ORGANIZATION
FOR A
NEW TECHNOLOGY

by

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May 15, 1959

Professor Alvin Sloane
Secretary of the Faculty
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Dear Professor Sloane:

In accordance with the requirements for graduation, I herewith submit a thesis entitled, "Organization for a New Technology".

I take this opportunity to express my appreciation and thanks to Professors Houlder Hudgins and Samuel E. Eastman for their guidance and counsel, to my wife and family for their patience and understanding, and to Mrs. Ethel O'Brien and the many other people at Grumman Aircraft Engineering Corporation who contributed in the preparation of this thesis.

Sincerely yours,

Signature redacted

Edward C. Nezbeda

ABSTRACT OF THE THESIS

Title of the thesis: ORGANIZATION FOR A NEW TECHNOLOGY

Name of the author: Edward C. Nezbeda

Submitted to the School of Industrial Management on May 15, 1959 in partial fulfillment of the requirements for the degree of Master of Science.

The recent increases in the rate of technological development, coupled with the demonstrated capabilities of the U.S.S.R. and the tenuous peace that has existed since Korea, have forced changes in the traditional methods that the aircraft industry employed in generating the aircraft required by the military agencies. The thesis is concerned with the development of an organizational structure that will satisfy the changing demands placed on the present-day aircraft producer.

The thesis develops an understanding of the factors that governed the industry in the past by a series of studies that cover the product, the industry, the customer, and expenditures for military aircraft. The factors that are likely to govern the industry in the future were determined by a series of studies that consider recent changes in the product, recent changes made by the industry, recent changes made by the customer, and an estimate of future expenditures for military aircraft. A study of the principles of sound organization provided the means for interpreting the information that was developed in the various studies and permitted the generation of a suggested organizational structure.

The thesis concludes that military expenditures for aircraft will continue to rise for the next few years. This increase will result in more spending for missile procurement and for research and development, but will be accompanied by a reduction in spending for the procurement of more conventional aircraft. The complexities of modern products have been partially answered by the development of teams of companies who have divided responsibilities for portions of a program, and partially by the reorganization of military agencies in an attempt to provide a more unified means of coordinating entire programs. The military reorganization has created changes in the traditional contracting methods. Companies now must be prepared to perform not only as prime contractors, but as subcontractors as well.

The very practical limits of fund availability, together with the increased costs of systems, indicate a reduction in the number of programs that will be under development at any one time. This, and the other major industries that have recently entered the aircraft field, will increase the competitive nature of the business.

The integration of the information developed in the studies with the principles of sound organizational practice indicates that the present and future economic performance of a company may be best served by a strong organization built around those divisions that perform activities that directly and vitally influence its products. The principal divisions should perform these activities for all of the programs. The necessary individual program identification is achieved by interlacing the coordinating efforts of properly authorized individual program managers. This arrangement permits ready adjustment to changing business conditions and maintains an intact, strong and flexible engineering force capable of balancing the needs of present programs and the pressures for new products.

The thesis is limited to the development of an organizational structure for the operating division of a company. It acknowledges the necessity and importance of other activities, but progress beyond this point requires intimate knowledge on an individual company basis and is considered beyond the scope of this study.

Thesis Supervisor: Houlder Hudgins
Title: Professor of Industrial Management

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CHAPTER I

INTRODUCTION AND SUMMARY

Man, in his unceasing struggle for survival and advancement, urged by curiosity and aided by his inquisitive mind, has always succeeded in devising and improving the many tools essential for the fulfillment of his varied needs and goals. The airplane, invented and developed in the last fifty years, is a monument to the technical ingenuity of mankind.

The possibility of powered air travel had intrigued man for centuries. It remained, however, an unrealized ambition until the Wright Brothers, in 1903, achieved their historic flights at Kitty Hawk. The airplane since then, with its many peaceful and war-making applications, has had a profound effect on the civilization of the world.

The military potential of the airplane and the birth of the military aircraft industry was recognized when, on February 10, 1908, the Signal Corps executed articles of agreement with the Wright Brothers for a heavier-than-air flying machine at an estimated cost of $25,000.[1] From this elementary start in 1908 the intervening half-century, with its two World Wars and Korea, has amply demonstrated the value of the airplane as an effective weapon. Expenditures for military aircraft were approximately 15 percent of the 1958 National Budget. This significant portion has an effect on the total economy of the country.

The early airplane builder, forced by the infancy of the business, supplied a greater portion of the complete aircraft than does the present-day manufacturer. The pressures of growth, and the need for better and more dependable products created an industry of highly specialized and specific talents. With time, technical necessity separated the industry into three interdependent elements: airframe manufacturing; engine manufacturing; and propeller and parts manufacturing; with airframe the predominant element.[2]

This industry composition, though it lasted for many years and was satisfactory while aircraft were developing by incremental steps, is giving way to the formation of an industry with a much broader base. The great aeronautical strides of recent years, particularly those of the past decade, have been marked by noteworthy and significant contributions from the nuclear, chemical, and electronics fields. The proper integration of the many skills required for successful manufacture of present and future products suggests, paradoxically, a re-melding of the basic and new elements of the industry. However, the vast amounts of both human and material resources required to conceive, design and build the modern airplane or missile, coupled with the inherent uncertainties of the industry, precludes the possibility of a completely integrated single company.

The industry-government team, aware of the magnitude and importance of the problem, is working toward a solution that will continue to provide the strong defensive capabilities our Nation requires, and will provide these capabilities in a manner that will be mutually satisfactory to all contracting parties.

In addition to the large military segment, the industry does produce the products used in the civil, general, and commercial aspects of aviation. This segment, however, is small, unpredictable and presently represents approximately 15% of the total annual business.[3] This 15% may seem a respectable portion when considered in total but which, when consideration is given to the very wide range of products, does not generate a great opportunity for the individual major producer. The product span from very small light planes to the very large commercial transports is so great that companies, necessarily, restrict their operation to one or two branches of this potential market. In reality, the major producers, though involved with particular aspects of commercial aviation, depend on the military for the major portion of their business.

For purposes of clarity, the civil, general, and commercial segments will be minimized in this presentation and emphasis will be placed on the large military aspects of the aviation business.

The Problem for Investigation

The stringent requirements of technical competence, mission accomplishment, contract and delivery performance are so demanding that, even though the spectrum of company size varies from the very small to the very large, the aircraft manufacturing field is dominated by a few major producers.[4] This domination, however, does not embrace monopolistic or cartel-type operations, for competition within the industry is very intense. It is not uncommon for each of the major companies to submit one or more proposed designs in answer to the stated requirements of a military design competition.

The problems that confront the military and the industry today, vastly different from those of a few years ago, are, characteristically, problems of much greater magnitude and complexity. The problems have forced changes in the classical approach to solutions.

The military, in an endeavor to meet the new problems, has made organizational changes that were designed to coordinate the many necessary governmental activities into one controlling office. Changes have been made in contractual arrangements with industry.

The industry, in its attempt to meet the new problems, has accepted the responsibility for managing some of the activities that were, in the past, strictly military responsibilities. In some programs this management responsibility covers the phases of design, development, manufacture, procurement and support elements for entire new weapon systems. In many instances the projects were so large that no single company had all the talents and facilities that were required to fulfill all aspects of the new concepts satisfactorily. To cope with the size, complexity and urgency of new weapons, companies that had the necessary talents pooled their efforts and formed teams or syndicates capable of undertaking the new projects.

A study of the recent and changing developments, imposed on an already existing and volatile industry, may suggest actions to further and improve the future organization of the individual member-firm in the aircraft industry.

Thesis Objective

The development of an organizational structure must consider, evaluate and integrate many functional and human requirements. The organization does not, by and of itself, achieve the objectives for which it was established. The organization can only attempt to define rules, regulations and procedures that will enable its people to work toward common goals in a coordinated, orderly and proper fashion. The achievement of objectives is accomplished by the people working within the structure. Company organization does not work in isolation and must consider the present and future needs and objectives of the customer and his people. The aircraft industry is composed of many successful companies that have been in the business for some time and who have reacted to the dynamism of the industry in a fashion each considered proper. This very dynamism has developed types of organization peculiar to each company. The complexity and variation of the many structures presently in successful use precludes individual analysis of all organizational types and forces a limitation in this study.

The objectives of the thesis are: (1) to isolate the fundamental factors that form the basis for any large company in the aircraft industry; (2) to determine the many meanings and implications of the new "weapon system management" concept and extract the fundamental factors that make it different from present forms of organization; and (3) to superimpose the new requirements, if any, over the existing basics in an attempt to describe the combined fundamental necessities.

The study should, for maximum utility, inject the combined fundamental necessities into the existing organizational structure of major companies and describe the new structure required. However, the limitation that precluded individual analysis of structural types also eliminates the possibility of individual treatment of any subsequent findings. Therefore, the study will be restricted to the determination of the new governing conditions and the development of an organization that reflects the combined fundamental necessities.

Method and Procedure for Thesis Development

To develop an organizational structure that will help to meet the objectives and needs of a company now and in the immediate future requires an understanding of the factors that governed the industry in the past, and an estimate of the factors that are likely to govern the industry in the future.

An understanding of the past factors was developed by (1) detailed analysis of historical facts and figures that describe the industry; (2) a study of the customer and his past needs; (3) a study of the manner in which business was conducted; and (4) a determination of past trends.

The future factors were determined by (1) an analysis of estimates of future military expenditures; (2) a study of recent changes instituted by the customer; (3) a study of recent changes made by the industry; and (4) the extrapolation of past trends.

