual procedure is to maintain a card file containing a card for each piece of equipment. This card should contain spaces for the following information:

1. Company assigned number
2. Kind of equipment
3. Description
4. Make of equipment
5. Model and serial number
6. Company identification number
7. Location of the equipment
8. Date of purchase
9. Cost
10. Maintenance costs and dates.

EQUIPMENT STANDARDS

In establishing office equipment standards, the systems department should usually adopt a careful attitude. As pointed out in Chapter IX, rigid standards must not be imposed which will limit the use of different types of equipment where such differences will result in greater over-all economy.

REQUISITIONING EQUIPMENT

Properly to control the purchase and use of office equipment, it is essential that all requisitions for new equipment, for the transfer, moving, and reconditioning of equipment be submitted to the systems department. The requisitions are scrutinized for conformance to established equipment and procedural standards.

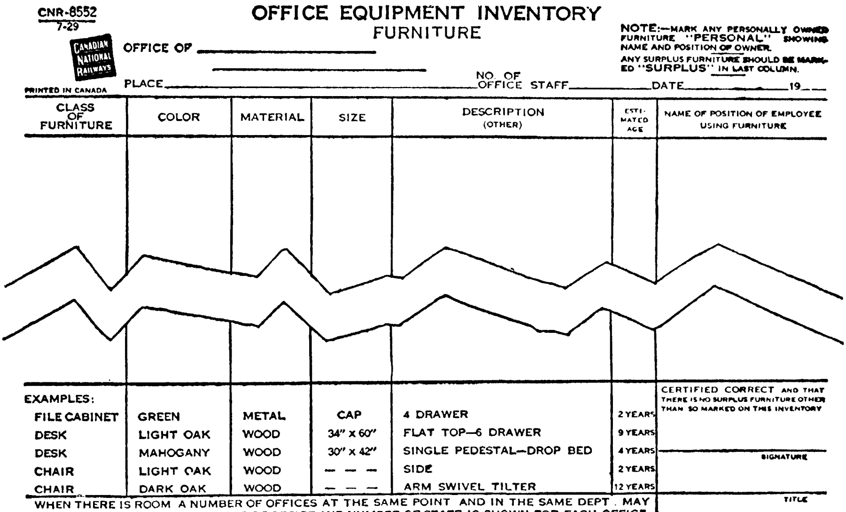
Requisitions for new equipment will be investigated by first determining whether the same kind of equipment is presently used for the performance of the work. If not, then the purchase of the new equipment will usually involve a systems change and should be investigated to determine its desirability. Is the requested equipment the best for the job?

The Equipment File should be checked to ascertain the age, cost, capacity, maintenance record, and obsolescence status of the presently used equipment. Then, an economy analysis must be made to ascertain whether, in accordance with established policies, the replacement should be made.

If the new equipment is intended to provide additional capacity, a detailed analysis of production rates and loads may be required. Can better scheduling reduce the peak load which causes the additional machine requirement? If a number of departments use the same type of machines and have different peak periods, is it possible to set up a central pool of machines which would be transferred from department to department in accordance with its requirements?

REVIEW OF EQUIPMENT

Not only should the equipment-control function of the systems department provide a source of expert technical information on new equipment developments, but a logical search for new applications of labor-saving devices and improved equipment should be conducted.



CNR-8552
7-29
CANADIAN NATIONAL RAILWAYS
PRINTED IN CANADA

OFFICE EQUIPMENT INVENTORY
FURNITURE

OFFICE OF ______________________
____

NOTE:—MARK ANY PERSONALLY OWNED FURNITURE "PERSONAL" SHOWING NAME AND POSITION OF OWNER.
ANY SURPLUS FURNITURE SHOULD BE MARKED "SURPLUS" IN LAST COLUMN.

PLACE ______________ NO. OF OFFICE STAFF ______________ DATE ______________ 19__

CLASS OF FURNITURE	COLOR	MATERIAL	SIZE	DESCRIPTION (OTHER)	ESTIMATED AGE	NAME OF POSITION OF EMPLOYEE USING FURNITURE
EXAMPLES:						CERTIFIED CORRECT AND THAT THERE IS NO SURPLUS FURNITURE OTHER THAN SO MARKED ON THIS INVENTORY
FILE CABINET	GREEN	METAL	CAP	4 DRAWER	2 YEARS	
DESK	LIGHT OAK	WOOD	34" x 60"	FLAT TOP—6 DRAWER	9 YEARS	
DESK	MAHOGANY	WOOD	30" x 42"	SINGLE PEDESTAL—DROP BED	4 YEARS	SIGNATURE
CHAIR	LIGHT OAK	WOOD	— — —	SIDE	2 YEARS	
CHAIR	DARK OAK	WOOD	— — —	ARM SWIVEL TILTER	12 YEARS	TITLE

WHEN THERE IS ROOM A NUMBER OF OFFICES AT THE SAME POINT AND IN THE SAME DEPT. MAY BE LISTED ON ONE SHEET IF NAME OF OFFICE AND NUMBER OF STAFF IS SHOWN FOR EACH OFFICE.

