

MODERNIZING UNITED STATES AIR FORCE LOGISTICS
BY UTILIZING
ELECTRONIC DATA PROCESSING MACHINES

By

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CHAPTER I

INTRODUCTION

Warfare is at best a confusing and chaotic business. It is also a very wasteful business. However, one of the most important trends in our modern military thinking is the growing conviction that warfare must not necessarily be unlimited in its waste and confusion; that, within limits, one can control the amount of waste and confusion involved.¹ We have learned that by intelligent long-range planning; by carefully and precisely anticipating each problem; by even learning to expect the unexpected, we can place military personnel, supplies, facilities, and services where needed, when needed, and in the amount and kind needed. The result is a faster victory, and a less costly victory.

Logistics Defined

This entire art of planning in terms of personnel and material is known today as "logistics," a word that is fairly new in our military vocabulary.

The history of warfare has been marked by a slow but constant shift from clashes between masses of men to clashes between masses of supplies, equipment, and men.² In the days of Caesar, when the sword and spear were practically the only weapons used, the victory usually went to the

¹AFROTC, Weapons (Montgomery, 1952), Vol. III, p. 4.

²Air University, Logistics - Supply & Maintenance (Montgomery, 1951), No. 65-1, p. 3.

army which had the greatest number of men.³ If one side had more extra swords or sharper swords than the other side, it made little difference. Further, Caesar had little trouble purchasing and transporting food and clothing for his legions. Their needs were comparatively simple and they could usually live off the resources of conquered countries.

Contrast that picture of the Roman wars with the picture presented by World War II. Greater numbers of men were involved in World War II, it is true, but the victory did not necessarily go to the side with the greater number of men in the field. Certainly one of the deciding factors in our victory in World War II was our ability to throw more ships, tanks, guns, aircraft, and foodstuffs into the fight than our enemy could. But our ability to simply produce more supplies and equipment than the enemy was not the entire story. Equally important was the fact that we arranged to place these supplies and equipment when and where needed throughout the globe.

What is the meaning of this shift in the nature of warfare--this shift from a conflict between opposing masses of men to a conflict between opposing masses of men and materiel? Through the years logistics has played an increasingly important part in warfare. Also, as our machines of war continue to become more numerous and more complex, and as the distances to be covered in warfare become steadily vaster, the role of logistics is certain to become even more vital. It is not at all unreasonable to assume that in case of another world conflict, logistics might well be the major factor that will determine the outcome of that conflict.

³AFROTC, Weapons (Montgomery, 1952), Vol. III, p. 3.

Rising Cost of War

The following figures show the rising cost of waging war:⁴

	Total Cost of War (in Millions)	Per Capita Expenditures
Revolutionary War	\$ 125	\$ 50
Civil War (Federal Government)	3,300	150
World War I	35,000	350
World War II	350,000	2,650

These figures are very impressive when studied carefully. Compare World Wars I and II. The latter cost us 350 billion dollars to fight, ten times the cost of World War I. Even on a per capita basis, World War II was almost eight times as expensive as World War I.

This indicates that planning of logistics for the future must be more efficient and accurate than ever. As a nation we must learn to get the maximum use out of our natural resources and productive capacity. We have already made great strides in this direction. How were we able to increase our production for military purposes from \$35 billion in World War I to \$350 billion in World War II? This was made possible solely by increasing our actual production output, that is, by streamlining our mass production assembly lines. We were also aided by having gained a better understanding of our national economic system and the ways and means of controlling that system. Added efficiency in developing the machinery of government and the administrative skills necessary to mobilize the nation's resources for war was a factor. There is still need to do even more in all of these areas of national logistics.

⁴Air University, Logistics - General (Montgomery, April, 1954), No. 325, Vol. IX, p. 3.

What does this mean to the military logistician? It emphasizes that military logistics must plan and program its materiel requirements in such manner as to stay within the limits of our nation's production and still enable the waging of successful warfare. Success in this field demands the very best of planning by the military, planning which will assure that all military materials are distributed and used with the greatest possible efficiency.

The military gets its supplies and equipment originally from the nation's productive output. It is then the job of the military to control the distribution of these supplies throughout its organization so that it can conduct successful operations. Military logistics is broken down into four areas known as supply, maintenance, transportation, and installations. The three basic tasks of military logistics in these areas is to (1) determine needs, (2) procure the means to fill these needs, and (3) distribute those means. The foregoing breakdown is a very general definition of military logistics.

History of the United States Air Force Logistics System

Prior to the Armed Services Unification Act of 1947, the Army Air Force operated as an element of the War Department.⁵ Under this setup, the Air Force had comparatively few logistics responsibilities. All broad logistics planning and coordination was performed by the War Department. The Air Force was concerned almost entirely with technical supplies peculiar to aviation.

Today the situation has changed. The Air Force is now an independent agency and is responsible for planning and coordinating its own logistics. (See Figure 1). It procures most of its supplies direct from the

⁵Air University, Supply - Course No. 210 (Montgomery, 1949), pp 8-11.

manufacturer. Some items, however, such as those in common use by several of the armed services, are procured for the Air Force by the Army or Navy. Even in the case of these items, the Air Force is still responsible for its own supply planning, presenting and defining of its budgets, and for advising the Army and Navy what supply items they are to procure for the Air Force.

The Air Force, when it became an independent military department, had a supply system which handled only a small portion of the items used. It therefore had to gain experience in filling most of its supply needs. There was not always enough time to service test new supply systems prior to their being adopted.

For the first few years of its independent existence the Air Force simply patterned its supply system after that of the Army. Today the Air Force has its own distinctive system for handling supplies—one that more nearly fulfills its needs. That system, though still comparatively new, is responsible for storing and issuing over 800,000 supply items.⁶ Although the Air Force still gets approximately 350,000 supply items from the Army and Navy, these items must pass through Air Force channels. All told, the Air Force uses approximately 1,150,000 separate supply items. To handle such quantities of material, the Air Force has built a vast supply system. This system is a major command in the Air Force - The Air Materiel Command. (See Figure 2).

⁶Robert Hotz, "AMC Streamlines Management Pattern," Aviation Week, August 16, 1954, p. 73.

ORGANIZATION OF THE UNITED STATES AIR FORCE

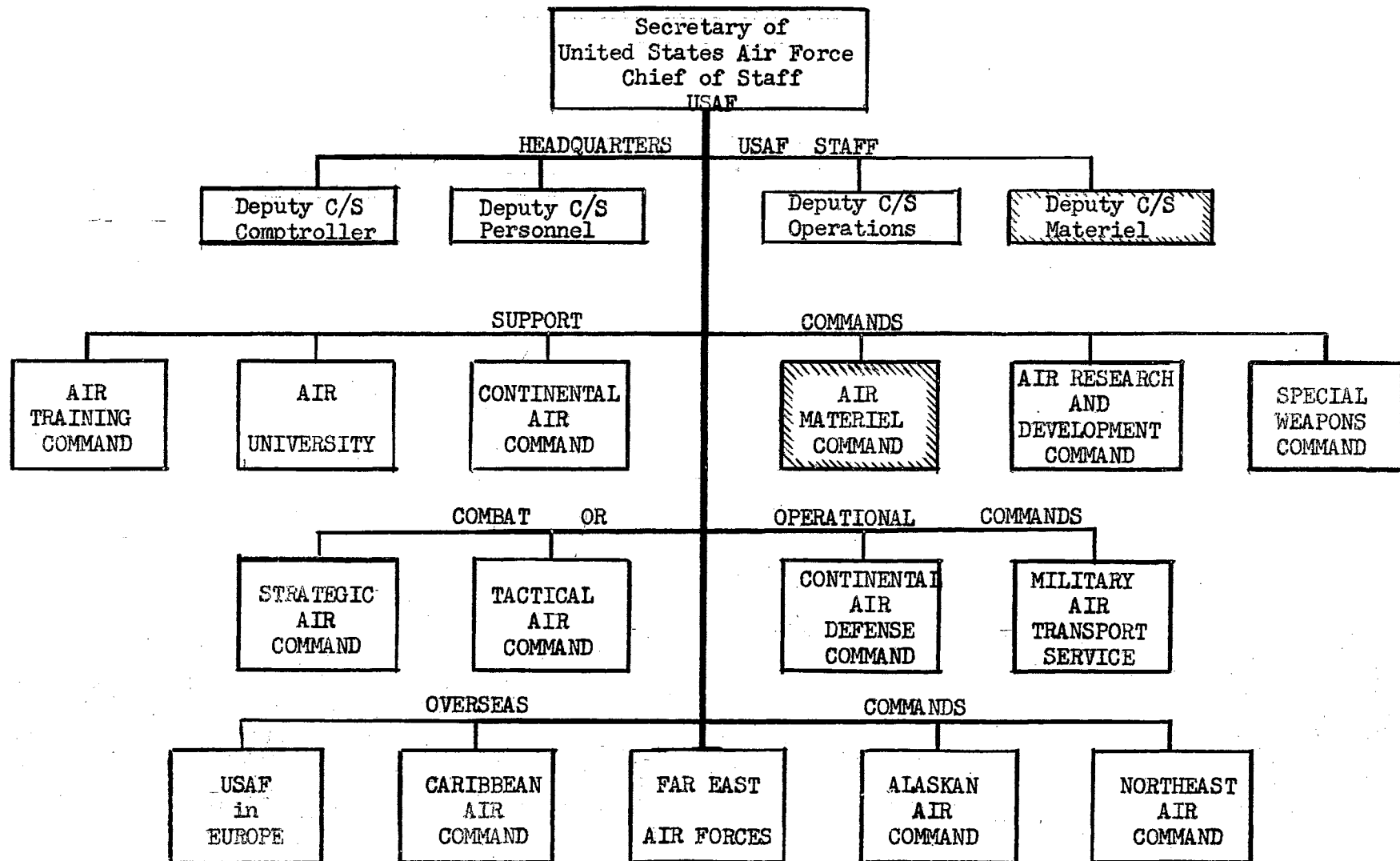
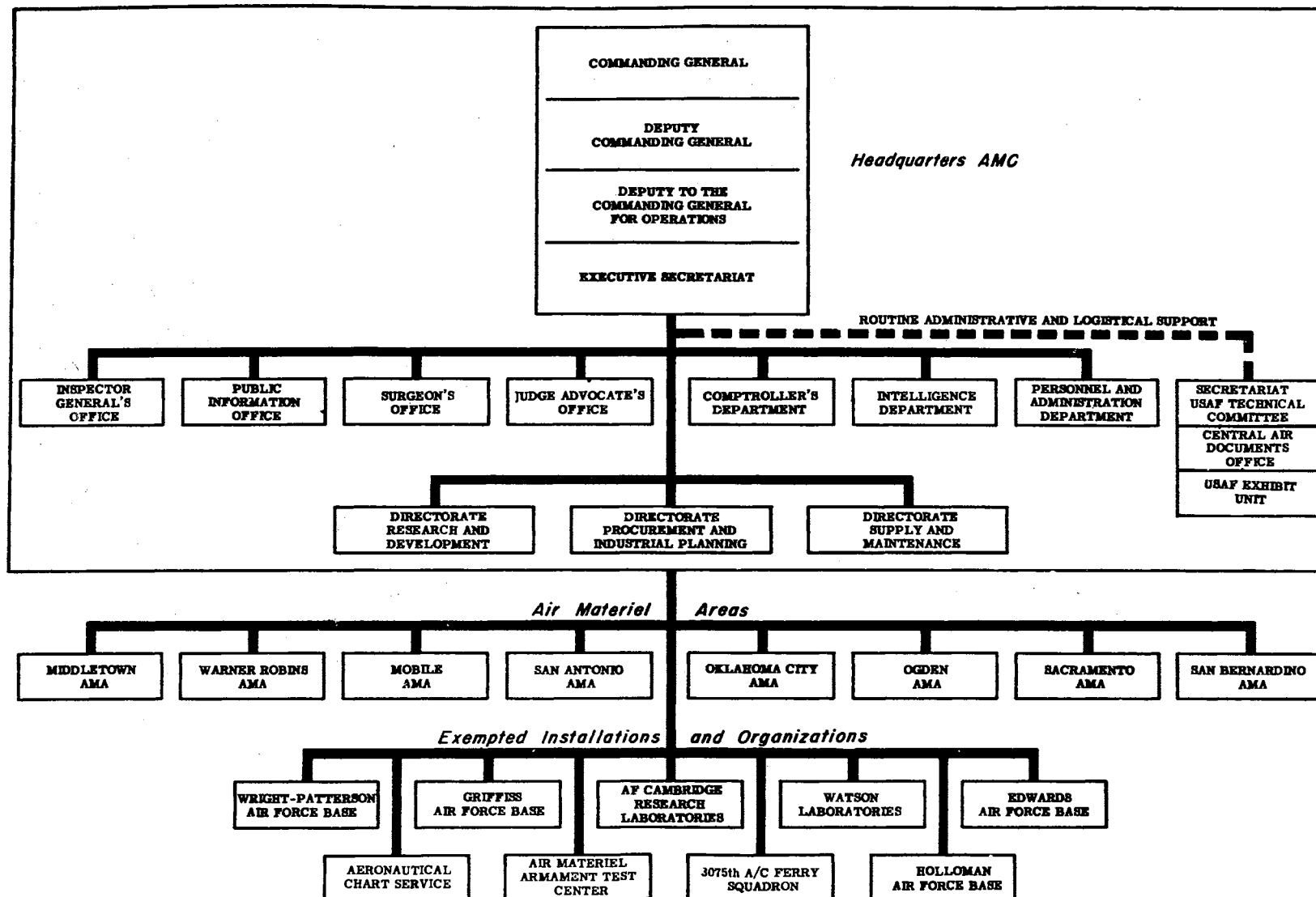