The many meanings and implications of "weapon system" and "weapon system manager"; recent changes made by the customer; and recent changes made by the industry were derived from a systematic search of pertinent material in many military journals and trade publications.

A survey of organizational theory, modified by the peculiar requirements of the aircraft industry, served to establish the basic organizational requirements. This was further modified, after digestion of the impact of recent changes and new needs, to describe the new governing fundamentals.

The studies that were conducted and the interpretations that were reached, form the basis for the organizational structure that is suggested.

Conclusions and Recommendations

The conclusions of this thesis are:

1. Weapon system management is not entirely new. The complexities of modern products have not changed the total duties but have expanded them. This expansion forced a reappraisal and reallocation of duties, with Industry playing a larger part in the technical and procurement aspects of new weapon systems while the military is providing a monitoring function rather than one of direct action.

2. Weapon system management has changed the traditional singularity of the individual company dealing with the military to a collection of companies working with military agencies whose organizations have grown more involved and intricate.

3. The military delegation of some of its procurement responsibilities and recent changes in contracting methods, requires that the individual major producer must be prepared to participate as a prime contractor, as an associate contractor, or as a subcontractor. A major portion of his work may come from associations with other companies in the industry.

4. Total military expenditures for aeronautical products will continue to grow for the next few years. Expenditures for missile procurement and for research and development are increasing. While expenditures for the procurement of more conventional aircraft are declining, they still represent the larger part of total procurement spending. However, increased system costs, when coupled with the practical limits of fund availability, indicate a reduction in the number of projects that will be under development at any one time.

5. The recent increases in the rate of technological development, and the rapidity with which these are translated into new products, has increased the rate of product obsolescence and has materially shortened the effective life span of any particular product. The present-day aircraft producer can no longer expect long production programs that run for years. He must develop a facility that permits rapid adjustment between the needs demanded by his present products and the needs required for the development of new aircraft.

6. The requirements of present conditions may be satisfied by creating a strong functional organization designed around the few different work elements that are required by all projects. Program identification and balance are achieved by interlacing the coordinating efforts of program managers in all the internal and external affairs of individual programs. This arrangement provides a broad field in which to train and test possible future leaders of the company.

FOOTNOTES

CHAPTER I

1. The first military contract for a heavier-than-air flying machine was written on 10 February 1908, between Captain Chas. S. Wallace of the Signal Corps and Wilbur and Orville Wright. The basic price was $25,000. The original contract provided a bonus/penalty incentive based on speed attained during trial flights.

2. Aircraft Industries Association of America, Inc., Aviation Facts and Figures, 1958 Edition, American Aviation Publications, Inc., Washington 5, D. C., pp. 17, 54-61.

3. Ibid., p. 9.

4. Ibid., p. 66.

CHAPTER II

THE INDUSTRY AND ITS CUSTOMER

The first military aircraft was delivered to the military services in 1909. On its acceptance flight, the airplane flew for one hour and twenty minutes at an average speed of $42\frac{1}{2}$ miles per hour at an altitude of slightly more than 100 feet. By way of comparison, the services are planning to fly, this year, the hybrid airplane/rocketship X-15 at speeds approaching 4,000 miles per hour at altitudes above 100 miles.[1] In October of 1909, at College Park, Maryland, Lt. Frederic E. Humphreys became the first Army officer to solo the Army's first Wright "Flyer". Two years later, after rejecting a request for a million dollars, Congress appropriated $125,000 for expenditure on military aircraft in fiscal year 1912. This was the first sum designated particularly for aircraft.

Production Analysis

Early aircraft were built, not by an industry organized solely for the purpose, but by interested men who supported their aeronautical efforts as an adjunct of other businesses. Annual production for military purposes was less than 100 airplanes up to the year 1915. Greater quantities were built for civil purposes than for military uses. The war in Europe, however, sharpened interest in this country, and in the next few years a formalized industry was established. In 1917, 2,013 airplanes were produced for the military and in 1918 the quantity went still higher, reaching a total of 13,991. In both these years military requirements represented, virtually, the total quantity produced.

The end of the first World War in Europe signaled the beginning of the first major reversal in the industry. Although the military continued to be the largest purchaser on a percentage basis for many years, production tumbled from the 13,991 of 1918 to a low of 226 military airplanes in 1922. Total industry activity continued at a pace below one thousand airplanes per year until 1926. In that year, total production exceeded one thousand and has never dropped below that mark since. The promising growth of the '26-'29 era, a period when total annual production was constantly rising, was reversed by the effects of the great Depression. It was not until 1934 that the downward trend was finally arrested.

A study of the production statistics for the period from 1912 to 1940 discloses that the military needs for quantities of aircraft were less than the civilian requirements in all but the actual World War I years and a few post war years. The study also indicates, as evidenced by the high percentage of military production during the post World War I years, the ready acceptance of the airplane as an effective weapon by the military, and the slower acceptance of aircraft for civilian purposes. The civilian acceptance was significantly changed by Lindbergh's nonstop flight from New York to Paris. His flight stirred the imagination of the American people and had a profound effect on the development of aviation in the United States. The period from 1927 to 1940 is marked by the high percentage of total aircraft production used for civilian activities.

The period from 1940 to the present follows, generally, the cycle of earlier years. World War II requirements demanded more and more aircraft. Production increased steadily from 12,813 airplanes in 1940 to 95,272 in 1944. The pattern of World War I was repeated. Military demands were, once again, greater than civilian needs. The years 1941-1945 were devoted, practically in their entirety, to the production of military aircraft. Every single plane produced in 1942, 1943 and 1944--100 percent of production for three years--was used for military purposes.

The end of World War II had a much greater detrimental effect on the industry than did the end of World War I. Military requirements were cancelled and production plummeted from quantities approaching the 100,000 per year mark to 1,417 aircraft. The percentage change was drastic: from 100 percent military production to 3.9 percent in a matter of one year. Of the 36,418 aircraft produced in 1946, 1,417 were for military purposes and the remainder for civil uses.

The severity of the military market collapse was not materially offset by the civilian market, for of the 35,001 airplanes built for civilian purposes, 30,766 were of the small 1 and 2 place variety, 3,802 were of the 3-5 place type, and only 433 were of over 5 place capacity.[2] The years 1946 and 1947 were marked by financial losses for all but a few major producers. The Korean situation produced results that, though not as severe as those of World War I and II, followed the same general pattern. The "cold war" situation that has existed since Korea has kept the military requirements for aircraft at a high level.

Table I and Figures 1 and 2 are graphical portrayals of the production elements of the aircraft industry from its military inception in 1908 up to the present time.

This study indicates, from a production viewpoint, the cyclical nature and volatility of the industry and the degree to which it depends on military requirements for the major portion of its production efforts.

Federal Expenditure Analysis

The industry produced, in 1930, a total of 747 military aircraft at a total cost to the government of $31 million. Sales to the military continued to drop during the depression and reached a low of $13 million in 1934. From this low point in activity there was a gradual improvement in business conditions that was reflected in military sales.

TABLE I

UNITED STATES AIRCRAFT PRODUCTION

Year	Total Aircraft	Military Aircraft	Percent Military of Total	Year	Total Aircraft	Military Aircraft	Percent Military of Total
1909	N.A.	1	- %	1934	1,615	437	27.0%
1910	N.A.	-	-	1935	1,710	459	26.8
1911	N.A.	11	-	1936	3,010	1,141	38.0
1912	45	16	35.6	1937	3,773	949	25.2
1913	43	14	32.5	1938	3,623	1,800	49.6
1914	49	15	30.6	1939	5,856	2,195	37.5
1915	178	26	14.6	1940	12,813	6,028	47.0
1916	411	142	34.5	1941	26,289	19,445	74.0
1917	2,148	2,013	93.6	1942	47,675	47,675	100.0
1918	14,020	13,991	99.8	1943	85,433	85,433	100.0
1919	780	682	87.5	1944	95,272	95,272	100.0
1920	328	256	78.0	1945	48,912	46,865	95.8
1921	437	389	89.0	1946	36,418	1,417	3.9
1922	263	226	86.0	1947	17,739	2,122	11.9
1923	743	687	92.4	1948	9,838	2,536	25.8
1924	377	317	84.0	1949	6,137	2,592	42.2
1925	789	447	56.7	1950	6,293	2,773	44.0
1926	1,186	532	44.8	1951	7,923	5,446	68.7
1927	1,995	621	31.1	1952	12,811	9,302	72.5
1928	4,346	1,219	28.1	1953	14,760	10,626	72.0
1929	6,193	677	10.9	1954	12,129	8,740	72.0
1930	3,437	747	21.8	1955	12,852	8,032	62.5
1931	2,800	812	29.0	1956	14,005[E]	6,800[E]	48.5
1932	1,396	593	42.5	1957	12,156[E]	5,500[E]	45.2
1933	1,324	466	35.2				