Courtesy Canadian National Railways

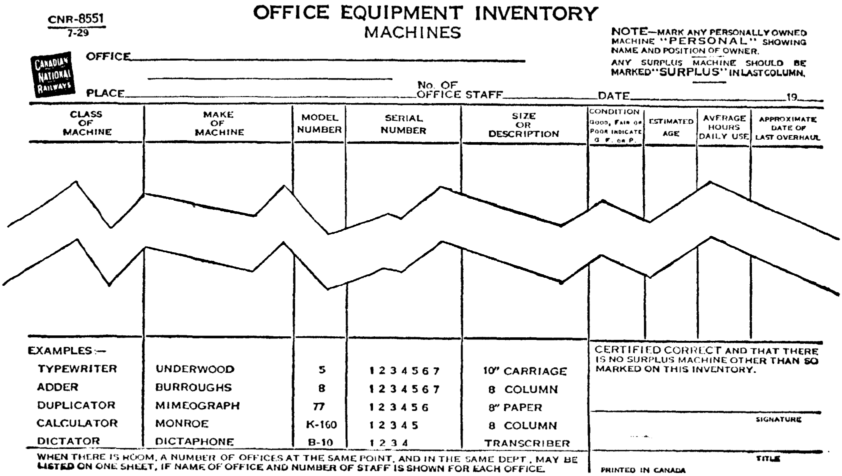
Figure 97. Office Furniture Inventory Form of Canadian National Railways.

Periodic reviews should be made of the office equipment in use in the company. The fact that equipment is old does not necessarily indicate that it should be replaced. Maintenance and repair costs may be low and newer machines may not show any significant operating improvements.

The equipment-control procedure of the Canadian National Railways is described below as an illustrative example of how such a system may be established: *

* "Standardizing Office Forms and Equipment," Policy Holders Service Bureau, Metropolitan Life Insurance Company, New York, 1947.

As a preliminary step, two blank inventory forms were designed, one for furniture and one for machines, and were distributed to every office in the railway system with instructions that they be filled in and returned to Office Services as of a certain date each year. These forms are reproduced as Figures 97 and 98. Inventories thus submitted provide a record of the equipment in use in each office and permit a comparison of the relative equipment requirements. From this it was possible to establish approximate standards as to the amount of machine equipment necessary for various volumes and types of business.


CNR-8551
7-29

OFFICE EQUIPMENT INVENTORY
MACHINES

CANADIAN NATIONAL RAILWAYS

OFFICE
PLACE
No. OF OFFICE STAFF
DATE 19

NOTE—MARK ANY PERSONALLY OWNED MACHINE "PERSONAL" SHOWING NAME AND POSITION OF OWNER.
ANY SURPLUS MACHINE SHOULD BE MARKED "SURPLUS" IN LAST COLUMN.

CLASS OF MACHINE	MAKE OF MACHINE	MODEL NUMBER	SERIAL NUMBER	SIZE OR DESCRIPTION	CONDITION GOOD, FAIR OR POOR INDICATE G. F. OR P.	ESTIMATED AGE	AVERAGE HOURS DAILY USE	APPROXIMATE DATE OF LAST OVERHAUL
EXAMPLES:—								
TYPEWRITER	UNDERWOOD	5	1 2 3 4 5 6 7	10" CARRIAGE				
ADDER	BURROUGHS	8	1 2 3 4 5 6 7	8 COLUMN				
DUPLICATOR	MIMEOGRAPH	77	1 2 3 4 5 6	8" PAPER				
CALCULATOR	MONROE	K-160	1 2 3 4 5	8 COLUMN				
DICTATOR	DICTAPHONE	B-10	1 2 3 4	TRANSCRIBER				

CERTIFIED CORRECT AND THAT THERE IS NO SURPLUS MACHINE OTHER THAN SO MARKED ON THIS INVENTORY.

SIGNATURE

TITLE

WHEN THERE IS ROOM, A NUMBER OF OFFICES AT THE SAME POINT, AND IN THE SAME DEPT., MAY BE LISTED ON ONE SHEET, IF NAME OF OFFICE AND NUMBER OF STAFF IS SHOWN FOR EACH OFFICE.