Figure 1



ORGANIZATION OF THE AIR MATERIEL COMMAND
Figure 2

Standardization, Classification, and Stock Control

Three basic tools help make this logistics system more efficient: standardization, classification, and stock control.⁷ Every supply procedure in the Air Force is either directly or indirectly affected by one or more of these procedures.

Standardization: Standardization is the keynote of any military organization.⁸ In the Air Force, for example, all airmen wear the same type of uniform.

Standardization is equally important in supply. The Air Force standardizes four important phases of supply: Supply personnel training, supply organizations, supply forms and procedures, and the supplies themselves.

Standardization of these aspects of the supply operation does much to make our supply system more flexible, economical, and responsive to the needs of the user.

Today, for example, the fuel-pressure warning light used on a small T-6 aircraft is interchangeable with that used on any other conventional aircraft in the Air Force. Rather than stock a different type of fuel-pressure warning light for every make and model of aircraft, it is necessary to stock only one type. Even with all this standardization of material, the Air Force still uses over one million different supply items.⁹ Without standardization, who can tell how many millions of items

⁷Air University, Supply - Course No. 120 (Montgomery, February, 1952), pp. 8-15.

⁸Headquarters, United States Air Force, Air Force Manual 67-1 (Washington, D. C., 1951).

⁹William J. Coughlin, "AMA: Supply at the Grass Roots Level," Aviation Week, Vol. 61-7 (August 16, 1954), 82-87.

would have to be procured, transported, stored, and issued? Standardization has done much to make this supply system simpler, more flexible, and easier to control.

Classification: The Air Force uses two systems to classify supplies; an Administrative Classification System to aid logistical planners at higher levels, and a Property Classification System to simplify storage, distribution, and issuance of supplies at all levels. The Administrative Classification System is made up of nine broad classes of supplies. This system is used by the Army, Navy, and Air Force, and includes all the supplies used by these services. The four classes which carry the letter "A" designate supplies peculiar to aviation.

At higher headquarters, the Administrative Classification System aids logistical planners in two ways: (1) it simplifies the computation of broad requirements, and (2) it simplifies the preparation of supply instruction for lower echelons.

The following example illustrates how the Administrative Classification System simplifies the computation of broad requirements. Experience shows that Class I supplies, which include rations, are used at the rate of 6.94 pounds per-man-per-day. If one knows the number of personnel involved in an operation one can quickly compute the number of tons of Class I supplies which will be required. This information is needed to estimate transportation and storage requirements.

The Administrative Classification System also simplifies the preparation of supply instructions. For example, logistical planners can state in their planning instructions that certain depots will handle Class II and Class IV supplies. This eliminates the need of listing the thousands of items that fall within each of these broad classes. Such a requirement

would expand supply instructions tremendously and would make them more difficult to follow.

The Property Classification System, used only by the Air Force, gives a much more detailed breakdown of supplies than the Administrative System. Under the Property Classification System, similar items are placed under each class or sub-class. For example, Class 15 supplies (aircraft instruments) are stored in one section of an Air Force warehouse. Within this section can be found 15 sub-classes such as 05C (aircraft flight instruments) and 05D (aircraft engine instruments). Under this system a warehouse clerk can go straight to the proper storage bin for a particular type of aircraft instrument. From this example, the reader can visualize how the Property Classification System aids in receiving, storing, issuing, and inventorying Air Force supplies.

This system is also a basis for identifying supply catalogs and technical orders. For instance, Supply Catalog (or stock list) S-01-D lists the parts included in Class 01-D (parts for Douglas Aircraft), and Technical Orders of the 01-D series contain the operating and maintenance instructions for these aircraft.

Stock Control: A third basic tool affecting Air Force supply is stock control. Stock control insures that sufficient supplies are on hand when and where needed and that stock levels are based upon actual need. Without stock control an organization may accumulate more supplies than it needs. This may result in a two-fold disadvantage: (1) the overstocked organization is tied down by its surplus supplies and becomes less mobile, and (2) other organizations are deprived of supplies which they need. Stock control, then, is that control over stock levels throughout the Air Force which assures that each unit is supplied according to its needs--no more and no less.

Accurate Stock Controls Essential to the Air Force

Effective stock control results in the maximum use of available supplies and eliminates purchase and storage of surplus stocks. Such control promotes economy, as well as increasing the mobility of Air Force units by preventing them from being burdened with excessive inventories. Finally, stock control helps insure that every organization will get enough supplies when and where it needs them.

These three tools--standardization, classification, and stock control, are the backbone of our supply system. Regardless of changes in the mechanics of supply procedures, these basic tools must always be applied. Whenever you find an efficient supply system, you know that it has some degree of standardization, some system of classification, and some method of stock control.

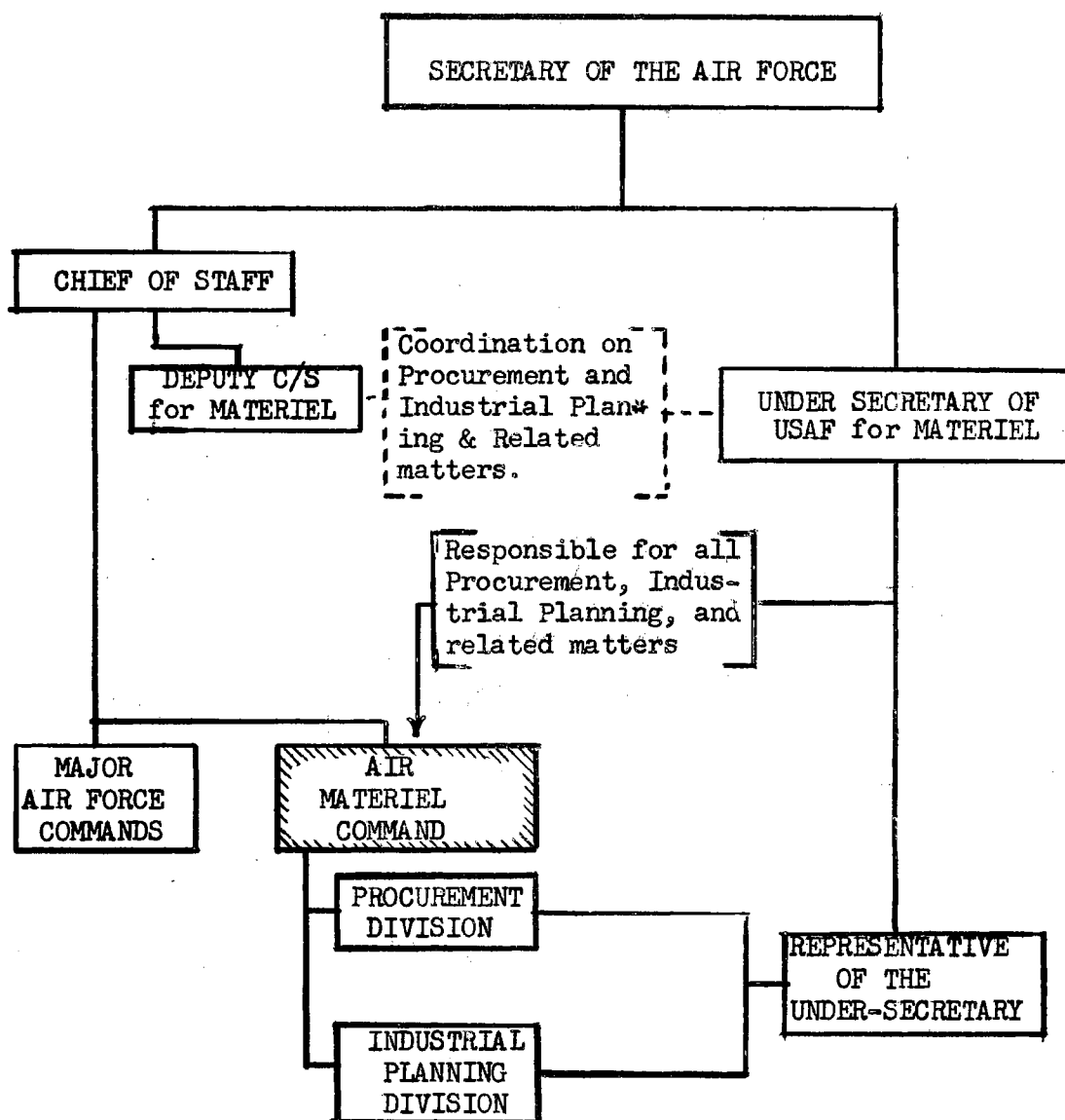
Logistics

To begin the logistics chain-reaction, we must first estimate our long-range materiel requirements for military operations. These estimates are made primarily by Headquarters, United States Air Force and Air Materiel Command planners, and are based upon (1) long-range plans prepared by the Joint Chiefs of Staff, (2) supply experience data that comes from the using units through a system of stock and supply control.¹⁰ Requirements must be determined before we can take the next step which is procurement. (See Figure 3).