N.A. Not available

[E] Estimate

Material Source: Aviation Facts and Figures - 1958 Edition

FIGURE 1

MILITARY AIRCRAFT
AS PERCENTAGE OF TOTAL PRODUCTION

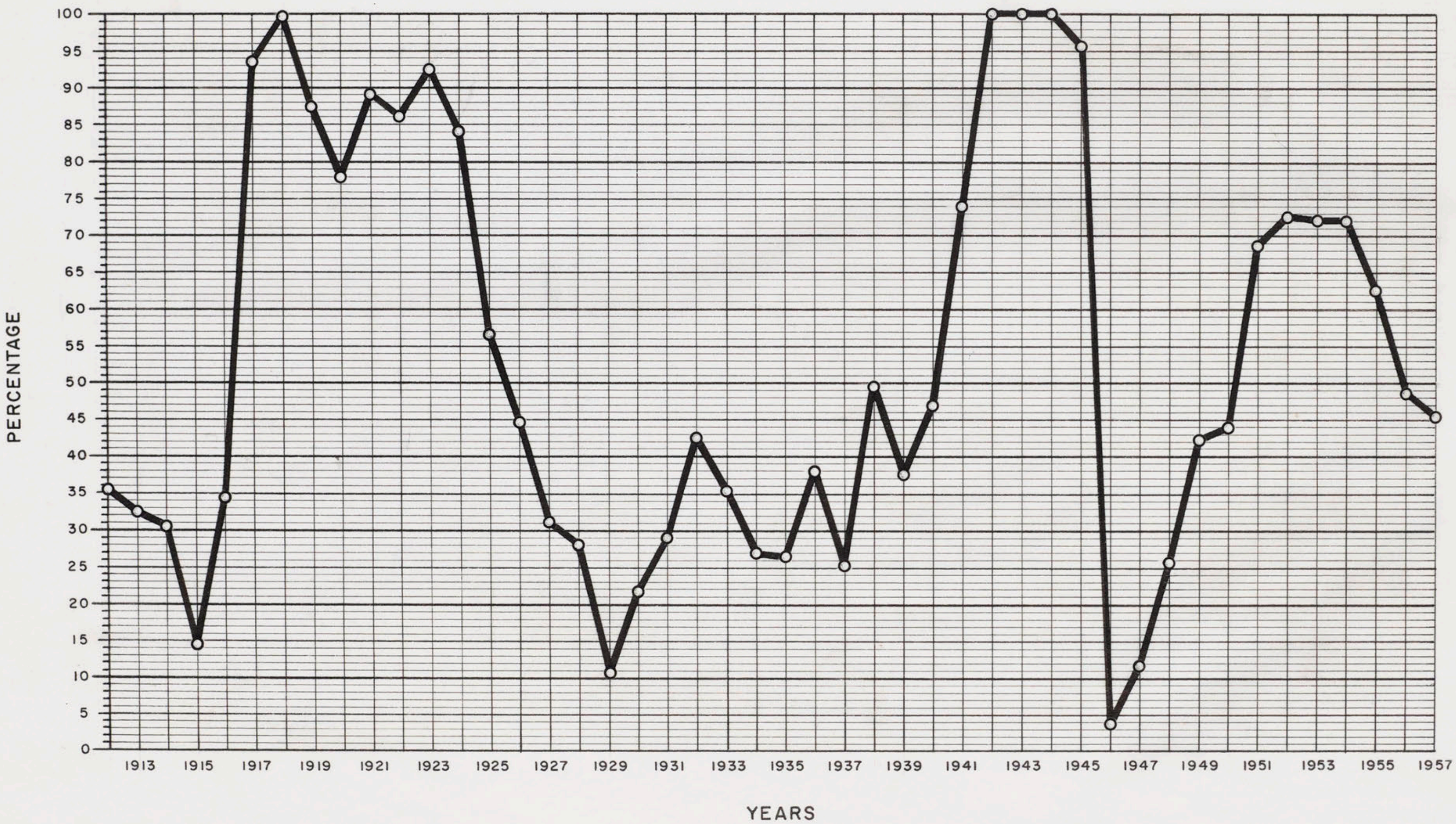
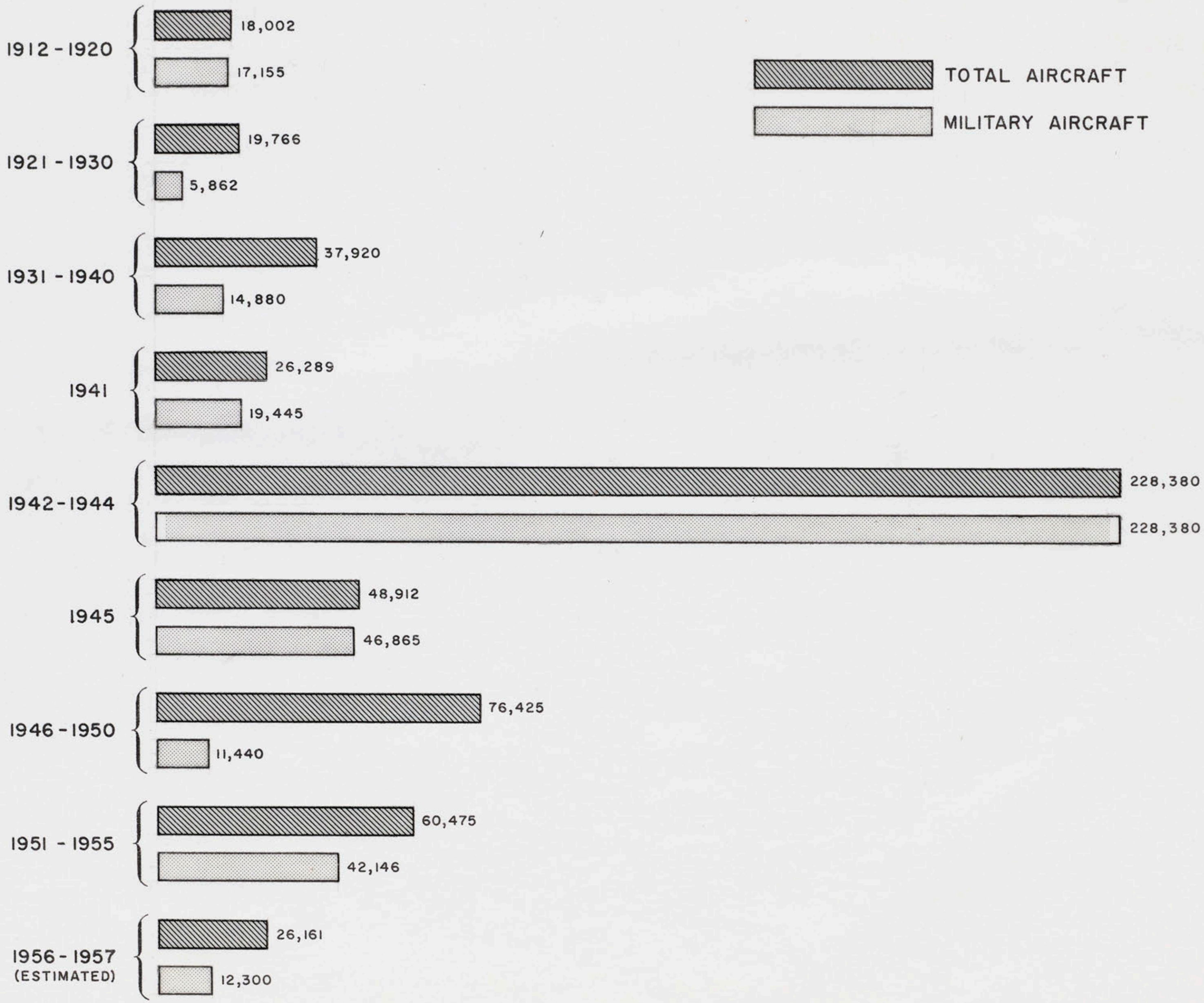


FIGURE 2

UNITED STATES AIRCRAFT PRODUCTION



MATERIAL SOURCE: AVIATION FACTS AND FIGURES - 1958 EDITION

By 1938 sales had reached $67 million; were $205 million in 1940; and in 1941, the year that the United States entered World War II on an active basis, sales were $587 million.

The pressures of the war pushed expenditures for aircraft higher and higher until, in 1944, they hit a peak of $12.83 billion. The eventual outcome of the war was now obvious to the leaders of the Allied forces and expenditures leveled off at $11.52 billion in 1945.

Since the industry was based completely on the military needs of the government, the cancellation of contracts at the end of the war had the expected effect on the sales of the industry. From a booming sales level of $11.52 billion in 1945, sales were restricted to $1.65 billion in 1946 and in 1947 were slightly less than $0.6 billion.

Federal purchases of aircraft continued at a low level for the next few years. It was not until the beginning of Korea that the industry really made a significant sales recovery. Once again military needs were coming to the forefront. From a level of expenditures at $1.71 billion in 1950, purchases increased to $7.71 billion at the end of the Korean War in 1953.

With the end of the war in Korea the usual cyclical pattern was broken. World War I and II both required great numbers of airplanes with resultant high expenditures. Both wars were followed by periods of depressed requirements and depressed expenditures. Korea was different. Although quantity requirements reversed in the usual cycle, expenditures did not. For the three years following Korea, expenditures remained at a level higher than that of 1953 and, in 1957, rose to even a higher level. This non-reversal in expenditures is significant.

This study indicates, by the usual reversal of quantities produced accompanied by the non-reversal of expenditures, the increased complexity and cost of modern military aeronautical products. It indicates, additionally, the difference between the outcomes of the two World Wars and Korea. Both World Wars ended with a definite victor, a definite loser, and a drop in military expenditures. The stand-off in Korea with no winner or loser has resulted in a very tenuous peace which, from a preparedness viewpoint, does not permit military reductions.