PRINTED IN CANADA

Courtesy Canadian National Railways

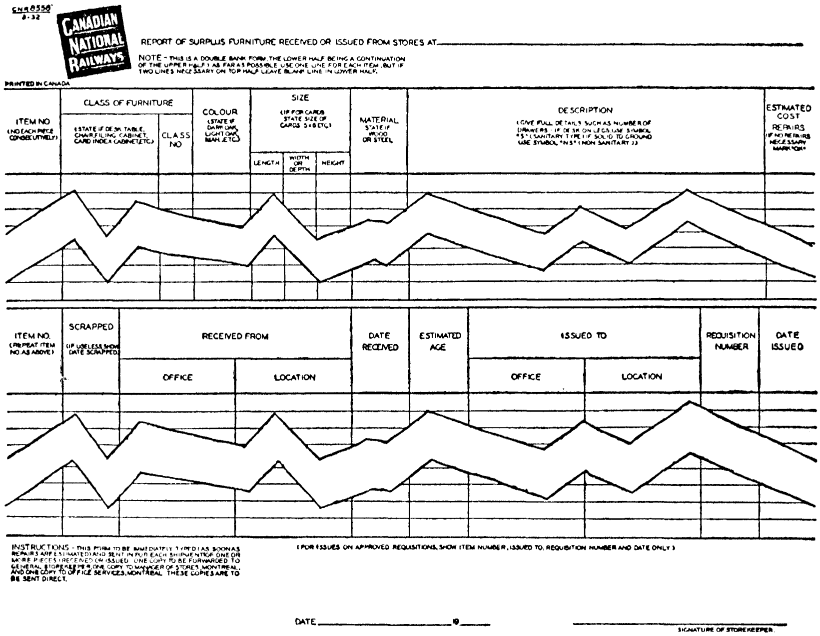
Figure 98. Office Machines Inventory Form of Canadian National Railways.

Two primary record files are maintained for purposes of equipment standardization. One of these is a current equipment inventory with a special designation for surplus or inactive equipment. For purposes of controlling surplus office equipment, a special form of report, illustrated in Figure 99, is prepared for each shipment of surplus equipment received or issued from surplus stores (a slightly different form is used for office machines). One copy of this report is sent to Office Services.

The other record is the Office Equipment Standards File, consisting of a separate card for each type of machine or equipment [which has been adopted as standard. The card provides for full description and specification of the standard equipment]. The reverse side of the card provides for attaching a catalog cut of the item and for notation of special features and specifications. These cards are filed according to the name of the position or office to which the equipment applies as well as by type of equipment.

With the primary objectives of securing the benefits of quantity purchases, interchangeability and minimum maintenance costs, equipment standardization in this company takes into consideration the following ten points.

1. Original cost of equipment
2. Guarantee
3. Durability
4. Portability
5. Repair service
6. Maintenance cost and depreciation
7. Operating cost including supplies
8. Production capacity and average expectation
9. Functional adaptability where a machine might be adapted to different kinds of work
10. Competitive costs of different types of machines for any specified class of work.



CNR 8558
8-32

CANADIAN NATIONAL RAILWAYS

REPORT OF SURPLUS FURNITURE RECEIVED OR ISSUED FROM STORES AT ____________

NOTE – THIS IS A DOUBLE BANK FORM, THE LOWER HALF BEING A CONTINUATION OF THE UPPER HALF) AS FAR AS POSSIBLE USE ONE LINE FOR EACH ITEM, BUT IF TWO LINES NECESSARY ON TOP HALF LEAVE BLANK LINE IN LOWER HALF.

PRINTED IN CANADA

ITEM NO (NO EACH PIECE CONSECUTIVELY)	CLASS OF FURNITURE (STATE IF DESK, TABLE, CHAIR, FILING CABINET, CARD INDEX CABINET, ETC.)	CLASS NO	COLOUR (STATE IF DARK OAK, LIGHT OAK, MAH., ETC.)	SIZE (IF FOR CARDS STATE SIZE OF CARDS 5×8 ETC.) LENGTH	WIDTH OR DEPTH	HEIGHT	MATERIAL STATE IF WOOD OR STEEL	DESCRIPTION (GIVE FULL DETAILS SUCH AS NUMBER OF DRAWERS – IF DESK ON LEGS, USE SYMBOL "S" (SANITARY TYPE) IF SOLID TO GROUND USE SYMBOL "NS" (NON SANITARY))	ESTIMATED COST REPAIRS (IF NO REPAIRS NECESSARY MARK "OK")

ITEM NO. (REPEAT ITEM NO. AS ABOVE)	SCRAPPED (IF USELESS SHOW DATE SCRAPPED)	RECEIVED FROM OFFICE	RECEIVED FROM LOCATION	DATE RECEIVED	ESTIMATED AGE	ISSUED TO OFFICE	ISSUED TO LOCATION	REQUISITION NUMBER	DATE ISSUED

INSTRUCTIONS – THIS FORM TO BE IMMEDIATELY TYPED (AS SOON AS REPAIRS ARE ESTIMATED) AND SENT IN FOR EACH SHIPMENT OF ONE OR MORE PIECES (RECEIVED OR ISSUED. ONE COPY TO BE FORWARDED TO GENERAL STOREKEEPER, ONE COPY TO MANAGER OF STORES, MONTREAL, AND ONE COPY TO OFFICE SERVICES, MONTREAL. THESE COPIES ARE TO BE SENT DIRECT.

(FOR ISSUES ON APPROVED REQUISITIONS, SHOW ITEM NUMBER, ISSUED TO, REQUISITION NUMBER AND DATE ONLY.)