Based on estimates of requirements, Air Materiel Command procures supplies for the using units. This is done by making contracts with industry.

¹⁰Air University, Logistics - Course No. 325 (Montgomery, 1949), pp. 29-35.

RESPONSIBILITY FOR PROCUREMENT & INDUSTRIAL PLANNING



Flow Chart indicating maximum assignment of responsibility for procurement, industrial planning, and related matters to the Air Materiel Command by the Secretary of the Air Force and Headquarters, United States Air Force.

Figure 3

SUPPLY FLOW CHART

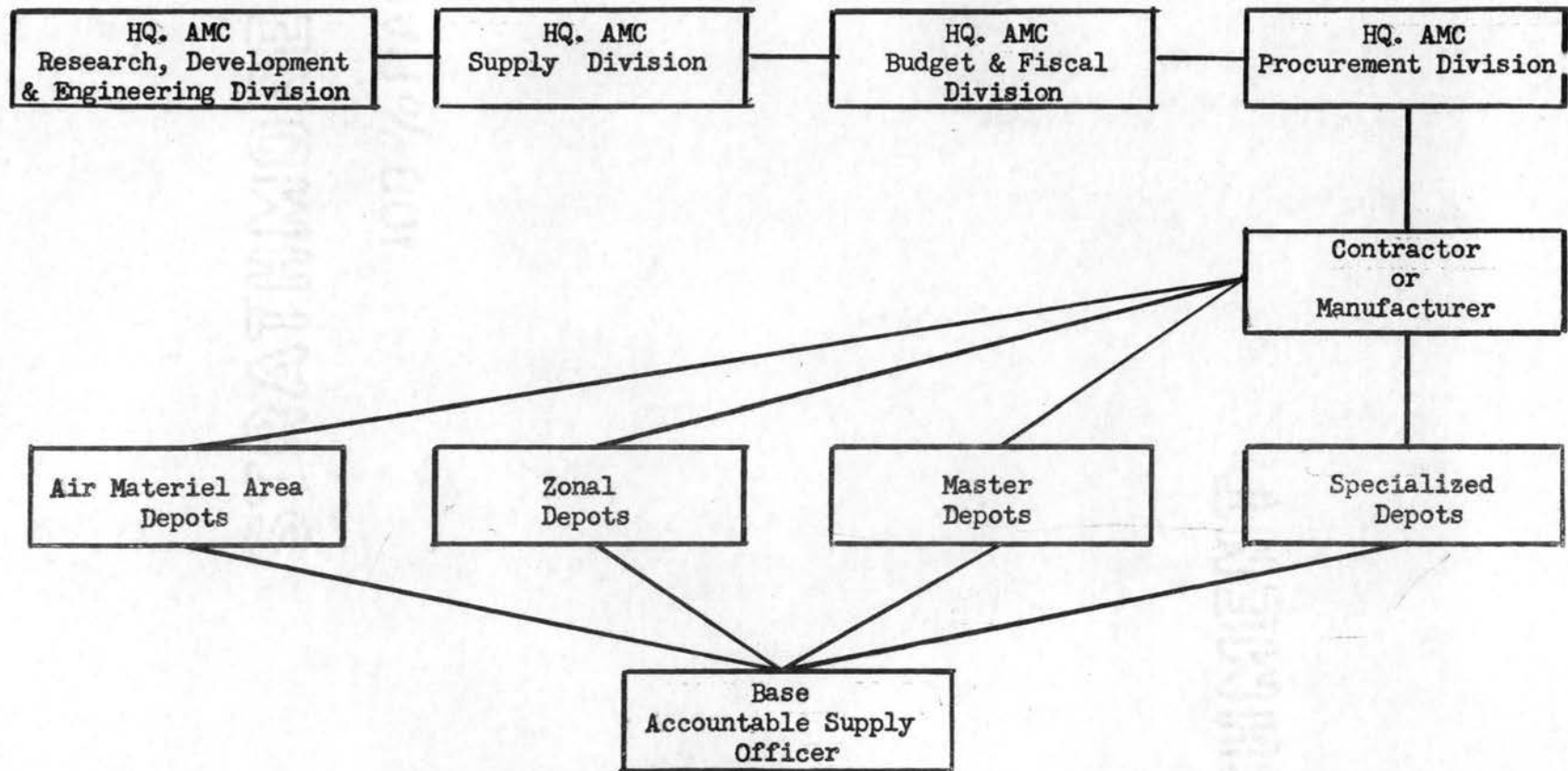


Figure 4

After supplies have been manufactured by industry, they are sent to the depots. This is the beginning of the distribution process. From the depots, supplies are shipped to using units.

Also entering the picture are maintenance and disposal. Maintenance at the various depots and bases repairs unserviceable equipment and returns it to storage so that it can again be placed in the distribution cycle. Disposal, on the other hand, removes supplies from distribution and disposes of them to the most economical advantage of the Government.

A system of stock control shows precisely what material has been used and what is still available. This system is operated by the Air Materiel Command. Stock control is an essential tool of management and helps insure control over all supply activities. Such stock control systems provide essential data for determination of requirements.

The main logistics tasks--determination of requirements, procurement, and distribution--depend one upon the other in logical sequence. Since a chain is only as strong as its weakest link, all of these tasks must be continually coordinated if our logistics system is to function effectively and economically.

CHAPTER II

UNITED STATES AIR FORCE LOGISTICS TODAY

Background for Present Logistics System Used by the United States Air Force

The system which supported the Army Air Forces in World War II consisted of twelve Air Materiel Area (AMA) depots which gave support to the bases within their areas.¹ For certain critical items of equipment these area depots were backed up by specialized depots located near the manufacturer. The area depots served the supply needs of all units within their respective boundaries, and the specialized depots acted as reserve stock points to replenish area depot stocks on critical or special items. Fundamentally, this was a general-depot system, and it carried all the disadvantages of the general concept. Since each area depot carried many of the same items, there was wasteful duplication of items in storage. Since many items passed from the manufacturer to the specialized depot and then through the area depot on their way to air bases, there was an unnecessary handling step between the manufacturer and the base. Because the total Air Force inventory of a particular item was divided between many depots, the level of supply at any one depot was frequently inadequate to give uninterrupted supply support to the bases. In December 1947, for example, nearly thirty-five

¹Air University, Supply - Course No. 210 (Montgomery, 1949), p. 5.

per cent of all items requisitioned from certain area depots were marked "not in stock" and had to be extracted or reordered from other area depots or from specialized depots.² Thus the area depot was a bottleneck for approximately thirty-five per cent of our total supply distribution.

Present Air Force Logistics System

Under our present system, the United States is divided into an eastern and western zone for supply and maintenance purposes. (See Figure 5). The Mississippi River and the eastern boundary of Illinois and Wisconsin form the dividing line between the two zones.

In a broader concept we can see that this line actually divided the world into two zones. The eastern zone supplies our European, African, and Near East bases; and the western zone our bases in the Far East, Alaska, and the South Pacific.

Each zone in the United States is further divided into Air Materiel Areas; the western zone has five such areas and the eastern zone three.

With few exceptions, each zone can completely supply and maintain Air Force units within its boundaries.³ This support is provided by a system of depots which are specialized in nature. Generally only one depot in each zone carries a particular class or item of supply. For example, in the United States, parts peculiar to F-84 aircraft are stocked in only two depots—one in the eastern zone (Mobile, Alabama) and one in the western zone (Ogden, Utah). In the eastern zone, F-84 units must requisition parts from Mobile, while such units in the western zone must get theirs from Ogden.

²Logistics Data from Statistical Services, Tinker Air Force Base, Oklahoma.

³Air University, Air Force Supply - Course No. 120 (Montgomery), p. 23.

The map displays the following regions and bases:

- SMAMA**: Southwest region, covering California, Nevada, and Arizona.
- SBAMA**: Southwest Base, located in Arizona.
- OOAMA**: Northwest region, covering Washington, Oregon, Idaho, and Montana.
- OCAMA**: Northwest Base, covering Wyoming, Colorado, and New Mexico.
- MAAMA**: Northeast region, covering the Northeast and Midwest.
- WRAMA**: Southeast region, covering the Southeast.
- MOAMA**: South region, covering the South.
- SAAMA**: Southwest Base, located in Texas.

Other labels on the map include state names (e.g., WASH., ORE., CALIF., NEV., IDAHO, MONT., WYO., N. DAK., S. DAK., MINN., IOWA, KANS., COLO., UTAH, NEBR., NEB., KANS., OKLA., TEX., ARIZ., N. MEX., ARK., MISS., ALA., GA., S.C., N. CAR., VA., MD., PA., N. J., N. Y., V.T., N.H., MASS., CONN., R.I., CT., DE., N.C., S.C., GA., FLA.), city names (e.g., WASH., ORE., CALIF., NEV., IDAHO, MONT., WYO., N. DAK., S. DAK., MINN., IOWA, KANS., COLO., UTAH, NEBR., NEB., KANS., OKLA., TEX., ARIZ., N. MEX., ARK., MISS., ALA., GA., S.C., N. CAR., VA., MD., PA., N. J., N. Y., V.T., N.H., MASS., CONN., R.I., CT., DE., N.C., S.C., GA., FLA.), and military installations (e.g., Hq. AMC, Brookley, Kelly).

USAF IN EUROPE

FAR EAST
AIR FORCES

CARIBBEAN
AIR
COMMAND

16

As a rule depots within a zone do not carry the same classes or items of supplies; yet, collectively, all the depots within one zone carry all items of supply. Therefore, an Air Force unit can usually fill its supply needs within its own zone.

What happens when a zonal depot cannot fill a requisition from its stock?

The following example illustrates the answer to this question. An air base in the western zone needing a part peculiar to F-84 aircraft will send a requisition to Ogden. If the part is not available at Ogden, then Ogden checks to see if any base in the western zone has a sufficient stock to supply the request. If the part cannot be located in the western zone, Ogden sends the request to the appropriate eastern zonal depot (Mobile). If Mobile has the part, it will fill the request.

If the part is not available in either zone, who is responsible for further action? The Air Force has solved this problem by assigning control responsibility over the property class in which the part falls to one of the depots stocking it. This depot is called a prime depot. Prime depots have been assigned for each property class. Their responsibility includes expediting delivery from the contractor, monitoring world-wide stock balance and consumption, determining requirements, and effecting procurement. Prime depots, however, do not procure equipment requiring extensive engineering such as airframes, propellers, and property furnished a contractor by the government--machine tools, for example. These items are procured by Headquarters, Air Materiel Command.

The depot in the opposite zone which stocks the property class containing the F-84 part is called the opposite depot. The opposite depot supplies its zone with this property class and communicates with the prime depot on all matters concerning the class. For example, if

the stock level for the F-84 part reaches the warning point (specified minimum stock level), the opposite depot notifies the prime depot which in turn takes action to replenish the stock.

In the example concerning F-84 spare parts, Mobile is the prime depot and Ogden the opposite. If the F-84 part could not be located in either zone, Mobile, as prime depot, would contact the manufacturer (if the parts were on contract) and request him to expedite delivery. Should the part not be on contract, Mobile would notify Headquarters, Air Materiel Command. Ordinarily Air Materiel Command would let a contract with the manufacturer to bring the balance of F-84 parts at Ogden and Mobile back up to authorized level. However, if procurement responsibility had been assigned to Mobile (the prime depot), it would take procurement action. For most classes of property, prime depots have procurement responsibility.