The tables and figures that follow on the next few pages describe, in detail, the interplay that existed among such indices as Gross National Product, total Federal expenditures, total military expenditures, and expenditures for aircraft. A study of the information indicates that:

1. Present expenditures for aircraft represent a greater portion of the total Federal budget than it did during World War II.

2. Present military expenditures for aircraft almost equal the amount spent during the height of World War II.

3. Present military expenditures for aircraft represent approximately one-fourth of the total military budget.

TABLE II

FEDERAL EXPENDITURE STATISTICS
(In Billions)

Year	Gross National Product	Total Federal Expenditures	Total Military Expenditures	Military Expenditures For Aircraft
1930	91.0	3.4	.84	.031
1931	76.0	3.7	.83	.031
1932	58.5	4.6	.83	.029
1933	56.0	3.9	.78	.025
1934	65.0	6.0	.71	.013
1935	72.5	7.0	.92	.023
1936	82.7	8.7	1.15	.044
1937	90.8	8.2	1.19	.058
1938	85.2	7.2	1.24	.067
1939	91.0	8.7	1.37	.068
1940	100.6	9.0	1.80	.205
1941	125.8	12.7	6.25	.587
1942	159.1	32.3	22.91	2.92
1943	192.5	76.2	63.41	10.07
1944	211.4	93.7	75.98	12.83
1945	213.6	100.4	80.36	11.52
1946	209.2	60.7	43.15	1.65
1947	232.2	39.3	14.77	.59
1948	259.0	33.8	11.98	.70
1949	259.0	40.1	13.99	1.25
1950	285.0	39.6	13.01	1.71
1951	329.0	44.1	22.44	2.43[c]
1952	347.0	65.4	45.96	5.06[c]
1953	365.0	74.3	51.83	7.71[c]
1954	363.0	67.8	47.87	8.84[c]
1955	397.0	64.6	42.09	8.76[c]
1956	419.0	66.5	41.83	8.31[c]
1957	440.0	69.4	44.41	10.07[c]

[c] Procurement and Production, military functions only.

Material Sources: Aviation Facts and Figures - 1958 Edition
Economic Report of the President - January 1958

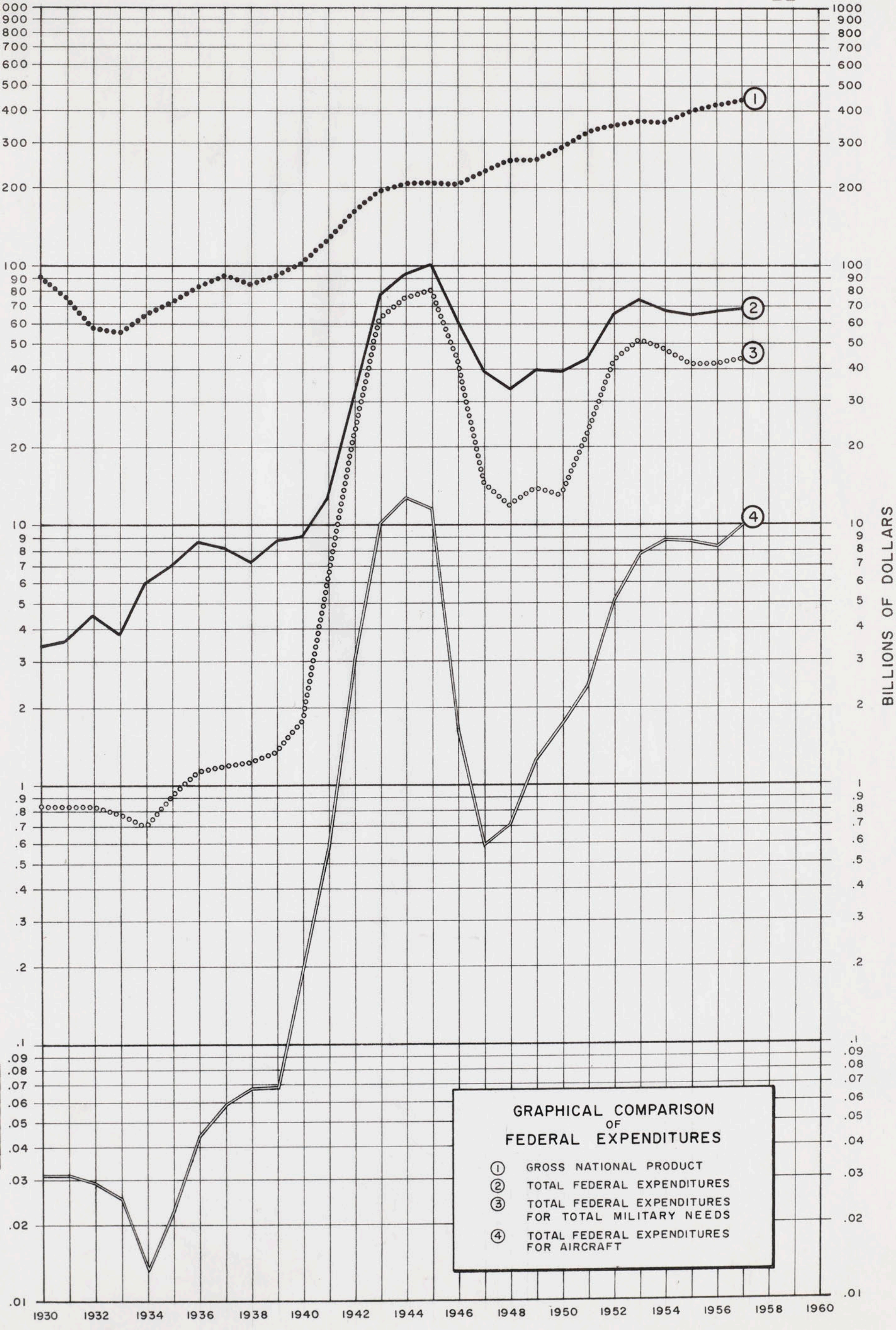

GRAPHICAL COMPARISON OF FEDERAL EXPENDITURES
① GROSS NATIONAL PRODUCT
② TOTAL FEDERAL EXPENDITURES
③ TOTAL FEDERAL EXPENDITURES FOR TOTAL MILITARY NEEDS
④ TOTAL FEDERAL EXPENDITURES FOR AIRCRAFT
BILLIONS OF DOLLARS
1930 1932 1934 1936 1938 1940 1942 1944 1946 1948 1950 1952 1954 1956 1958 1960

FIGURE 3

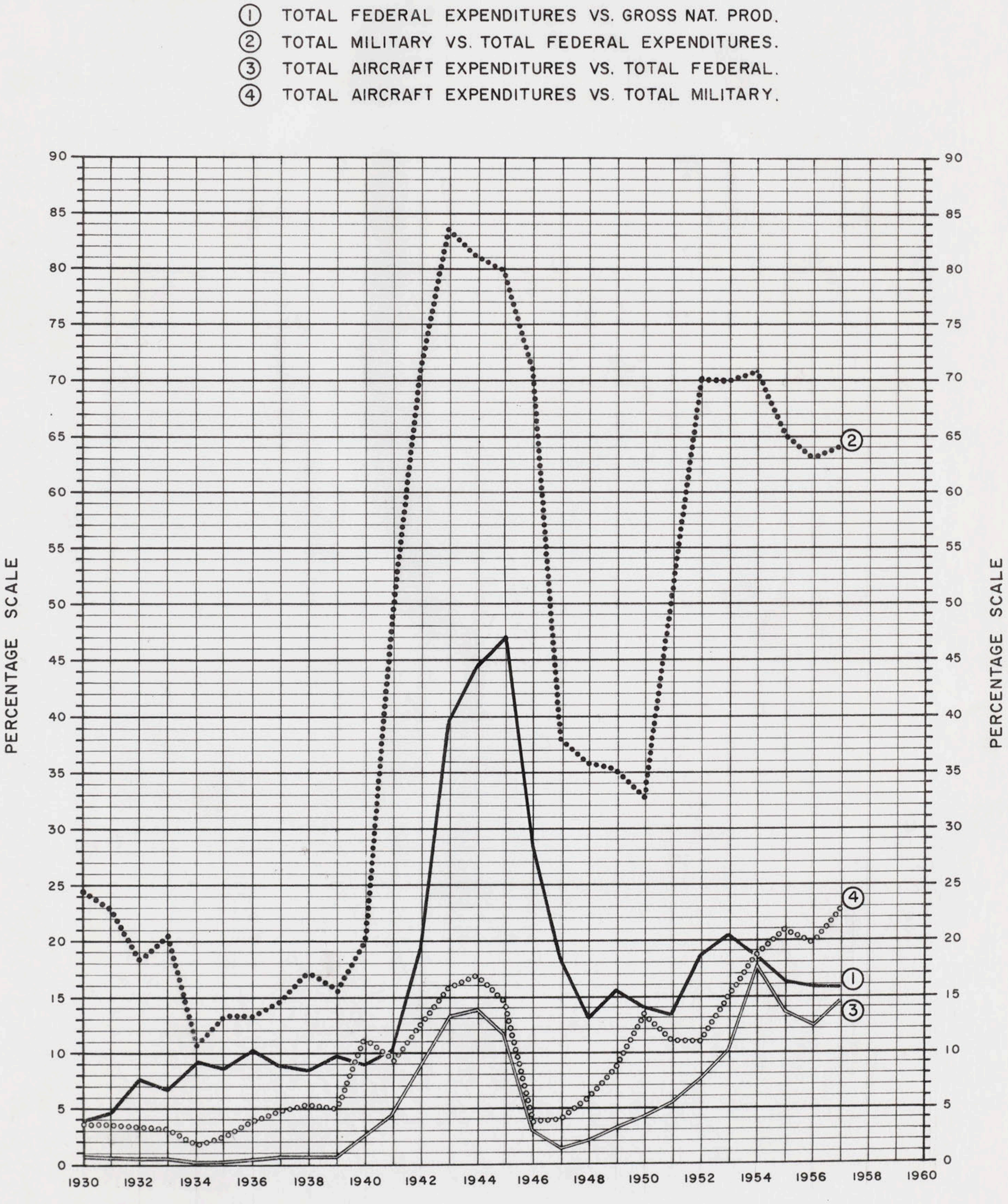
TABLE III

FEDERAL EXPENDITURE STATISTICS
(Expressed in Percentages)