DATE ____________ 19____

____
SIGNATURE OF STOREKEEPER.

Courtesy Canadian National Railways

Figure 99. Surplus Stores Equipment Form of Canadian National Railways.

As a means of establishing the need for each piece of equipment purchased, two forms are provided for recording all the necessary data regarding its proposed use. These forms, reproduced as Figure 100 for office machines and Figure 101 for office furniture, must be completed and submitted with each requisition whether for additional equipment or replacements. The information requested on the forms has been simplified as much as possible so as to minimize the burden on the requisitioning department, but is designed to provide a check on all unnecessary expenditures. In some cases supplementary information must be called for as the investigation progresses.

CNR-8553
7-29
PRINTED IN CANADA

REQUISITION DATA—OFFICE MACHINES

CANADIAN NATIONAL RAILWAYS

OFFICE OF ______ REQUISITION NUMBER ______

ADDRESS ______ DATE ______ 19__

1. TYPE OF MACHINE REQUIRED (EXAMPLE:—CALCULATOR, DUPLICATOR, TYPEWRITER, ADDER, ETC.) ______
   ______ I.A. REPLACEMENT OR ADDITION? ______
2. FOR TYPEWRITER STATE PERCENTAGE OF CORRESPONDENCE ______%. STATEMENTS ______%. CARD WRITING ______%
   FOR ADDER OR CALCULATOR, STATE PERCENTAGE OF ADDITION ______%. MULTIPLICATION ______%. SUBSTRACTION ______%.
   DIVISION ______%. PERCENTAGE OR RATIOS ______%. NUMBER OF COLUMNS ______
   FOR DUPLICATOR ______% OF WORK REQUIRES ______ COPIES. ______% OF WORK REQUIRES ______ COPIES. LARGEST SIZE PAPER TO BE DUPLICATED ______ X ______
3. DESCRIBE THE WORK TO BE DONE ON THIS MACHINE, AND STATE IF THE WORK REQUIRES OTHER THAN STANDARD MACHINE SUCH AS WIDE CARRIAGE, SPECIAL KEYBOARD, DECIMAL TABULATOR, ETC. ______
   (PICA TYPE (10 TO 1 INCH) IS THE MOST SATISFACTORY AND ECONOMICAL TYPE FOR TYPEWRITER, AND WILL BE SUPPLIED UNLESS OTHERWISE SPECIFIED)
4. IF ADDITIONAL MACHINE, HOW IS THIS WORK DONE NOW? ______
5. ANTICIPATED NUMBER OF HOURS DAILY USE IN YOUR OFFICE ______
6. WILL IT BE AVAILABLE FOR USE OF OTHER OFFICES? ______ IF SO, HOW MANY HOURS? ______
7. MACHINE TO BE TRADED IN, IF ANY: (IF FOR MORE THAN ONE MACHINE, GIVE SIMILAR INFORMATION FOR EACH EXTRA MACHINE ON BACK OF THIS FORM)
   A. MAKE? ______ D. DATE AND COST OF LAST OVERHAUL? ______
   B. MODEL NUMBER? ______ E. PRESENT OVERHAUL ESTIMATE? ______
   C. SERIAL NUMBER? ______ F. ESTIMATE MADE BY? ______
8. WHAT DIFFERENT MAKES OF THIS TYPE OF MACHINE DO YOU NOW USE IN YOUR OFFICE? (GIVE TOTAL NUMBER OF EACH MAKE AND MODEL). ______
9. GIVE FULL DETAILS OF THE SAVING, IF ANY, WHICH WILL JUSTIFY FILLING THIS REQUISITION ______
10. APART FROM THE FAMILIARITY OF YOUR OFFICE STAFF WITH THE ABOVE MAKE OF MACHINE, IS THERE ANY ESSENTIAL REASON WHY ANOTHER STANDARD MAKE OF THE SAME TYPE OF MACHINE SHOULD NOT BE FURNISHED? ______

DATE ______ 19__ OFFICER ______

TITLE ______

INSTRUCTIONS FOR USE OF THIS FORM

THIS FORM IS TO BE ATTACHED TO ALL REQUISITIONS FOR OFFICE MACHINES.
MANUFACTURERS' NAME SHOULD NOT BE SHOWN ON REQUISITION.
GIVE AS MUCH INFORMATION AS POSSIBLE IN ANSWER TO THE ABOVE QUESTIONS.
IF MORE SPACE REQUIRED, MARK "OVER" AND USE BACK OF FORM.

Courtesy Canadian National Railways

Figure 100. Form for requisitioning office machines of Canadian National Railways.