Because of the warning point system, zonal depots rarely run completely out of a supply item. When the stock reaches the warning point, the prime depot immediately takes action to purchase additional quantities unless procurement responsibility has been retained by Headquarters, Air Materiel Command. In this case Headquarters, Air Materiel Command is notified and takes purchase action.

A zonal depot might be the prime depot for one property class and the opposite depot for another class. For example, Mobile in the eastern zone is the prime depot for F-84 parts and is the opposite depot for F-86 parts.

In almost all cases, maintenance is the responsibility of the depot that stocks a particular class or item of supply, whether it be a prime or opposite depot.

Each Air Materiel Area (AMA) depot provides technical and administrative supply and maintenance assistance to installations in its area. For

example, if Vance Air Force Base, which is in the Oklahoma City Air Materiel Area, has an administrative supply problem, it requests assistance from the Oklahoma City Air Materiel Area depot. Oklahoma City is then responsible for satisfying Vance's needs.

The two-zone supply and maintenance system is modified when it can be made more economical and efficient. One such modification is that of the base point supply system. It was recognized that certain Air Force activities located near the zonal boundary could requisition certain supplies more efficiently and more economically from a depot in the opposite zone than from the prescribed zonal depot. With the base point supply system modification, selected activities can requisition from the depot that can give the most efficient supply support.

The effect of the two-zone distribution system has been to centralize our supply activities. The entire system is under the operational control of Air Materiel Command. This agency establishes depots, determines what classes of supply they will stock, and sets up operating procedures. Air Materiel Command operates the depot system within the framework of the policies of the Deputy Chief of Staff for Materiel, Headquarters, United States Air Force.

The advantages over the old area depot system are four. First, since only one depot in each zone carries any one supply class, the two-zone system reduces duplication in storing and handling of supplies.

Second, time is no longer wasted searching through our entire distribution system for an item not in stock at a particular depot. If a depot in one zone is out an item, it can usually be found in a depot in the opposite zone. There is no other depot to which to go.

Third, a more direct manufacturer-to-consumer flow of supplies has been established. Supplies now move from the manufacturer through a

zonal depot to the Air Force installation. Under the old area system, many supplies flowed from the manufacturer through a specialized depot, then through an area depot, and at last to the Air Force installation.

Finally, under the two-zone system, we have better control over distribution. This control has been centralized in one depot, the prime depot. Besides the advantages of the present Air Force distribution system over the systems used in the past, it also provides for economy, security, future expansion, as well as strong management and planning control.

Distribution Controls

Control over distribution is based on: (1) providing physical inventories at least once each year, (2) securing stock balance information every six months, and (3) providing a warning system when stocks fall below minimum levels.

Distribution control is maintained primarily through stock balance and consumption reports. These reports show how many supplies each base consumes and the balance on hand. Stock balance and consumption reports originate at base level, are processed through area depots to prime depots, and finally go to Headquarters, Air Materiel Command. The prime depots use these reports to see that supplies are distributed to bases according to need, and as a basis for master repair schedules. Headquarters, Air Materiel Command uses these reports to help determine future materiel requirements and to estimate the Air Force budget.

Another example of control is the Supply Effectiveness Report which shows the percentage of items furnished by an Air Force depot against requests presented to it. This last report reveals areas where supply action is weak by indicating which depots are failing to meet their support responsibilities.

CHAPTER III

AREAS FOR IMPROVING UNITED STATES AIR FORCE LOGISTICS

Size and Economy

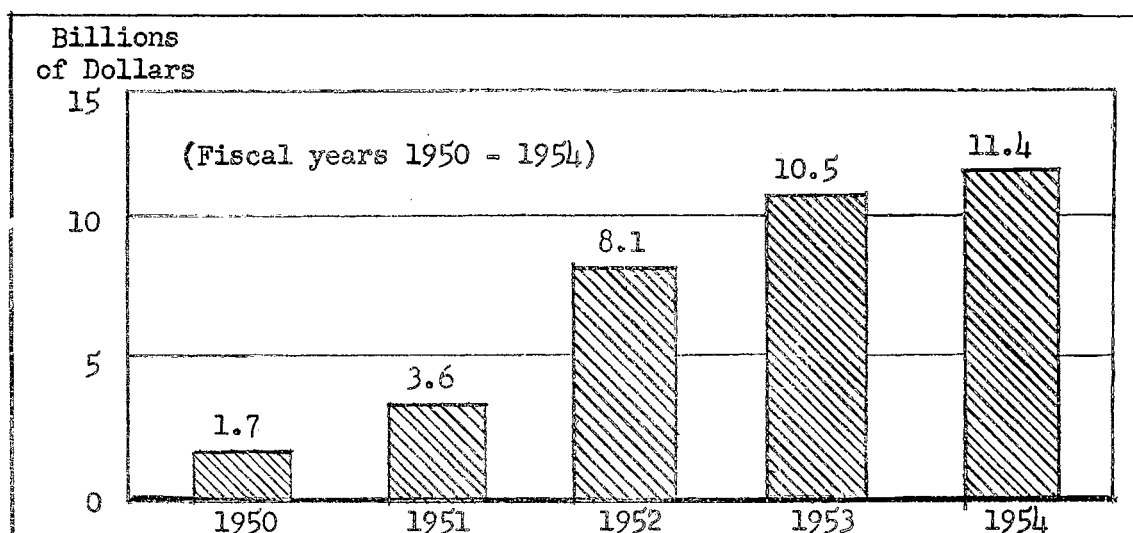
A study of economics reveals that organizations increase in efficiency with growth, but that a definite maximum point is reached for each type of organization after which average costs begin a steady increase. This decrease in efficiency is determined by many factors, one of which is the limitations of effective leadership.¹ According to Barnard, the leadership limitations depend upon the complexity of purpose and technological conditions: the difficulty of the communication process, the extent to which communication is necessary, and the complexity of the personal relationships involved.

From a study of the Air Materiel Command it is possible that one may conclude the Air Materiel Command has grown far past the optimum point. Air Materiel Command operates the largest business in the world within a framework of legislative and regulatory restrictions that would doom most civilian management to frustration and bankruptcy. Air Materiel Command has total assets of \$30 billion, \$6 billion more than the combined total assets of the two largest private corporations in the country.²

¹C. I. Barnard, "Functions of the Executive," Harvard Press, 1953, p. 107.

²Robert Hotz, "AMC Streamlines Management Pattern," Aviation Week, August 16, 1954, p. 72.

During 1954 Air Materiel Command spent \$11.4 billion of which more than \$8 billion bought weapons systems (combat aircraft fully equipped with supporting materiel) and hardware required by the United States Air Force.³ In the past four years, Air Materiel Command has spent over \$25 billion to buy modern combat aircraft for the under-strength United States Air Force. At the present time on its procurement books, Air Materiel Command carries contracts with hundreds of firms for future delivery of \$17 billion worth of United States Air Force equipment.



AIR MATERIEL COMMAND EXPENDITURES

Figure 6

But, Air Materiel Command is not a "bachelor." It is the provider for the world's largest family - the various commands of the United States Air Force. It is spread around the world - serving every unit wherever the location may be.

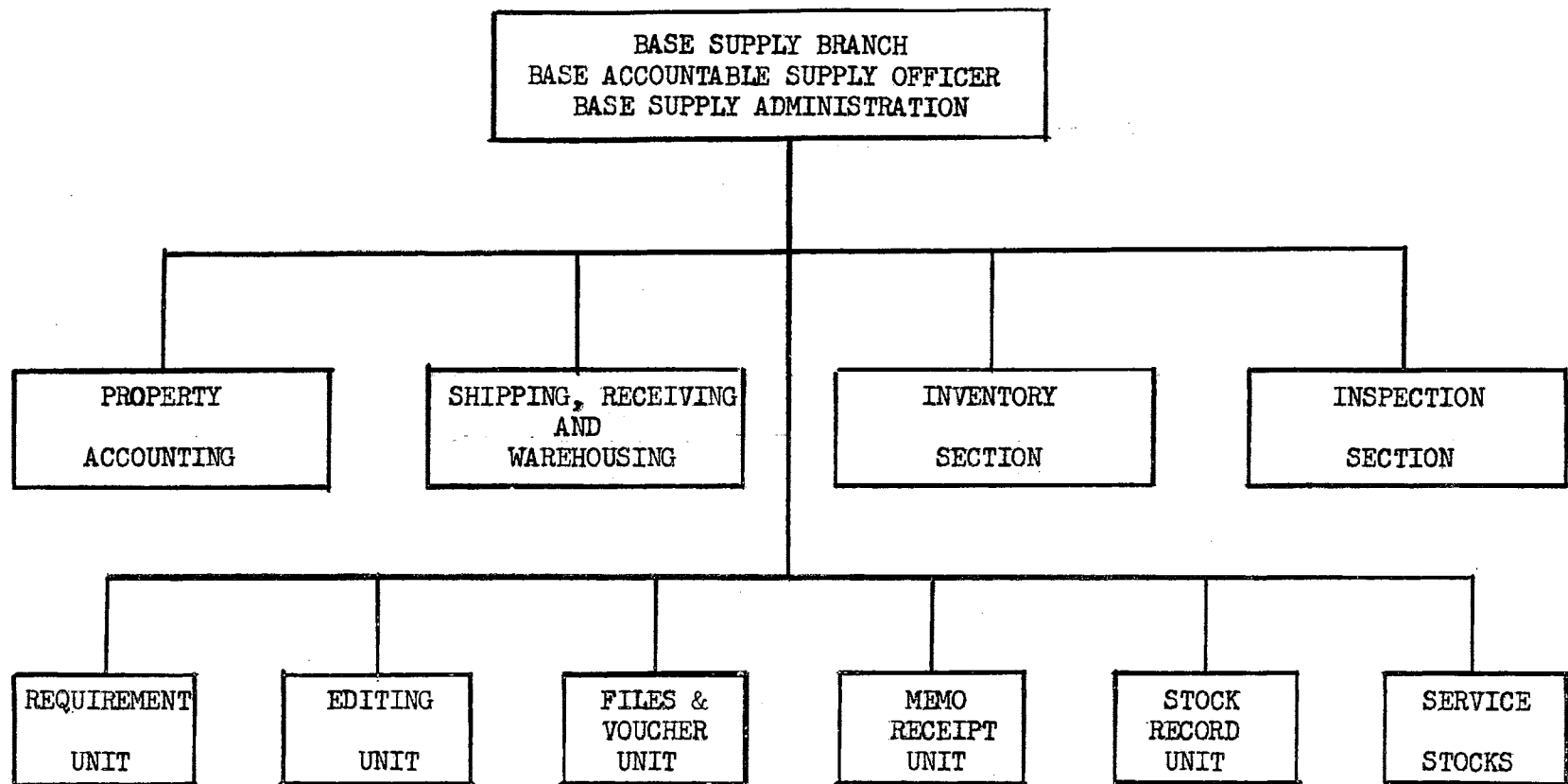
³Ibid., p. 72.