Year	Total Federal Expenditures vs. G.N.P.	Total Military vs. Total Federal Expenditures	Total Aircraft Expenditures vs. Total Federal	Total Aircraft Expenditures vs. Total Military
1930	3.8%	24.5%	.9%	3.7%
1931	4.8	22.8	.8	3.7
1932	7.7	18.4	.6	3.5
1933	6.9	20.3	.6	3.2
1934	9.3	10.9	.2	1.8
1935	9.7	13.2	.3	2.5
1936	10.4	13.3	.5	3.8
1937	9.0	14.5	.7	4.9
1938	8.5	17.1	.9	5.4
1939	9.6	15.7	.8	5.0
1940	9.0	20.0	2.3	11.4
1941	10.1	49.2	4.6	9.4
1942	19.6	71.0	9.0	12.7
1943	39.5	83.5	13.2	15.9
1944	44.5	81.2	13.7	16.9
1945	47.0	80.0	11.5	14.3
1946	28.8	71.0	2.7	3.8
1947	17.9	38.0	1.5	4.0
1948	13.1	35.7	2.1	5.9
1949	15.4	35.0	3.1	8.9
1950	14.0	32.8	4.3	13.1
1951	13.4	51.0	5.5	10.8
1952	18.9	70.2	7.7	11.0
1953	20.3	70.0	10.4	14.9
1954	18.5	70.8	17.6	18.5
1955	16.2	65.1	13.6	20.8
1956	15.8	63.0	12.5	19.9
1957	15.7	64.0	14.5	22.7

FIGURE 4

FEDERAL EXPENDITURE STATISTICS EXPRESSED IN PERCENTAGES



Industry Financial Analysis

The industry has, since 1940, depended on the military services for the major portion of its business. The violent cyclical swings of military needs have left its mark on the profitability record of the entire industry.

The combined airframe industry enjoyed, in 1940, a net profit that amounted to 12.9% of sales. Net profit dropped during the war until, in 1946 and 1947, the industry generated losses of 2.1% and 7.7% respectively. By 1950 the industry had recovered and showed a 4.5% return on sales. Since then profits have fluctuated, generally downward, to where in 1957 it was 2.4% of sales. The profits for the years 1953 through 1957 are still subject to the Renegotiation Act of 1951 and, hence, are probably overstated. The profit pattern for the combined industry is shown statistically on Table IV and graphically on Figure 5.

Table V and Figure 6 provide a means for comparing the profitability of the aircraft industry with other large segments of American Industry. The profit returns for the combined industry have ranked lower than any of the industries compared for the entire period from 1951 to 1957.

Table VI provides a means of identifying the twelve major producers who comprise the combined airframe industry. In this table they are ranked according to the net value of military prime contracts awarded during the 1950-1957 period.

TABLE IV

12 MAJOR AIRFRAME COMPANIES COMBINED

NET PROFIT AS PERCENT OF SALES

Year	Net Federal Taxes as Percent of Total Income	Net Profit as Percent of Sales
1940	26.9	12.9
1941	59.5	7.4
1942	72.6	2.2
1943	72.0	1.4
1944	71.7	1.0
1945	57.5	1.7
1946	Not Applicable	- 2.1 (loss)
1947	Not Applicable	- 7.7 (loss)
1948	82.3	0.3
1949	37.5	3.2
1950	43.7	4.5
1951	68.6	1.6
1952	62.9	2.2
1953[a]	63.2	2.3
1954[a]	50.8	3.7
1955[a]	51.8	3.4
1956[a]	52.3	2.8
1957[a]	52.0	2.4

[a] Subject to renegotiation.

Material Source: Aviation Facts and Figures - 1958 Edition

FIGURE 5

TWELVE MAJOR AIRFRAME COMPANIES COMBINED
NET PROFIT AS PERCENT OF GROSS SALES

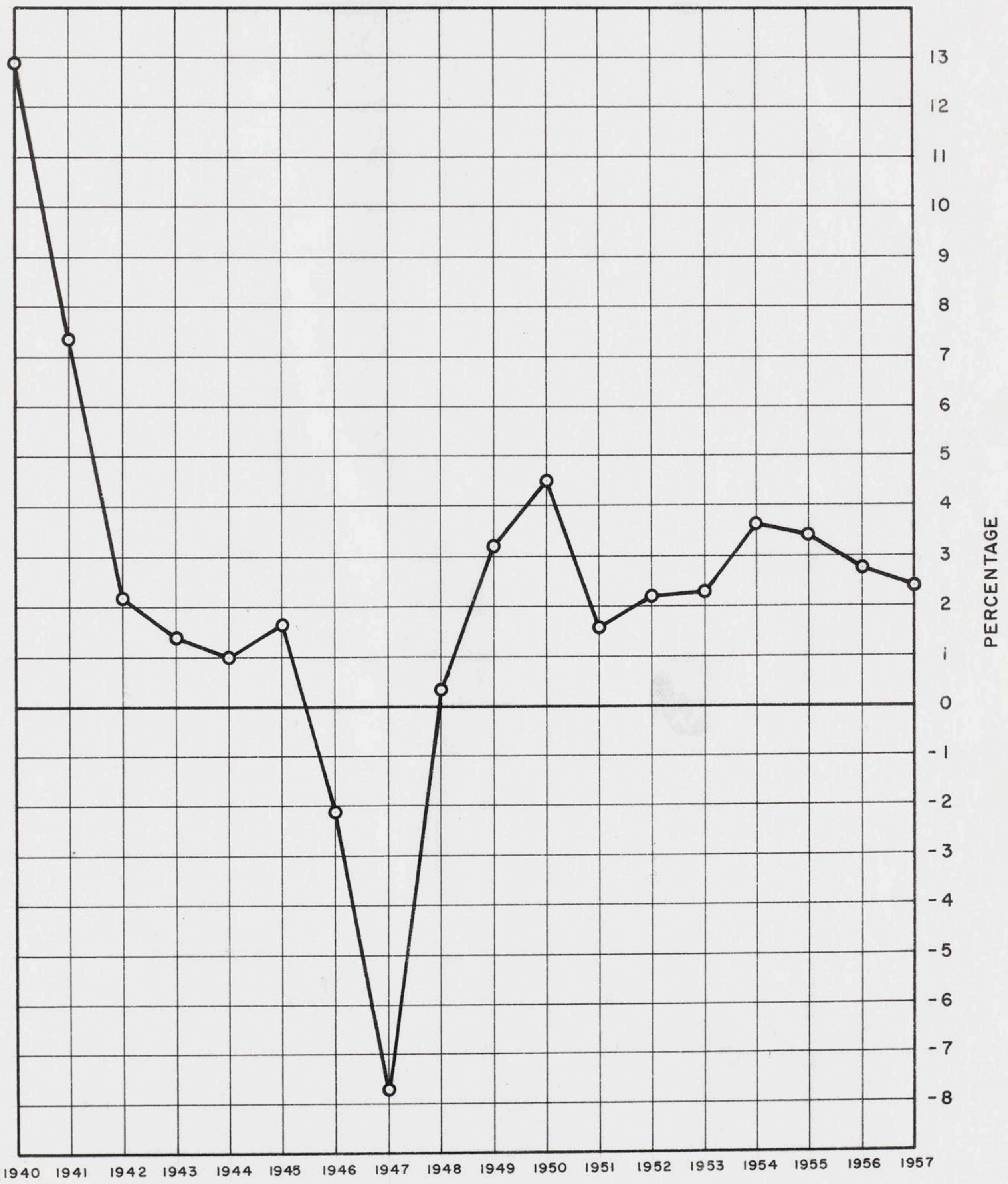


TABLE V

NET PROFIT AS PERCENTAGE OF SALES

SEVEN SELECTED INDUSTRIES

	1951	1952	1953	1954	1955	1956	1957
Nonferrous Metals	8.8	7.7	6.9	7.3	9.5	10.5	7.9
Petroleum Products	11.5	10.5	10.6	10.7	10.6	10.4	9.7
Autos and Trucks	5.2	5.5	4.4	6.4	7.4	5.7	5.7
Railway Equipment	4.8	3.8	3.3	4.1	4.7	4.4	4.4
Iron and Steel	5.8	5.0	5.7	6.0	7.8	7.2	7.4
Aircraft and Parts	2.2	2.4[a]	2.4	3.8[a]	3.9[a]	3.4[a]	3.0[a]
Total Manufacturing	6.2	5.4	5.3	5.9	6.7	6.0	5.9

[a] Subject to renegotiation.