CNR-8554
7-28
PRINTED IN CANADA

REQUISITION DATA—OFFICE FURNITURE

OFFICE OF__________ REQUISITION NO.__________

ADDRESS__________ DATE__________19___

1. FURNITURE REQUIRED? (GIVE FULL PARTICULARS AS TO TYPE, COLOR, SIZE, ETC.)__________

I.A. REPLACEMENT OR ADDITION?__________

2. IF REPLACEMENT, WHAT DOES IT REPLACE?__________
   A. GIVE AGE AND CONDITION__________
   B. STATE PROPOSED DISPOSITION?__________
   (IF CONDEMNED, FURNISH DETAILS IN SPACE FOR REMARKS BELOW)
3. IF ADDITIONAL, IS IT FOR EXTRA CLERK?__________
   A. PERMANENT OR TEMPORARY CLERK?__________
   B. IF CLERK TRANSFERRED FROM ANOTHER OFFICE, GIVE REASON FOR NO TRANSFER OF FURNITURE?__________
4. POSITION OF EMPLOYEE WHO WILL USE THIS FURNITURE?__________
5. IF FILE OR INDEX CABINET, GIVE NUMBER AND SIZE OF PRESENT CABINETS AND DRAWERS__________
   A. DESCRIBE CONTENTS?__________
   B. CAN ANY OF THE CONTENTS BE TRANSFERRED?__________
   C. WHEN WERE THEY LAST COMPLETELY REVIEWED FOR TRANSFER?__________
   D. WHAT IS THE PRESENT OVERFLOW (IN INCHES) WHICH CANNOT BE PROVIDED FOR BY TRANSFERRING OTHER RECORDS?__________
   (SURVEYS HAVE DISCLOSED THAT IN THE AVERAGE OFFICE OVER 35% OF THE SPACE IN FILING CABINETS IS OCCUPIED BY DEAD AND DORMANT RECORDS, WHICH SHOULD BE TRANSFERRED INTO WOOD DRAWER TRANSFER CASES, THIS SHOULD BE CHECKED VERY CLOSELY).
6. HAS IT BEEN DEFINITELY DETERMINED THAT THERE IS NO SURPLUS FURNITURE THAT COULD BE REPAIRED, CLEANED, OR REFINISHED TO FILL THIS REQUIREMENT?__________
7. APART FROM MATCHING COLOR AND DESIGN OF PRESENT FURNITURE, WOULD USED FURNITURE BE SUITABLE?__________
8. HAS CONSIDERATION BEEN GIVEN TO POSSIBLE RE-ARRANGEMENT OF PRESENT FURNITURE AND STAFF TO SAVE THIS EXPENDITURE?
9. REMARKS__________

DATE__________19___ OFFICER__________

TITLE__________

INSTRUCTIONS FOR USE OF THIS FORM
THIS FORM IS TO BE ATTACHED TO ALL REQUISITIONS FOR OFFICE FURNITURE.
MANUFACTURERS' NAME SHOULD NOT BE SHOWN ON REQUISITION.
GIVE AS MUCH INFORMATION AS POSSIBLE IN ANSWER TO THE ABOVE QUESTIONS
IF MORE SPACE REQUIRED, MARK "OVER" AND USE BACK OF FORM.

Courtesy Canadian National Railways

Figure 101. Form for requisitioning office furniture of Canadian National Railways.

When all the necessary information has been secured, each case requiring investigation is individually considered by the Office Services staff. This includes a check against the surplus inventory record to determine whether the article is on hand or must be purchased and reference to the Office Equipment Standards File. Where necessary, comparative tests of competitive products are conducted, the practice of running two independent tests for checking purposes being followed in most cases. After full investigation, a digest report, containing definite reasons why the requisition should or should not be approved, how it can be filled within the standards at the least expense to the railroad, including costs, savings and suggested action to be taken, is prepared by the Manager of Office Services and submitted to the Office of the President or the Vice-President in duplicate for formal approval. Usually the duplicate is returned "approved," when a notation is made on it as to the estimated savings, if any, from the transaction for entry in the Savings Record Book and the new standards, if any, are entered in the Office Equipment Standards File.

The procedure as described has been used by this Company over a period of several years and has resulted in an estimated saving of more than 15 per cent of the total value of the items involved in over one thousand requisitions handled during that time. The plan of providing for the uniform and complete presentation of the supporting data required has facilitated executive action and permitted better informed decisions as to whether (a) the purchase should be approved, (b) less expensive but equally suitable equipment should be substituted, (c) idle or surplus equipment should be transferred, or (d) the request should be cancelled.

QUALIFICATIONS FOR SUCCESSFUL SYSTEMS MEN

What qualifications are desirable for systems work? How can the systems department supervisors distinguish between those likely to succeed and those who will undoubtedly fail to achieve desired results in systems analysis? How can a person measure his own qualifications for a systems position?

There is no magic formula for the correct combination of attributes which will result in a successful systems analyst. The descriptions of the systems techniques presented in this book should give you a general idea of the kind of qualifications which will prove helpful. However, some aspects of systems work partake of the nature of an art rather than a science. Many unusual combinations of various qualifications may therefore be valuable in systems work.

Some of the generally desired qualifications for systems work are presented here. To some extent, they summarize the work of the systems analyst. The order of presentation is not in any way related to an evaluation of the relative importance of these characteristics.