Communication Problems

Due to the vastness of Air Materiel Command operations, both in quantity and location of materiel, a mammoth task is faced by management in obtaining accurate information on various operations and inventories. Reports and papers are prepared by organizations of all sizes and at all locations, then channelled into Headquarters, Air Materiel Command. Log-jams occur in reports which curtail consolidation of information. The chain-of-command routing of correspondence, reports, and data requires from ten days to over three months to find its way to Air Materiel Command. By this time much of the data is obsolete or useless.

The Oklahoma City Air Materiel Area (OCAMA) located at Tinker Air Force Base, as an example, prepares over 2,000 reports a month of which approximately 90 per cent are forwarded on to Air Materiel Command. The information for preparing these reports is not readily available at Oklahoma City Air Materiel Area. All air bases in the western part of the United States, the Pacific Ocean area and the Far East which procure equipment from Oklahoma City Air Materiel Area must send in their reports before Oklahoma City Air Materiel Area can complete their reports.

Since World War II the Oklahoma City Air Materiel Area has made great strides in improving the communications necessary to carry on an efficient business. International Business Machines punch card machines have been installed throughout the system. However, the punch card method is still far too slow, expensive, and subject to a great degree of error. At present Oklahoma City Air Materiel Area punches 9,875,000 cards per month, therefore, has on hand many times this amount. The physical handling of all these cards imposes a back-breaking task upon the statistical systems office. Sorting of these tons of cards is a



ORGANIZATIONAL CHART
BASE SUPPLY BRANCH

Figure 7

never-ending task—24-hours a day, seven days a week. Even with this schedule, the statistics branch never catches up completely with the workload. What would be the situation were war to begin?

Management Information

The commanding general and his staff at Headquarters, Air Materiel Command has prime responsibility for carrying out the Air Force logistics mission. Upon this top-management's shoulders rest the materiel capability of the combat potential of the fighting United States Air Force commands. For Air Materiel Command management to function and plan efficiently, it must rely upon accurate, essential, and current data regarding world wide Air Force logistics. The degree of success achieved in gathering and presenting this information has a direct relationship upon the validity of decisions rendered by the management in directing Air Materiel Command logistics business.

Supplies are not consumed at a constant rate due to seasons of the year, military maneuvers, changing types of equipment, varying world wide military activities, fluctuating Congressional appropriations, and other factors. Yet, Air Materiel Command must determine requirements, issue procurement contracts, and make distribution of equipment within the world-wide network. As has been already mentioned, reports reaching Air Materiel Command are based upon facts 90 to 100 days old. Air Materiel Command can only read its history - not its present status. From this information decisions are made - many right, but too many wrong. To avoid or reduce the possibility of buying too small a quantity of an item (because procurement is based on old data) a margin-for-error is added. This margin is sometimes too small but most of the time too large. The results from either type of variance are obvious. The

overstocking which usually results from adding a safety-factor to an estimate, is tremendously expensive. It results in excess inventories, overcrowded warehouses, unbalanced stocks, and eventual disposal of obsolete but expensive new materiel, not to mention shortage of funds for many badly needed items.

Another area where up-to-the-minute information is needed is in the aircraft--both on the production line and in operational use. The last aircraft of a series, for example the B-36, is quite different and much improved over the first one off the assembly line. The process of improving the series is called Aircraft Configuration Control. For Air Materiel Command to perform its function properly, all data from engineering testing, operational flying, aircraft accident reporting, maintenance repairing, and research engineering must be gathered, sorted, and evaluated. Next, the changes are given to the manufacturer who programs them into the production line.

All this may sound simple but the mass of data is overwhelming, making accurate decisions almost impossible. The Oklahoma City Air Materiel Area reports that over 450,000 changes have already been processed on the B-47 and B-52 aircraft alone. All aircraft maintained by Oklahoma City Air Materiel Area have had 2,500,000 changes made, with another 4,000 changes per month coming along.

Time required to process this information by conventional means renders management unable to evaluate data and make prompt decisions. Thus, changes which should be made on the production line must presently be made later in a modification center. Prompt availability of data could eliminate this wasteful lag in initiating needed alterations.

Administrative Dilemma

In 1776 when the embattled citizen-soldiers of Portsmouth, New Hampshire needed an emergency shipment of gunpowder, they sent a horseman with a requisition to Boston, where General Artemas Ward promptly supplied the powder from the commissary.⁴

It took the rider a full day to cover the 57 miles from Portsmouth to Boston, and it took two and one-half more days for wagons to haul the gunpowder from Boston to Portsmouth. The average speed at which the gunpowder moved toward the Portsmouth citizen-soldiers after they first sent out their call was about one and one-third miles per hour.

Today, fast trains, trucks, ships and airplanes, instead of wagons, bring the supplies from the depot to the combat zone. Yet, it took an average of 106 days during the later phases of World War II for a combat commander in Germany to requisition and obtain an item from the United States. The average speed from requisition to delivery was about 3 1/2 miles per hour. Thus, in the past 175 years, with all the advantages of modern transportation we have increased the speed of getting supplies to the front by only two miles per hour.

What is the friction in the system which slows down the supply movement? The greatest time consumers involved in getting materiel to the field commander who requires it are statements of requirement by user, requisitioning, transportation, transient storage, and issue. Personnel in the Logistics Systems Office at Oklahoma City Air Materiel Area state that studies show 80 per cent of the time consumed is required for information flow. The other 20 per cent of the time represents materiel flow.

⁴Air Materiel Command, Logistics Planning Booklet (Wright-Patterson Air Force Base, Ohio, 1955).

Materiel accounting is a tremendous problem. It is an area where paper-work sprouts like fungus. Recent manpower surveys at Oklahoma City Air Materiel Area produced the startling fact that approximately 55 per cent of the 20,000 civilian employees working there have a primary duty of handling paperwork. The results of their work are essential to the logistical system, however, when machines are obtained which can yield the same results, these people can be employed in more productive undertakings.

CHAPTER IV

UTILIZATION OF ELECTRONIC DATA PROCESSING MACHINES TO MODERNIZE UNITED STATES AIR FORCE LOGISTICS

Mechanization in Industry

In the factories, where mechanization first began, operations performed over and over again in a similar manner were quite obvious and machines were built to speed up the process. Examples of these machines were the drill press, lathe, and milling machines.¹ Mechanization to speed up the processing of paperwork has followed. Electronic data processing machines can compare, make logical decisions, make selections, add, subtract, multiply, divide, read, write, and perform other functions, such as "remember," all at the same time.² The vast power of this new equipment is achieved by combining an advanced and highly integrated storage medium with the tremendous computing speeds of electronics. This is not a single-purpose machine, nor one-of-a-kind, but a tremendously versatile device actually in quantity production, which although designed principally for defense projects, has innumerable peacetime applications relating to engineering, research, and science. This, then, is an introduction to the International Business Machines

¹Rey W. Brune, "Automation," United Press (Detroit, Feb. 28, 1954).

²R. S. Erickson, "The Logistics Computer," I. R. E., Vol. 41-10, October, 1953.

Model 702 electronic data processing machine (EDPM), which has been installed recently at Tinker Air Force Base, Oklahoma City, Oklahoma.

General Description of Electronic Data Processing Machine Equipment at Oklahoma City Air Materiel Area

The International Business Machines Model 702 consists of versatile units merged into a flexible, high-speed system. The complete series of operations required for any data handling task can be performed. Fast input and output units, large capacity electrostatic memory, and complete automatic control are characteristic of the equipment.

Magnetic tape input-output units permit masses of data to rapidly enter and leave the internal memory of the machine. Permanent files of records may be stored on magnetic tape at a great reduction in file space requirements.

Card reading and card punching units offer an alternative means of input and output. Cards presently serving other areas of a business can thus be incorporated readily into model 702 procedures.

For preparing final reports, line printers are used. Line printers write reports directly from the 702, or may be used independently with tape units as tape operated printers.

All functions of the operating units are displayed on an operator's console, enabling the operator to inspect and observe any stage of procedure at will. A further operational aid is a typewriter printing unit which permits communication from the machine to the operator.

Data processing requirements vary from business to business and application to application. Length of record, volume, ratio of input and output to processing, and the format of documents are examples of such variation. These variations are balanced in the 702 because of the



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TOP SECRET

functional-unit principle employed. The number of individual card readers, tape units, card punches or printers is determined entirely by the work to be performed, providing great flexibility.

For the first time in the history of office mechanization, the amount of information which may be taken from original records is virtually unlimited. The number of characters per field and per record is not limited by arbitrary capacity standards.

The storage of information on magnetic tape is extremely compact. A reel of tape can store the data contained in 25,000 punched cards of 80 columns each, the equivalent of 8 card-file drawers. Tapes can be reused, since old information is automatically erased during a new recording.

The 702 can accommodate any combination of numerical, alphabetical, and special characters with equal facility in all reading, writing and processing functions.

The stored program is an important underlying principle of the 702. This means that all instructions for a given procedure are contained in the memory of the machine or on the drum. These instructions are referred to, one at a time, in the proper sequence required for handling each problem. Each instruction not only specifies the functional operation to be performed; it also directs the results into appropriate channels. Provision is made in programming for alternative routines where the logical elements of the machine choose between two separate courses of action. Thus, in ascertaining that a calculated result is a minus figure, the 702 can select program steps appropriate only to the minus figures, ignoring these when plus results are obtained.

At the start of each procedure, the program instructions is read into memory from tape or cards and is stored there for use with each

record processed. This one entry of instructions suffices to set up all units, as all are controlled from the stored program. Changes from one procedure to another, or within a program, are readily accomplished.

The arithmetical and logical unit of the 702 has been made compatible with the variable field capacities of magnetic tape. The time consumed in calculating is measured in millionths of seconds and full advantage is taken of the important feature of using less time for smaller fields than for larger ones.

Accounting controls are an integral part of any data processing system. Not only can established control procedures be fully protected by the 702, but because of the logical ability of the system, inconsistencies in source information can be detected. Corrective routines to handle these discrepancies may be planned and incorporated in the stored program. The flexibility of the 702 permits the programmer to select the method of verification.

For example, determination of a discrepancy in source data can result in the machine stopping, noting the facts through written instruction on the typewriter, repeating the process in question, or correction in a variety of additional ways.

Accuracy is further safeguarded through automatic checking devices which keep data transferred within the system under constant electronic scrutiny, and permit the same kind of corrective routines to be applied.

To insure maximum flexibility and utilization, the input-output devices have been designed so that they can be combined with one another independently of the 702 to provide a wide range of auxiliary equipment.

The following examples illustrate the versatility of these units: A tape unit can be combined with a card reader for converting cards to

magnetic tape. Conversely, the same tape unit can be connected to a card punch to create cards from tape. The printer can be used in connection with a tape unit as a tape operated printer. In this way, operations not requiring the arithmetical and logical ability of the 702 can be performed separately, reserving the main unit for more vital operations.

Electrostatic memory is the principal storage medium in the 702. Information is recorded in the form of electrical charges on the face of a cathode ray tube. This is the same basic type of tube as the picture tube in a television set, but highly refined by extensive International Business Machines research to meet data processing requirements. This tube is considerably smaller than a television tube and the "picture" it stores is a pattern of dots and dashes. These dots and dashes represent characters in the same way as the fields in magnetic recording.

Electrostatic storage is one of the fastest storage mediums, operating in a few millionths of a second. It is capable of "random access" which means that the electronic beam which reads and writes on the face of the tube can go directly to any given section of storage without having to scan the entire tube in a fixed sequence; thus, 10,000 characters may be stored in this manner and can be located at the rate of twenty-three millionths of a second per character.