Material Source: Aviation Facts and Figures - 1957, 1958 Editions

FIGURE 6

NET PROFIT AS A PERCENT OF SALES
FOR
SEVEN SELECTED INDUSTRIES

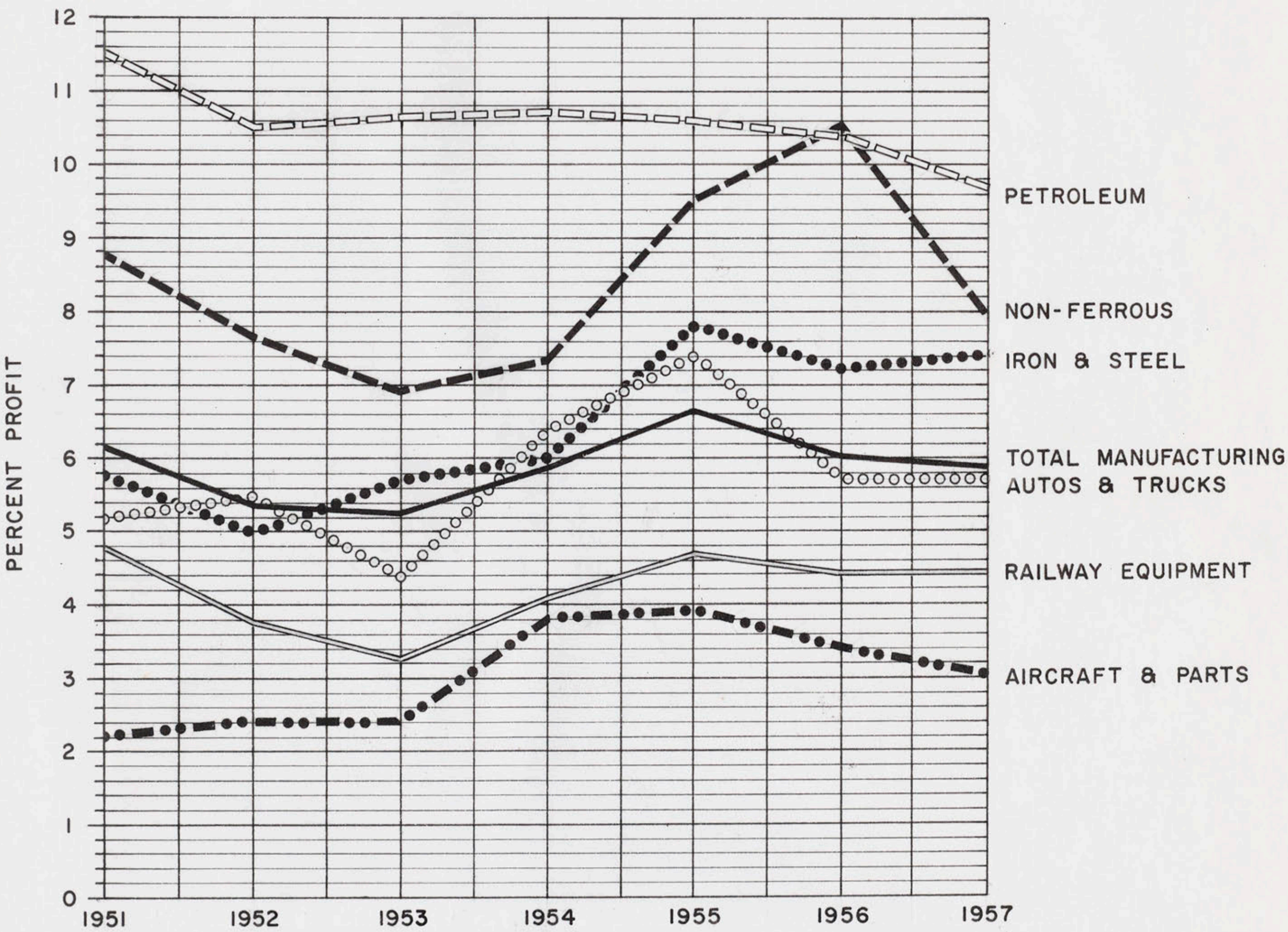


TABLE VI

TWELVE MAJOR AIRFRAME MANUFACTURERS

(Listed by rank according to net value of military prime contracts awarded during the period 1950-1957)

	July 1, 1950 to June 30, 1957	Jan. 1, 1955 to June 30, 1957	During World War II
U. S. Total, All Defense Contracts (in Billion $)	159.5	44.8	193.3
	Percent of Total Awarded		
1. Boeing Airplane	4.4	4.3	1.5
2. North American Aviation	2.9	4.1	1.6
3. Douglas Aircraft	2.9	1.9	2.5
4. Lockheed Aircraft	2.5	2.7	1.9
5. Republic Aviation	1.6	.9	.7
6. Martin	1.1	1.7	1.3
7. McDonnell Aircraft	1.0	1.8	-
8. Grumman Aircraft	.9	.9	.8
9. Northrop Aircraft	.8	.8	.1
10. Fairchild	.5	.3	.2
11. Bell Aircraft	.4	.4	.7
12. Chance Vought	-	1.0	-

N.B. Excludes Convair, a division of General Dynamics, Inc. The corporation does not publish separate figures for Convair who, presumedly, would rank in the first five.

Material Source: Aviation Facts and Figures - 1958 Edition

Table VII indicates the position of the twelve major producers ranked by sales during 1957. It provides, in addition, the latest sales and profit figures and the position of the company relative to the 500 largest U.S. industrial corporations.

Table VIII provides a means of comparing the changes that occurred in a few of the principal financial accounts of the combined industry. The deterioration of the cash position in spite of large bank loans is of particular interest.

One of the most pressing problems that confronts the industry today is the generation of a source of funds to build the facilities required for the research and manufacture of modern complex aircraft. In recent years the earnings rate of the industry has dropped considerably and, in general, earnings have been the principal source of funds for this necessary expansion. It is a problem of no mean dimension to determine if retained earnings will be capable of supporting expansion in the future.

The Customer

The Federal Government, through the efforts of the Department of Defense and its three military branches, is the final customer for all of the military aircraft and associated products and services that are developed and produced by the aircraft industry.

TABLE VII

TWELVE MAJOR AIRFRAME MANUFACTURERS
RANKED BY 1957 SALES
(In Millions)

Company	Sales	Net Profit	Percent Profit of Sales	Rank Position in Fortune Directory: By Sales	Rank Position in Fortune Directory: By Profit
1. Boeing Airplane	$1,596.5	$38.2	2.4	19	65
2. North American Aviation	1,243.8	33.9	2.7	25	77
3. Douglas Aircraft	1,091.4	30.7	2.8	33	79
4. Lockheed Aircraft	868.3	16.3	1.9	44	128
5. Martin	423.9	11.4	2.7	91	187
6. McDonnell Aircraft	335.3	9.67	2.9	124	211
7. Northrop Aircraft	281.2	5.52	2.0	150	324
8. Republic Aviation	269.0	6.10	2.3	155	305
9. Chance Vought	237.3	6.15	2.6	183	303
10. Grumman Aircraft	205.2	5.24	2.6	206	331
11. Bell Aircraft	202.3	4.35	2.2	208	359
12. Fairchild	158.6	.50	0.3	262	485

N.B. Excludes Convair, a division of General Dynamics, Inc. The corporation does not publish separate figures for Convair who, presumedly, would rank in the first five.

Material Source: The Fortune Directory - August 1958

TABLE VIII

COMBINED AIRFRAME INDUSTRY
SELECTED FINANCIAL STATISTICS
(In Millions)

	1951	1952	1953	1954	1955	1956	1957
Net Sales	1,979.3	3,731.1	5,120.1	4,926.8	5,188.1	5,637.1	6,912.7
Net Profit	30.9	81.7	116.6[a]	182.6[a]	178.8[a]	156.5[a]	166.4[a]
Cash	159.7	216.5	261.9	295.4	295.5	311.6	233.3
Receivables	360.2	479.5	526.4	461.9	463.8	594.2	792.0
Inventories	373.4	531.0	583.9	592.1	638.2	874.5	947.7
Total Net Plant	124.5	154.0	166.1	186.4	214.1	310.0	431.5
Payables	369.9	541.0	544.2	396.2	375.8	635.0	874.7
Renegotiation Refunds Due U. S.	209.0	297.1	406.9	409.0	375.6	347.6	335.2
Bank Loans	27.8	30.7	8.6	8.6	36.8	73.7	127.8
Capital Stock	66.2	94.8	95.5	125.7	135.5	168.4	178.6
Earned Surplus	260.8	283.4	353.9	415.4	495.9	549.0	638.4

[a] Subject to renegotiation.