The analyst should have an analytical mind to enable him to probe to the essential elements of a problem. The analytical mind simplifies the problem by eliminating all superfluities from consideration.

Having reduced the problem to its essential elements, he will want to be able to reason logically, to understand cause and effect relationships.

The systems analyst must always be a skeptic. He must not accept hearsay information without verification. He must be critical of all procedures and operating methods. He should be eternally curious: Why is this done? Where does that originate? Why can't it be done another way? He must have a naturally inquisitive instinct and desire for knowledge.

He must be resourceful and imaginative to be able to strike out in new paths, to be able to project himself into undiscovered fields, and into future possibilities.

The analyst should have the ability to keep things in their true, broad perspective—to be able to distinguish the forest from the trees.

He must have objective, unbiased attitudes. His mind must be flexible, open, and ready to be logically convinced of the best answer.

He must understand people, sympathize with their problems, and possess the tact necessary to cooperate and convince effectively. The importance of these characteristics was repeatedly illustrated in the preceding chapters describing some of the problems of the analyst in conducting his investigation.

The systems man must be open-minded and honest, with himself and with others. This characteristic will display itself in a number of ways: he will not delude himself into considering his own proposals as the best at all times; he will give credit to other people for whatever contributions they make towards the perfection of the system he is working on.

He should be able to express himself convincingly, orally, in writing, and graphically. Much of the systems investigation is done by word of mouth and a large part of the selling job in systems work is done verbally. To assure common understanding of systems facts and procedures and effectively to present proposals for systems changes, facility in composition is important. Since graphic analysis and presentation can often clearly summarize in a readily grasped form many pages of complicated written material, skill in the graphic arts may be a valuable aid to the analyst.

Finally, he must possess a drive which will enable him to continue in his tasks despite discouragements, defeats, and necessary compromises. He must possess a firm realization that improvements result from constant hard work in the application of sound principles.

APPENDIX A*

The following example is taken from the introduction to one of the general standard practice instructions of a well-known engineering and manufacturing enterprise. It illustrates the scope and organization of a complete manual system.

STANDARD PRACTICE INSTRUCTIONS	Page 1 of 4	Classification No. 1.A.2
General Standard Practice Instructions	Date Issued	By order of
	Supersedes	Distribution

Subject
THE COMPANY'S SYSTEM OF MANUALS

CONTENTS

I *GENERAL*
II *MANUALS OF SUPERVISORY GUIDANCE AND INSTRUCTION*
A. General Manuals
B. Divisional and Departmental Manuals
III *TECHNICAL MANUALS*

* From Reading Course in Executive Technique, Section I, Volume 4, R. E. Gillmor, *A Practical Manual of Organization,* pages 53–56. Used by permission of Funk & Wagnalls Company.

* * *

I *GENERAL*

The Company's system of manuals consists of several sets of written instructions and information on policies, procedures, responsibilities, and standards which are prepared and approved by positions of recognized authority. Each set of instructions is issued in a binder to the supervisory personnel and, in some cases, to the operating personnel whose activities the manual governs. The structure of Company manuals can be divided into two basic groups: first, manuals of supervisory guidance and instruction; second, technical manuals.

II *MANUALS OF SUPERVISORY GUIDANCE AND INSTRUCTION*

As a group, these manuals contain instructions and information concerning policies; organization structure; the responsibilities of specific positions; operating routines, records, and reports; equipment, personnel, and other standards or specifications; and rules or regulations. Such manuals may govern the entire Company or they may be only departmental or divisional in scope.

A. *General Manuals:* Following is a description of the scope of each manual governing the entire Company.
   1. The *General Standard Practice Instructions Manual*—see statement of scope and purpose in SPI 1.A.1, "Introduction to General Standard Practice Instructions Manual."
   2. The *Organization Manual* contains organization charts of all supervisory positions within the Company, a definition of the responsibilities of each supervisory position and the responsibilities common to all positions, and statements of the relationship between positions.
   3. The *Salary and Wage Administration Manual* contains approved occupational titles and definitions of salaried and hourly occupations. Occupational definitions or specifications consist of a statement of the duties, skills, and experience required in the occupation. The manual is used as an aid in selecting applicants for jobs, in establishing salary ranges, and as a basis for determining eligibility for promotion.
   4. The *Standard Equipment Manual* contains purchase specifications for office furniture and equipment and other

capital items which can be used interchangeably between divisions and which have been standardized for purposes of economy and uniformity of appearance.

5. The *Secretary's Manual* contains selected General SPIs and other instructions regarding filing, preparation of correspondence, interoffice mail, and related subjects. This manual is prepared for the guidance and instruction of all secretarial and stenographic personnel.