The accumulators are provided, each with a capacity of 512 character positions. The function of accumulators is to store temporarily portions of the contents of electrostatic memory and the intermediate results of computation. Operations may then be performed on the contents of accumulator storage without altering the original field or fields which remain in memory.

The Arithmetical and Logical Unit (ALU) is the calculating heart of the 702. Not only is it capable of addition, subtraction, multiplication

and division, but it also can perform any desired combination of these basic computations. The "logical" ability to make decisions is centered here. By being able to distinguish between positive, negative and zero values, and by the ability to make comparisons, the Arithmetical and Logical Unit determines the paths that results follow.

Information is received from memory and processed according to instructions received from the stored program. Results are routed to accumulator storage for further operations or to sections of memory, depending on the instruction.

The large storage capacity of electrostatic memory will suffice for many applications. In those cases where the nature of the work requires additional storage capacity, magnetic drum units can be added to the 702. Data are recorded on the surface of a drum in the form of magnetized spots. Revolving at high speed, the drum surface can be scanned at the rate of 1,500,000 characters per minute. The capacity of each drum is 60,000 characters.

Information recorded on oxide-coated cellulose acetate tape in the form of magnetized spots is read or recorded at the speed of 900,000 characters per minute. The density of recording is 200 characters per inch. Tape units can be used for either reading or writing.

A reel is 10 1/2 inches in diameter and holds 2400 feet of tape. Normally tape is fed in a forward direction, under program control. The tape may be back-spaced to any section and re-read. Rewinding can be automatically programmed or can be set for operator control. Only 1.2 minutes are needed to rewind a complete reel. Loading and unloading of tape reels is a simple operation requiring an average of 45 seconds.

Data "spots" are spaced in seven parallel channels or "tracks" along the length of the tape. Each character is represented by two or more magnetized spots. The coding system employed provides that there is always an even number of spots to represent each letter, number or symbol. These patterns are under constant inspection for validity.

The characteristics of magnetic cores permit their use in a highly advantageous way with input-output units. These cores provide intermediate storage of data between input-output and the main units. Data flow is thus synchronized for entering and leaving the 702 at the highest possible speed. This type of storage allows reading and writing functions to overlap the electronic speed of data processing.

Alphabetical, numerical, or symbolic data can be read at the rate of 250 cards per minute. The versatility of the individual units is illustrated by the use of card readers with either the 702 or with tape units. In the latter case, the information on cards is converted to tapes independently of the 702.

Results can be printed at the speed of 150 lines per minute per printer. A new printer which prints 1,000 lines per minute has been ordered by Oklahoma City Air Materiel Area. The printers have 120 type wheels, each equipped with 47 alphabetical, numerical and special characters. Results to be printed directly from the main unit are transferred to temporary storage at electronic speed so that the main unit can continue its processing while printing is taking place.

Alphabetical, numerical or symbolic data are punched at a speed of 100 cards per minute. Punches may be used as direct output units or with tape units as independent tape-operated punches.

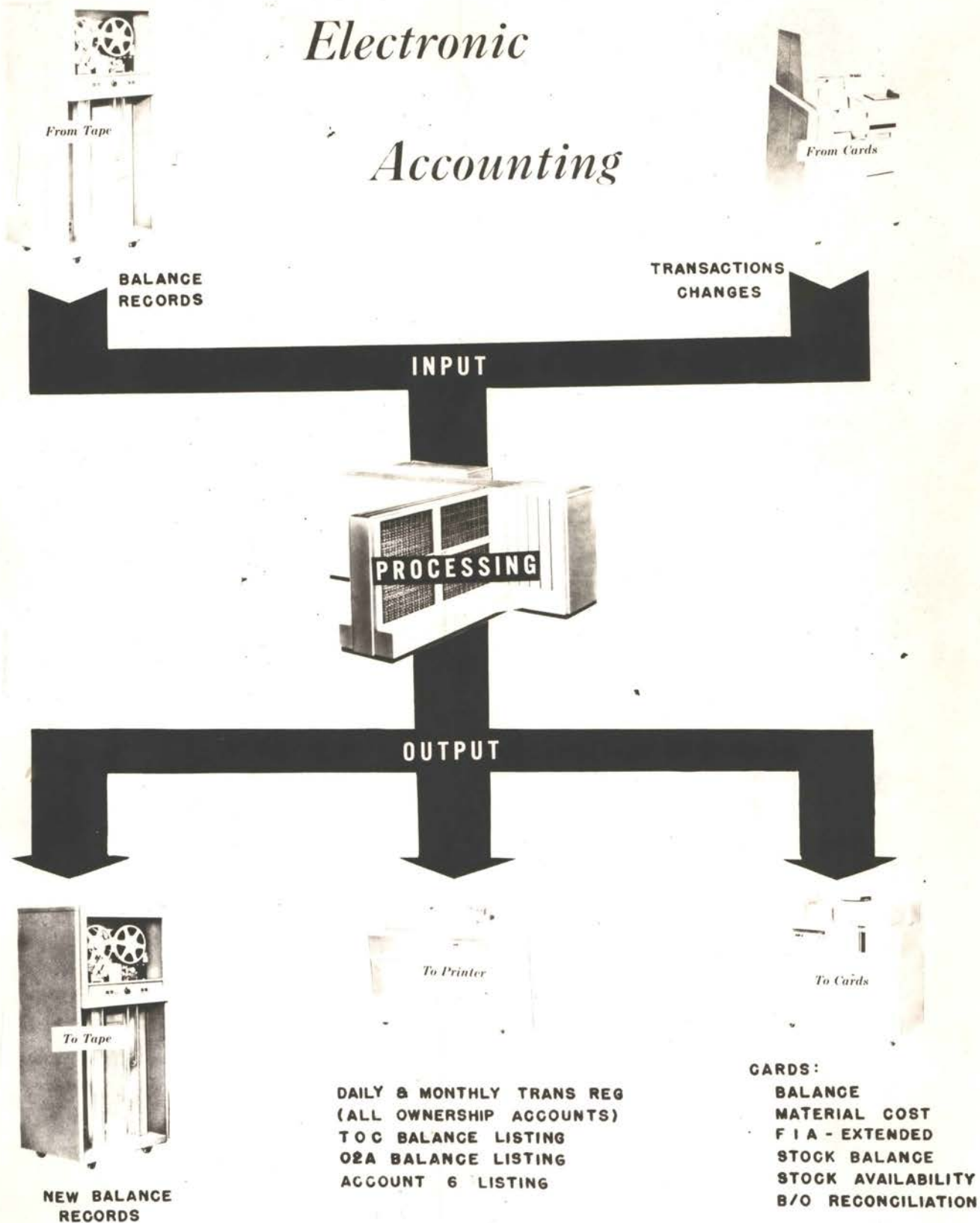


Figure 9

The 702 was developed after intensive study of the requirements of International Business Machines Department of Defense, and of certain large commercial customers. Each step in its design was carefully planned not only from an engineering and production point of view, but from the standpoint of the ultimate user as well.

The result is a system of equipment which has been explored for a variety of applications. Many business organizations have made invaluable contributions. Millions of man-hours were devoted to perfecting equipment that has the inherent ability to process a wide variety of information.

This thoroughly reasoned approach has established the fact that the 702 can be applied to present accounting functions, and in addition, for the first time many new areas of office operation can be mechanized.

CHAPTER V

APPLICATION OF ELECTRONIC DATA PROCESSING EQUIPMENT TO AIR FORCE LOGISTICS MANAGEMENT

Background of Present Logistics Research and Planning

The program of the Air Materiel Command for mechanizing Air Force logistics management and related activities is divided into two phases: First, installation of existing electronic data processing equipment at several depots and bases for experimental and training purposes. Second, development of an ultimate system for Air Force logistics control and fiscal accounting and the specification and procurement of equipment to meet the requirements of this ultimate system.

In April, 1955, as a part of the first phase of the Air Materiel Command program, International Business Machines submitted a proposal for furnishing Electronic Data Processing Machine 702 equipment for mechanizing present logistics management activities at the Oklahoma City Air Materiel Area (OCAMA). Personnel of Oklahoma City Air Materiel Area and of Headquarters, Air Materiel Command have been familiarized with International Business Machine 702 equipment and with the techniques of International Business Machines as developed for planning the application of electronic data processing equipment. Provision of continuing assistance at Oklahoma City Air Materiel Area and elsewhere as required in preparing definite plans for the early mechanization of clerical operations is a portion of the International Business Machines proposal just mentioned.

In addition, International Business Machines representatives have been working closely with the Logistical Systems Office of the Air Materiel Command on the development of the ultimate system for Air Force logistics management and fiscal accounting which constitutes the second phase of Air Materiel Command's program.

Proposed Utilization of Electronic Data Processing Equipment

The ultimate Air Force logistical management system must be comprehensive. This system must be comprehensive because:

It encompasses all materiel that is procured, stocked and used by the Air Force, any place in the world.

It controls and accounts for this materiel from the time it first comes under the cognizance of the Air Force until it is dropped from accountability, by sale, transfer to another agency, destruction or usage.

It supplies all records, reports and other documents pertaining to Air Force materiel, including usage experience, budget estimates, procurement requisitions, accountability records, stock control records, and the necessary documents to transfer materiel from one organization to another within the Air Force.

This is of course, a large undertaking, but one that is entirely within the capabilities of modern data-handling and communication equipment. Anything less will leave the Air Force with two or more partially duplicating clerical systems with resultant delay and excessive costs.

Speed of Equipment

A military supply system, and especially an Air Force supply system, must be extremely fast in its operation.

As Air Force personnel and airline officials have repeatedly pointed out, materiel can be physically moved between any two world-wide locations in a matter of hours. Need for the materiel and its present location must, in emergency, be made known in a matter of minutes. The necessary paper work to effect and record the transfer must not in any way delay the physical movement of the materiel.

Under present clerical methods, there is no possible way to attain such speed in any formal or orderly manner. Emergencies have to be met by informal, emergency methods, outside of regular procedures with serious risk of resulting loss of control.

Again, it is entirely within the capabilities of modern data-handling and communication equipment to take care of emergency requests, within the regular system, at a speed that will not in any way delay the fastest physical movement of materiel that can be provided. This fact should represent one of the most vital contributions of such equipment as is under discussion.

Centralization

Centralization is a word that has unpleasant connotations of vulnerability, unmanageably large numbers of people at one location, and decisions that are not based on adequate knowledge of local conditions. Nevertheless, a certain degree of centralization is recognized as a logical necessity in any world-wide stock control system that claims to be able to place materiel where it is needed on short notice.

To secure materiel quickly, the request must be directed to a location where the materiel is known to be available. This requirement permits only three alternatives:

1. Maintain all stocks of a given class of materiel at one or a few locations. This means at least some transportation delay and many small shipments in getting materiel to the places where it is needed.

2. Maintain stocks that are adequate to meet all local needs at a great many locations. This is entirely practical in the case of plentiful, inexpensive materiel, but it is not possible in the case of materiel in short supply, and it places an excessive strain on the national economy in the case of expensive materiel, being an intrinsically wasteful alternative.

3. Maintain limited stocks at locations convenient to places where they probably will be needed, and maintain at a central location up-to-date knowledge of available stocks. The first part of this method is now in practice as mentioned earlier.