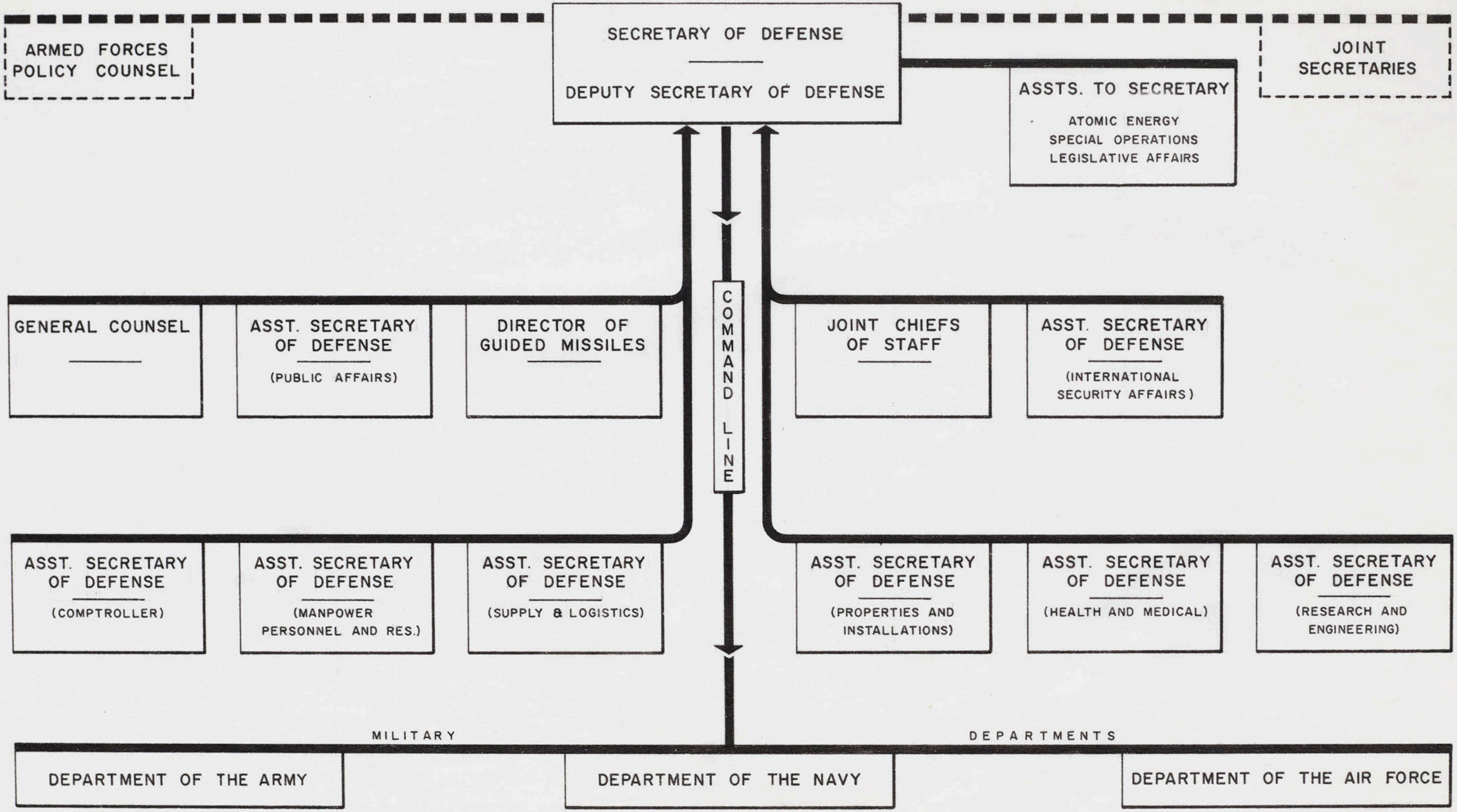
Material Source: Aviation Facts and Figures - 1957, 1958 Editions

The Department of Defense stems from the Department of War which was established as an executive department at the seat of government by an act approved August 7, 1789. The Department of Defense, originally designated the National Military Establishment by the National Security Act of 1947, was established as an executive department of the government by the National Security Act Amendments of 1949. The Act established within the Department of Defense the Armed Forces Policy Council, the Joint Chiefs of Staff, the Joint Staff, the Munitions Board, the Research and Development Board, and three military departments--the Department of the Army, the Department of the Navy, and the Department of the Air Force. The Department of Defense was created as a part of a comprehensive program designed to provide for the future security of the United States through the establishment of integrated policies and procedures for the departments, agencies, and functions of the government relating to the national security.[3] In enacting this legislation, it was the intent of the Congress to provide three separately administered military departments with assigned combat and service duties. The Department of Defense does not operate a procurement section. The purchasing function is provided by procurement groups in each of the three military departments.

FIGURE 7

DEPARTMENT OF DEFENSE

OFFICE OF THE SECRETARY OF DEFENSE



The Department of the Army is charged with the responsibility of providing support for national and international policy and the security of the United States by planning, directing, and reviewing the military and civil operations of the Department of the Army, to include the organization, training and equipping of land forces of the United States for the conduct of prompt and sustained combat operations on land in accordance with plans for national security.[4] The aircraft needs of the Army, when measured by dollar volume, are the smallest of the three military branches. The procurement function is performed by the office of the Deputy Chief of Staff for Logistics which acts on recommendations and requirement determinations made by the United States Continental Army Command. The Army's air activity is restricted to those directly connected with land operations. Typical air activities include liaison, artillery spotting, observation and logistic support. It does not include the major air defense of our continent. The Army has made significant contributions to the science of modern missilery. Its present missile activity is concentrated in the development of short-range and portable varieties.

The Department of the Navy and the office of the Secretary of the Navy were established by Act of Congress approved April 30, 1798. Prior to that, the conduct of

FIGURE 8

DEPARTMENT OF THE ARMY

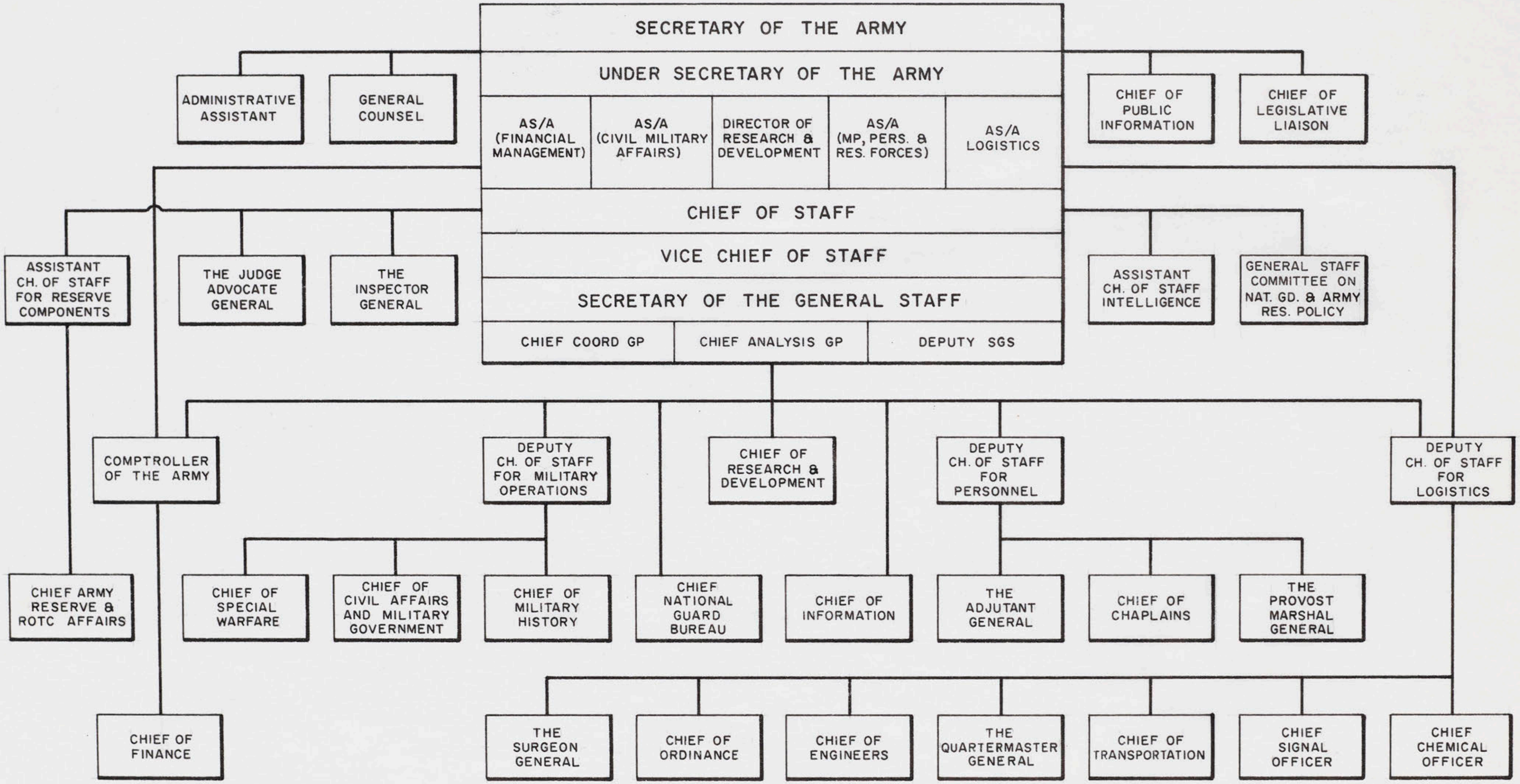
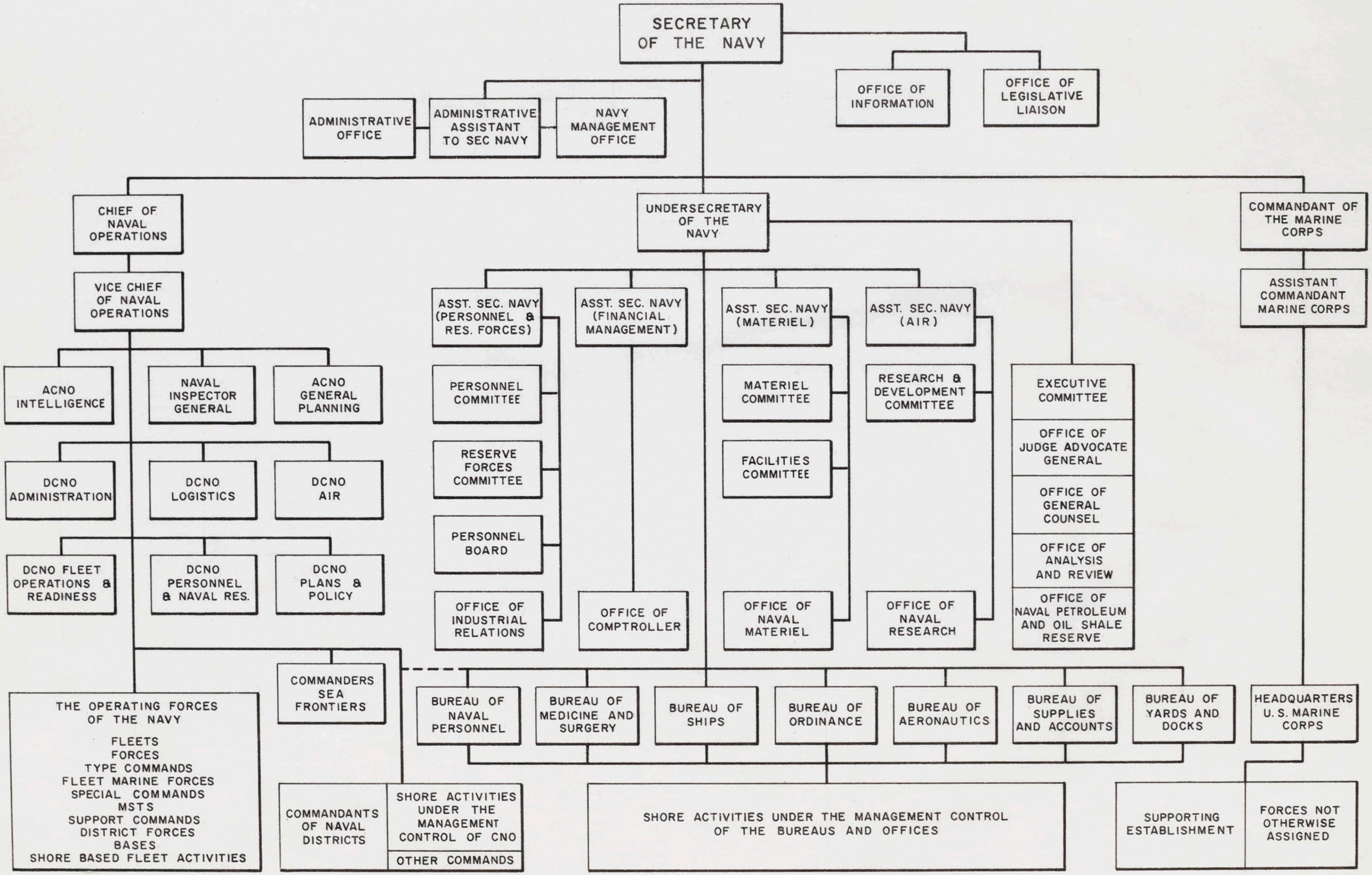