B. *Divisional and Departmental Manuals:* These manuals generally contain instructions regarding those procedures, records, and reports which must be carried out, maintained, or prepared by personnel of one division or one department only. However, the material contained in these manuals is necessarily interwoven with other departmental manuals and with general policies and procedures. Following is a list of the Company's departmental manuals:

1. The *Accounting Manual* contains a chart of accounts which governs the capital and expense charges of the entire Company. Other sections (e.g., general accounting section, cost accounting section, and timekeeping section) are departmental in scope.
2. *Engineering SPI Manual*
3. *Emergency Facilities Instruction Manual*
4. *Guards Manual*
5. *Inspection SPI Manual*
6. *Methods SPI Manual*
7. *Personnel Department SPI Manual*
8. *Production Control SPI Manual*

III *TECHNICAL MANUALS*

The Company's technical manuals contain such information as materials specifications, standard contract clauses, maintenance and repair instructions, etc. The following constitute the Company's group of technical manuals:

1. *Contracts Summary Manual*
2. *Field Service Manual*
3. *Standard Parts Manual*

APPENDIX B

AMERICAN MACHINE & FOUNDRY COMPANY
STANDARD PRACTICE INSTRUCTIONS

S. P. I. NO. 1.A.1
PAGE 1 OF 4
REV. NO. 2 OF 1-1-
EFFECTIVE DATE 11/1/47

TITLE: DEVELOPMENT, APPROVAL & ISSUANCE OF SPI's

APPROVED BY: M. PATTERSON
EFFECTIVE AT Company Wide

DATE ISSUED 11/1/47

These instructions are effective immediately upon receipt and they supersede SPI 1-1-0, issued 4/8/47 and all other relative material previously issued.

PURPOSE: To revise and clarify the authorized method of developing, coordinating, approving and issuing Standard Practice Instructions.

1. SCOPE & PURPOSE OF THE MANUAL

The AMF Standard Practice Instruction Manual will contain the following types of material:

a. Statements of the Company's objectives and policies.
b. Charts of the Company's Organization structure and descriptions of departmental responsibilities.
c. Descriptions of standards and specifications established to facilitate and control basic company activities.
d. Descriptions of repetitive procedures in which two or more Offices, Divisions, or Departments participate.

This Manual of instructions is designed to achieve the following objectives:

a. To promote common understanding of Company objectives.
b. To insure uniformity in the interpretation and administration of all Company policies.
c. To eliminate unnecessary duplication of records and activities.
d. To assist in coordinating the activities of Offices, Divisions, and Departments of the Company.
e. To provide a basis for effecting Management control of Company activities.
f. To serve as a medium for training supervisory members of the Organization.
g. To encourage constant review and improvement of policies, practices and procedures.

2. HOW SPI's WILL BE DEVELOPED

The Procedures Manager, under the direction of the Corporate Secretary, will assist Vice Presidents, General Managers and their designees in the preparation of requested SPI's. The Head of each Division and Office will develop a master list of SPI's required for his activities and assign a member of his staff to develop the basic material required to prepare these SPI's. The Corporate Secretary upon request, will have this material written in SPI form and will then arrange for the final approval and distribution of the instructions.

NOTICE

1. WRITE S. P. I. TITLE AND NUMBER IN MANUAL INDEX.
2. FILE THIS S. P. I. IN MANUAL - SECTION 1. SEQUENCE A.1
3. REMOVE OBSOLETE S. P. I. NO. DATED AND DESTROY IT.

FORM 100-1

AMERICAN MACHINE & FOUNDRY COMPANY
STANDARD PRACTICE INSTRUCTIONS NO. 1.A.1

REVISION NO. OF PAGE PAGE 2 OF 4

The Procedures Manager will analyze an existing procedure or system, upon request, for the purpose of proposing improvements and ultimately preparing and issuing applicable instructions in SPI form.

3. HOW SPI'S WILL BE APPROVED

The Procedures Manager will contact all supervisory personnel concerned to obtain their concurrance on what is being written. After all concurrances have been obtained, he will forward the final SPI draft and a list of the names of those who have concurred, to the Corporate Secretary who in turn will forward the SPI to the President or appropriate Vice President or General Manager with a recommendation that it be approved for final issue.

SPI's will be issued over either the signature of the President, a Vice President or a General Manager, whichever is appropriate.

All Offices and Divisions, except the Pinspotters Division which has an established Procedure Staff, will clear their SPI drafts through the Corporate Secretary before final issue. The Pinspotters Division will clear only those SPI drafts through the Corporate Secretary which involve the establishment or revision of a company policy or a procedure which affects other Offices or Divisions, in which case the Corporate Secretary will coordinate management approval of the SPI. Copies of all Pinspotters SPI's will be forwarded to the Procedures Manager for distribution to holders of Master Manuals at other locations.

The Procedures Manager is responsible for seeing that the knowledge and experience of all supervisory personnel is utilized in preparing an SPI and where major differences of opinion cannot be reconciled among those concerned, he will refer the policy or procedural problem to the Corporate Secretary for decision from the management.

4. HOW SPI'S WILL BE CLASSIFIED

The identifying classification of each Standard Practice Instruction consists of three parts, separated by a period. For example, S.P.I. 12.E.1.

12 denotes the section of the manual in which the S.P.I. is filed. (The sections are listed in the Table of Contents)

E denotes the group in section 12 in which the S.P.I. is filed.