Centralization of record keeping to the degree necessary to maintain up-to-date knowledge of the world-wide locations of available stocks is recognized as a basic requirement of an adequate Air Force logistics control system.

This does not necessarily mean a single stock record location for all Air Force materiel. Undue vulnerability would rule against a single location. This approach does mean centrally maintained records on any one class of materiel. It also means rapid communication and rapid data handling, to insure that the records at the central location are continuously up-to-date.

Machine Locations

People are accustomed to thinking of reports being prepared by the organizations that use them. Actually, this is not always or even usually

the case. Reports are prepared by clerical organizations, perhaps in the next room, but still physically separated from the people who use them. Many reports are also received from lower echelons.

Modern communication being what it is, there is no physical reason automatic clerical equipment cannot be located any distance from people who use the reports and records. Neither is there any reason why needed reports cannot come down the line from central machine installations rather than up the line from lower echelons. This is a principle in mechanizing Air Force logistics control, which is necessary to a workable and economical system.

We can free all Air Force units of routing clerical work by sending raw data to a relatively few automatic data-handling centers and returning completed reports, by wire if necessary, to the organizations requiring them.

Machines will be located at from perhaps three to eight logistics control centers, where complete, up-to-date, world-wide, logistics records would be maintained on given classes of materiel.

In addition, there probably will be regional computation and communication centers located wherever enough clerical work exists to justify machine installation. Such centers will presumably be at Air Force Depots and at the larger bases.

Observe, however, that every Air Force organization, wherever located, can have its logistics paper work done for it by some machine installation so that automatic high-speed transmission of information and requests is practicable.

Operating Economy and Improved Management

Some people emphasize the personnel savings or operating economy of electronic clerical equipment. Others emphasize the improved management tools it provides. Both are available and should be demanded. But by far the most important principle provided is the ability in time of war to make sound, logical decisions for getting materiel to the right units, at the proper place, at the appropriate time to win. Another principle is that of insuring that the ultimate Air Force logistics control system is, at the same time, designed to give fast, smooth, economical operating results as far as the clerical work of supply is concerned, and also to give all of the information that can be effectively used by management.

Automatic Input

As mentioned in the description of Electronic Data Processing Machine equipment, manual input to an automatic system can be expensive, in addition to being the least accurate part of the over-all operation. Thus it is desirable to get input automatically, or as a by-product of some operation that has to be performed anyhow, or in some other way in which its accuracy is self-enforcing. This is a principle to be followed in any comprehensive stock-control system. The basic input to a logistics control system is a record of the transfer of materiel from one organization to another, as from manufacturer to warehouse, from warehouse to base supply, from base supply to using organizations. To effect a transfer, some form of communication is required. The individual who wants the materiel or who wants it transferred must tell the organization that has the materiel what is wanted and to whom it is to be shipped or delivered. Basic input data can be secured as a by product of this communication.

As far as shipments of any kind are concerned, the rule can be followed that Air Force materiel is to move only on machine-prepared shipping documents. Requests for materiel or shipping directions can be communicated directly to the machines. The machines know where materiel is located. They can prepare necessary order-filling tickets and shipping documents, and they can remember what shipments they have directed.

When it comes to local transfer from base supply to using organizations, or from one using organization to another, the proposed method would provide simple "Transaction recorders," which would both record and, where necessary, communicate. Thus, again, the rule would apply that Air Force materiel would move only on machine-prepared documents, which would leave an input record in machine language. The proposed transaction recorders are now under development by several business machine manufacturers.

Receiving and Warehousing Practice

Another important step that can be followed in an electronic stock control system is that of "receiving by exception."

Shipping papers will be prepared by central equipment. Copies of these papers advise the shipping organization what to ship and advise the receiving organization what is to be received. The machines can immediately credit the shipping organization and charge the receiving organization. This makes it incumbent on the receiving organization, since they know they have been charged, to see that the materiel is in fact received -- or that a proper report is made of lost, damaged or short shipments, and that a machine-prepared credit memorandum is received relieving the receiving organization of responsibility. Tracing lost

shipments and properly reporting damages and shortages is thus made self-enforcing. Furthermore, no in-transit accounting is necessary and no manual input is required to record either shipments or receipts.

If a warehouse is told by the automatic equipment what to ship, what is to be received, and what balances should be on hand for reconciliation with physical inventories, the warehouse requires no records whatever, except locator files. And there are techniques by which even warehouse locations can be maintained by central equipment and printed on order-filling tickets. Warehousing can be limited to purely physical operations.

There are, of course, several different ways in which electronic clerical equipment can handle shipments and receipts. The procedure outlined above illustrates the extreme simplicity, as well as the self-enforcing disciplines that are possible with the imaginative use of such equipment.

Accountability Records

If central machines are advised of all transfers of materiel from one organization to another, these same machines can produce accountability records. They can also produce any necessary reports of the dollar value of the materiel that an organization uses and for which it is accountable.

When shipping instructions are prepared by automatic equipment, one copy becomes the shipping organization's credit voucher and another copy becomes the receiving organization's debit voucher.

As a by-product of these operations, the central equipment has a record of all charges and credits. It can thus prepare daily, weekly or monthly accountability reports, showing starting balances or initial

accumulations, (tape input taken from its memory of the last previous report), a detailed listing of all charges and credits since the last report, and a closing balance or final report accumulation.

Each organization can, if it wishes, check these periodic statements of accountability against the original charges and credits that have been received. An audit can be made in the same manner, going back to locked-in printed copies if the organization's own copies have been lost.

Thus, it is possible for complete, auditable, accountability records to be prepared for all Air Force organizations, without any clerical work on the part of the organizations themselves.

Post Audit

Post audit can be applied when electronic equipment is used in an integrated stock control and accounting system.

No materiel can move from one organization to another without a machine record of the transfer being made. This rule is self-enforcing because no organization is relieved of accountability until a machine-produced credit is received. Even in small installations where mechanization to produce an immediate machine record might be uneconomic, transfers can be made on a three-copy, hand-written form. One copy is sent to the nearest machine installation for keyboard input and preparation of machine-printed debit and credit vouchers.

The machines can be programmed never to credit one organization without at the same time charging another organization or account. Thus, no materiel can move without a charge being made, (unless the materiel is stolen, lost, or given away, which are "transactions" not subject to approval or accepted by audit in any event).

Since no one can receive materiel without being charged and since the automatic machines can be programmed to report charges in any desired manner, it should not be necessary to "approve" or "censor" requests for materiel, (except requests for materiel in short supply where rationing is necessary). What we would ask the machines to do is to compare stocks on hand with organizational allowances and to compare accumulated receipts with budgeted usage and to report all discrepancies to higher authority. This is what is meant by post audit, as contrasted with audit or approval before supply action is taken.

Post audit is not something that has to be done when electronic equipment is used, but it has the tremendous advantage of permitting immediate action, without any red tape, while at the same time not being subject to abuse. No responsible officer is going to requisition unauthorized materiel without good reason, if he knows that his action will surely and promptly be reported to higher authority.

Automatic Replenishment

Automatic replenishment speeds supply action by making it possible to ship materiel without the delay and clerical work of placing requisitions. As usually applied, however, automatic replenishment robs local commanders of responsibility for their inventories or, worse, it divided responsibility.

With central electronic equipment, it is possible to combine the advantages of automatic replenishment with local responsibility, which is followed in planning a mechanized supply system for the Air Force.

The automatic equipment is given complete information on planned missions and dispositions, together with tables of allowances and any available engineering data on probable consumption and replenishment

rates. The computing equipment already knows present materiel dispositions and past usage. It has all of the information anyone could have as a basis for calculating future demand.

From this information, the automatic equipment calculates future requirements, for each base or other supply unit. The complete detail of these calculations is printed. The resulting reports are sent to local commanders for their review, approval or change. Any changes they make are re-input and are used by the machines in place of the originally calculated figures as a basis for making automatic replenishments.

The machines are programmed to recognize any significant changes in the factors used in calculating requirements. Whenever any factor changes or is changed by a significant amount, a new set of projected requirements is calculated and submitted to the local commanders.

We thus have automatic replenishment based on requirements for which local commanders can accept and have accepted complete responsibility, and without any record keeping or other clerical work on the part of the local commands.

Management Reports

When it comes to the use of electronic clerical equipment as a means for better management, better supply, lower inventories, less warehouse space, lower transportation expense, less obsolescence, fewer surpluses, and all of the other intangible benefits that accrue to more timely and adequate factual data, one must remember that the reports the electronic equipment supplies are by no means an end in themselves and do not of themselves insure the results anticipated. Unless the right information is reported and unless it is intelligently acted upon,

no managerial benefits whatever will come from the installation of electronic equipment.

One of the great risks of installing electronic clerical equipment is that it will be allowed to turn out even greater quantities of partially meaningless and somewhat deceptive figures than we are now struggling with.

Thus, concurrent with the planning that is necessary to operate with electronic equipment, there must also be thoroughgoing analysis of the basic requirements of supply management, of the decisions that will be made and of the information that influences these decisions. It is on the skill with which these analyses and plans are made, even more than on the equipment itself, that possible improvements in management will result..

Information That Can Be Acted Upon

One of the first rules to follow in deciding what reports are necessary and what information should be shown on them is to think in terms of actions. If you cannot act on a report, of what use is it? Precisely what actions have to be taken? Precisely what actions can be taken? Precisely when do these actions have to be taken? Precisely what information can and should affect these actions? Precisely what arrangement of data will most effectively focus attention on the actions that should be taken?

Historical information that cannot be acted upon may be interesting. It may affect someone's judgment at some later date. But there is a limit to what we can afford to pay for interesting information even with electronic equipment, just as there is a limit to the amount of it that anyone will read.

Unless some objective criterion, such as the action criterion, is used in evaluating need for information, we can find ourselves furnishing merely interesting information, or highly theoretical information, or whatever information anyone may ask for or whatever information people are getting now.

Management by Exception

One of the greatest savings of managerial time that electronic clerical equipment can offer lies in its ability to select the cases and only the cases that call for prompt action.

It is not necessary to print reams of paper for someone to scrutinize to see what cases, if any, call for action. The machines can be programmed to make these selections. A manager's time and attention can be focused on the cases that do require action.

For example the machines may check each day to see what procurement levels, if any, are reached. They print procurement requisitions, for managerial review, for only those stock numbers on which available stocks have fallen to the procurement level.

This equipment can go further than this. Procurement levels themselves are based on estimated requirements, which, in turn, are usually based on military plans and consumption rates. The machines can be programmed to look for any changes in recorded military plans or in accumulated consumption rates that have a significant effect on procurement levels. When significant changes are first recognized, new procurement levels can be calculated at once on the stock numbers affected, which will be automatically printed for managerial review.

This exception principle runs all the way through the reporting that is possible with electronic equipment. The machines are programmed

to look for exceptions or deviations from plan; to recognize them when they first occur; and, without lengthy reports, to immediately call managerial attention to cases that call for action.

Actual vs. Planned Performance

One of the most useful types of managerial information is knowledge of actual performance as compared with planned performance. This knowledge serves two purposes:

First, people can judge and improve their judgment only by constantly checking what they plan to do or what they predict with what they actually do or with what actually happens.

Second, one can, or should, judge other people only on the basis of the results they produce; only on the basis of their actual performance as compared with reasonable standard, budgeted or required performance.