1 denotes the sequence within group E in which the SPI is filed.

hence

12 = Manufacturing Division section of Manual
E = Quality Control group of Manufacturing Division S.P.I.'s
1 = 1st S.P.I. in Group E.

NOTICE

1. FILE THIS S.P.I. IN MANUAL - SECTION 1. SEQUENCE A.1
2. REMOVE OBSOLETE S.P.I. NO. DATED AND DESTROY IT.

FORM 100-B

AMERICAN MACHINE & FOUNDRY COMPANY
STANDARD PRACTICE INSTRUCTIONS NO. 1.A.1

REVISION NO. OF PAGE PAGE 3 OF 4

5. HOW SPI'S WILL BE DISTRIBUTED

The Procedures Manager will issue a Master Manual, containing a copy of all SPI's to the Chairman of the Board, the President, the Corporate Secretary, Vice Presidents, General Managers, Work Managers; to individuals assigned to offices of the above executives and to any other executives whose duties require a knowledge of all Company policies and procedures.

A regular SPI Manual (receiving selective distribution) will be issued to all management and supervisory personnel not indicated above, and such Manual Holders will receive a copy of only those SPI's that relate specifically to their activities.

All copies of Standard Practice Instructions will be distributed through the regular line of organization in order that Executives and Supervisors may transmit the instructions directly to their subordinates.

6. HOW SPI'S WILL BE INSTALLED

Where necessary to effect thorough installation of procedures and systems, the appropriate executive will conduct individual or group training activities at the time the Standard Practice Instructions are issued. Upon request the Procedures Manager will be available to assist all executives in this work.

7. HOW SPI'S WILL BE EVALUATED

The check list for determining the effectiveness of each SPI will be:

a. Has it simplified methods and clarified policies?

b. Does it effect maximum standardization of policies and operations at all company locations?

c. Is it sufficiently detailed and presented in comprehensive form?

8. INTERIM INSTRUCTIONS

The development and publication of policies and procedures is a constant function of executive and supervisory personnel and it is recognized that the Procedure Staff cannot always meet the SPI schedule-demands of the Organization. Hence, where necessary to expedite issuance of an order, any supervisory employee may issue, within the limits of his authority, an interim policy or procedure in the form of a memo, bulletin or letter. A copy of all such material will be forwarded to the Procedures Manager who, upon request and proper authorization, will schedule the preparation of the interim instructions in final SPI form. The Procedures Manager will be available to assist executive and supervisory personnel in the preparation of interim instructions.

9. ORGANIZATION ANNOUNCEMENTS

Section 2 of this manual contains an organization chart of the basic company

NOTICE

1. FILE THIS S.P.I. IN MANUAL - SECTION 1. - SEQUENCE A.1
2. REMOVE OBSOLETE S.P.I. NO. DATED AND DESTROY IT.

FORM 100-8

AMERICAN MACHINE & FOUNDRY COMPANY
STANDARD PRACTICE INSTRUCTIONS NO. 1.A.1

REVISION NO. OF PAGE PAGE 4 OF 4

structure and a description of the functions of each Office and Division within this structure. All other sections contain detailed organization charts and departmental descriptions pertaining to the applicable Office or Division. These charts and descriptions are designed to permit a number of current organization changes to be noted thereon by the Manual holder as changes are announced.

All organization changes will be announced on an Organization Bulletin, which will provide the necessary information needed to make change-notes on the applicable organization material in the SPI manual.

The Procedures Manager will issue revised charts and descriptions as often as necessary to keep this data free from excessive notes.

All organization changes will be announced by means of the Organization Bulletin and all requests to issue this bulletin will be forwarded to the Procedures Manager who will ascertain that the requested change has been properly approved and will then prepare and issue the bulletin over the proper signature.

Organization changes in the Pinspotters Division will be issued directly from that Division with copies supplied to the Procedures Manager for distribution to holders of master manuals at other locations.

10. RESPONSIBILITY OF MANUAL HOLDERS

a. Persons holding copies of Standard Practice Instruction Manuals are responsible for keeping their manuals in orderly, usable condition and for inserting new material as soon as it is received. All SPI's will be filed and indexed in the manual in accordance with the instructions given on the bottom of each SPI page. The Procedures Manager will issue a revised index periodically in order that all manual holders may audit their manuals to see that they are complete and in order.

b. Each manual holder will make his manual readily available to his subordinates for reference, and will instruct them in the purpose and use of Standard Practice Instructions.

c. Standard Practice Instruction manuals are Company property and are not transferable. Therefore, whenever a manual holder leaves the Company or is transferred to another department, his superior is responsible for returning that person's manual to the Procedures Manager.

NOTICE

1. FILE THIS S. P. I. IN MANUAL - SECTION 1. SEQUENCE A.1
2. REMOVE OBSOLETE S. P. I. NO. DATED AND DESTROY IT.

FORM 100-S

INDEX

Figures in italics refer to illustrations