Determining exactly what one can reasonably expect of themselves or others in terms of measurable results is no easy task. There are usually a number of things to take into consideration, many facts to gather and some rather involved calculations to make, in arriving at a fair and reasonable standard or budget. In many cases, this work is beyond the capabilities of present clerical methods. So, it is necessary to guess or make mental allowances, which invalidate the value of objective standards. With electronic equipment, more nearly accurate standards and budgets on which to base our evaluations of ourselves and others are provided.

An electronic system can also aid in making comparisons between standard or budgeted performance and actual performance. It can remember, in detail, the standards or budgets which have been established. It can gather and summarize data on actual performance. It can then print, for

all to see, a record of each individual's or organization's performance as compared with the standard or budget. Thus, as has been stated, cases that require unusual attention, either special rewards or replacement, can be automatically flagged for action.

Theoretical vs. Actual Correlations

Another principle in determining what information to accumulate and report is that of using tested correlations instead of assumed ones.

We would certainly assume that fuel consumption for a given type of plane is directly proportional to flying hours. If we know, from military plans, how many hours are to be flown in a given period of time, we would assume that we could calculate exact fuel requirements for that period of time. We might assume that the same would apply to tire wear, engine overhauls, and parts consumption, among other things.

Usually, however, inexplicable differences between estimated and actual requirements are experienced. With present clerical methods about all that is feasible is to continue using simple, theoretical correlations and throw in a "factor of safety" to cover these inexplicable differences.

With electronic equipment, it is possible to search until correlations that actually work are found, if such exist. For example, it might be found that fuel consumption correlates with both flying hours and type of mission, according to some perhaps rather complex formula. One might find, as it now seems to have been determined, that required engine overhauls can be predicted very accurately if the age distribution of engines since their last overhaul is taken into consideration along with projected flying hours. The same method might be applicable to other components, granted the clerical capability of accumulating required data and making required computations both of which are within the scope of this equipment.

Sometimes it is found that after every conceivable correlation is tried, the required factor of safety is still larger than the calculated requirement. In these cases, future requirements can be realistically calculated only by aiming at a given probability of not running out of stock, based on past experience. These probability computations are also within the capabilities of electronic clerical equipment.

Operations Research

The last principle in connection with management reports is that of operations research, also called "linear programming" and "optimization."

Essentially, what operations research means from a management point of view is that, for the first time, we have both the techniques and the machines to execute them that will tell us the best action to take in a given situation everything known considered. This, of course, is the essence of management.

When replacement stock levels are reached, for example, there might be three possible courses of action open; rebuild available components in unserviceable condition, make extensive transfers of available stock, or initiate an immediate procurement of stock that may have to be procured sooner or later in any event. Provided numerical values can be assigned to the costs, risks and time factors involved, electronic equipment can be programmed to disclose first, which of these alternatives are in fact possible and, second, which of two or more possible alternatives is the most economical one.

There are limitations to the possibilities of linear programming. First, one has to be able to assign numerical values to all of the factors involved. Second, the extensive calculations that are required take considerable time even on equipment as fast as electronic computers.

But where they can be applied, optimization techniques give us a new and extremely powerful tool to use as an aid to effective management.

Men and Machines

A postscript should be added to the discussion of automatic equipment as an aid to management. Automatic clerical equipment can replace clerical labor. It can aid management, it can perhaps reduce managerial time, but it cannot replace management.

As has been seen, someone has to act on the information that machines supply. Furthermore, the machines have to be told what to do, and told in the most precise and detailed manner conceivable, which is a managerial task of the highest order.

As the reader has also seen, no important machine decisions can be left unchecked by managerial review. The machines can make previously programmed decisions, but their decisions are made purely by a fixed course. Someone should review machine decisions to see whether or not a routine answer in each particular case really does make sense.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Nature of the Problem Summarized

Through recorded history war has progressed in its complexity as technology, economic expansion, and political power increased. There has been a gradual but definite shift in military tactics, from conflicts between masses of men to conflicts between masses of increasingly complicated equipment operated by men. This change has resulted in modern military organizations taking on a new and vast task - maintaining a logistics system which will furnish the desired supplies and equipment to the proper military units at the desired locations at the optimum time. Logistics three tasks are to determine the needs, procure the means to fill the needs, and to efficiently distribute those means.

The United States Air Force is a new organization - having been born in 1947 under the Armed Forces Unification Act. Prior to 1947 the Air Force operated under the United States Army and used the Army system of supply. Since 1947, the Air Force has developed its own system of supply, but has followed the Army's organizational structure to a great degree.

In August of 1954, the Air Force was using more than 1,150,000 separate supply items as compared with only 150,000 different items sold by Sears Roebuck & Co. To be able to manage such a variety of items

scattered world-wide in required quantities, the Air Force adopted big business methods of management. Items were standardized and classified. Efficient and flexible stock control was, of course, essential.

The Air Force logistics task was placed under one authority, the Air Materiel Command. This command is of equal status with the combat commands of the Air Force. The Air Materiel Command bought \$23 billion worth of supplies and equipment in 1953. This materiel was distributed to units deployed world-wide.

The Air Materiel Command is managed centrally from Wright-Patterson Air Force Base at Dayton Ohio, however, its physical facilities are dispersed throughout the United States and overseas. Basically, the Air Force adopted a zone system of logistics support. Under this system the United States is divided into eight zones or "Air Materiel Areas." Each Air Materiel Area is responsible for the common-item logistics support of all Air Force organizations within its geographical area. Expensive items of equipment, however, are not stocked in all Air Materiel Areas, but are stocked by only two Air Materiel Areas within the United States. One is located east of the Mississippi River and the other west.

Headquarters, Air Materiel Command delegates to each Air Materiel Area the exclusive responsibility for procuring certain supplies and equipment for the Air Force. Once these are contracted for by the responsible or "prime" Air Materiel Area, the materiel is divided between the procuring zone and the Air Materiel Area stocking the same materiel on the "opposite" side of the Mississippi River. Overseas depots are operated by the Air Materiel Command. The European, African, Caribbean, and Northeastern Commands procure materiel from Air Materiel Areas east of the Mississippi River. Likewise, the Far East, Alaskan, and

Hawaiian Commands procure materiel from the western air materiel areas.

The Air Force is continually increasing the complexity of its equipment which results in more and more different items of supply. Strategy necessarily changes with equipment improvements, world political shifts, and budget fluctuations. The Air Force needs to know the best combination of weapons and supporting logistics for each situation.

At present, it is impossible for the Air Force to calculate accurately the existing logistics picture. The flow of data from the world-wide activities of the Air Materiel Command is overwhelming in quantity, and is required to pass through so many intermediate headquarters, that from ninety to one-hundred days pass before the data is processed into usable facts and reports. This delay would render the reports practically useless during wartime when enemy operations coupled with sporadic and changing Air Force tactics would make smooth routine consumption of materiel impossible.

Even at present the Air Materiel Command makes poor decisions in procurement, modification, maintenance, and stock control because of the inaccurate and out-moded data used for planning.

Air Force combat organizations are flying aircraft at the speed of sound, however, its supplies move at the speed of a one-horse wagon. Studies have shown that this delay is due to time wasted in processing the typed requisition for supplies. Only twenty per cent of the time consumed in getting materiel to the using organizations is chargeable to transportation, the other eighty per cent to paper-work.

At Tinker Air Force Base the paperwork dilemma is terrifically burdensome. The latest manpower survey at Tinker Air Force Base indicated that fifty-five per cent of the 20,000 civilian personnel have a primary

duty of handling paperwork. This is a time-consuming and expensive task which limits the desired flexibility of Air Force logistics.

In recent years, much progress has been made by automation in industry - substituting machine labor and energy for human labor and energy. The same progress is being made in data handling and processing equipment.

Univac, the electronic brain developed by Remington Rand, made a name for itself in 1952 by predicting with amazing accuracy the victory of President Eisenhower. Since then there have been great strides made in the development of electronic computers and electronic data processing machines. These machines can compute complex mathematical problems in the twinkling of an eye, can store vast quantities of information in comparatively tiny space, make decisions, type reports, receive and transmit messages, and duplicate the work of punch card equipment in a small fraction of the usual time. Many large companies are installing electronic data processing machines in an effort to break through present restraints log-jamming communication which is so often observed in large companies and other large-scale organizations. This equipment has cut statistics processing from many weeks to relatively few hours or even mere minutes.

If properly understood and applied, electronic data processing machines will do for administration what automation is doing for production.

Conclusions

The Air Force logistics system is not functioning at the desired efficiency required for the "jet-atomic-age." The present hand-typed method of correspondence and data handling is slow, burdensome, inflexible, and unsatisfactory. It is presently impossible to calculate

the status of Air Force logistics - one can only review logistics history up to the past three months. What has happened in the most recent quarter is not effectively accessible.

The Air Force must for reasons of economy, good management, improved stock control, and national defense of the country modernize its logistics administration.

Electronic data processing machines presently in production by American firms can take over the data handling and data processing tasks. This equipment can be tied by telephone lines or radio to similar equipment located anywhere within the United States. Data can be automatically fed into, transferred from, or processed within the machines at phenomenal speeds. This equipment can constantly keep track of all items within the Air Force logistics system from the time it enters the system until it is consumed, destroyed, or disposed of through salvage.

Electronic data processing machines can enable the Air Force to centralize record keeping yet decentralize the locations of materiel. As data is current and centralized, better management is facilitated.

When optimum use is made of electronic data processing machines within the Air Materiel Command, the United States Air Force will have an estimated 500 per cent faster logistics system combined with greater efficiency, sensitivity, responsiveness, and mobility. Given this, the United States Air Force will have, for the first time, a materiel support as modern as its jet-atomic-age combat organization.

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APPENDIX

ADMINISTRATIVE Classification		Type of Classification	PROPERTY
Air Force, Army, and Navy		Used by	Air Force
Conduct broad planning			
for supply for an operation		Used by you	Segregate bulk supplies.
Simplifies field administrative instructions		to	Facilitates supply of related items. Simplifies storage and distribution. Serves as an aid to positive identification. Permits a specialized yet flexible supply organization.
Class I	Rations	Consists of	Class 01 Aircraft and maintenance parts
Class II	Supplies & equipment authorized by tables, lists or letters which prescribe specific allowance for a unit or for an individual and which are not peculiar to aviation.		Class 02 Aircraft engines and maintenance parts
Class II-A	Class II type items which are peculiar to aviation.		Class 03 Aircraft and engine accessories and maintenance parts
Class III	All fuels and lubricants except those peculiar to aviation.		Class 04 Rubber materials, casings, and bearings
Class III-A	All fuels and lubricants peculiar to aviation.		Class 05 Aircraft and training aids, instruments and electrical meters.
Class IV	Supplies and equipment (other than those peculiar to aviation) for which allowances are not prescribed or which are not otherwise classified.		Classes 06 through 72 omitted. Many classes are further divided into subclasses. For example Class 05.
Class IV-A	Class IV type items which are peculiar to aviation.		05A Aircraft navigation instruments
Class V	Ammunition and chemical agents except those peculiar to aviation.		05C Aircraft flight instruments
			05D Aircraft engine instruments
			Etc.

Class V-A Class V type items
which are peculiar
to aviation.

(Reference AFM 400-5)

(Reference T. O. 00-35A-1)

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