FIGURE 9

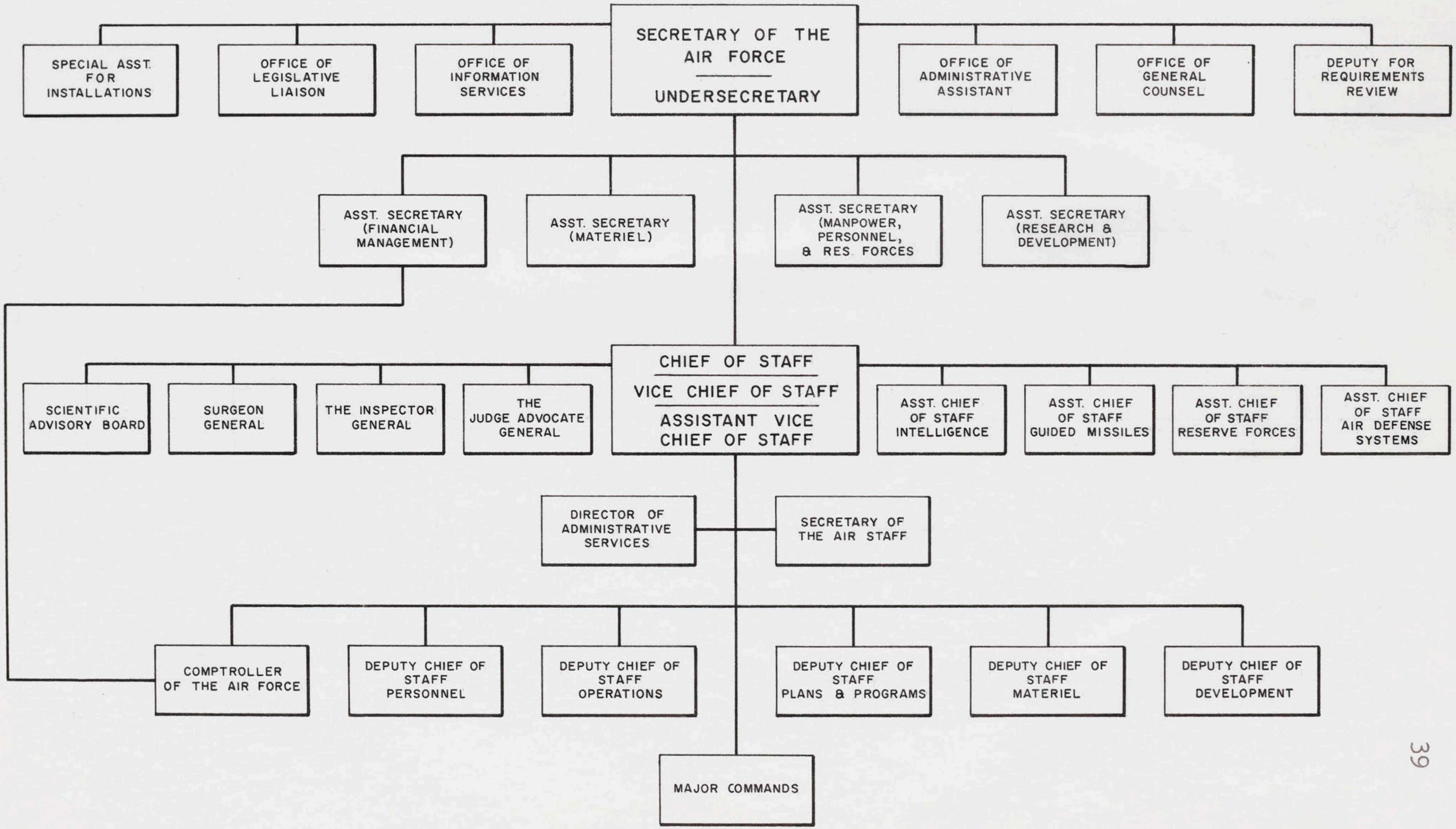
DEPARTMENT OF THE NAVY



naval affairs was under the Secretary for the Department of War. The Chief of Naval Operations commands the Operating Forces of the Navy, and is responsible to the Secretary of the Navy for their use in war and for plans and preparations for their readiness for war. He is charged with the preparation, readiness and logistic support of the Operating Forces of the Navy, and with the coordination and direction of effort to this end of the bureaus and offices of the Navy Department.[5] The Bureau of Aeronautics performs the actual procurement function on orders from the office of the Chief of Naval Operations. In addition to purchasing, the Bureau is responsible for the design, research, development, scheduling and general administrative functions for all Naval and Marine aircraft programs.

The Department of the Air Force, legally founded in 1947, is the youngest of the three military departments. Of the three major services, the Air Force has primary responsibility for: defending the United States against air attack; gaining and maintaining air supremacy; defeating enemy air forces; and controlling vital air areas. The fifteen major commands within the Air Force are responsible for organizing, administering, equipping, and training the subordinate elements for the accomplishment of assigned missions.[6] The plans and requirement determinations for aircraft are generated by the fifteen major commands. The procurement

FIGURE 10 DEPARTMENT OF THE AIR FORCE



function, however, is performed not by one but by two agencies. The Air Research and Development Command, responsible for the development, evaluation, and testing of all new Air Force aircraft, is also responsible for the placement and administration of all early development-type contracts. Once the aircraft has been satisfactorily tested and evaluated, the procurement function and associated administration becomes the responsibility of the Air Materiel Command.

Method of Conducting Business

The complexity of modern products, the increased competitive situation that exists in the industry, the large amounts of money involved, and the very practical limit of availability of funds all contribute to the difficulty of doing business in the military aircraft field. The inherent uncertainties demand diversification of product with activity, usually, in more than one military service.

Because of the vast amounts of money required and the long-time period between inception and delivery of a product, aircraft design and manufacture can only be conducted on a contract basis, where the terms and conditions are agreed upon before work is begun. The customer and the supplier draw contracts that depend on the nature of the work. The different types are:[7]

1. Firm Fixed Price - Applicable when firm specifications have been established and supplier has sufficient production experience on which to base a valid price. Profit is dependent upon supplier's control of costs.

2. Fixed-Price Incentive - The share ratio, firm target cost, target profit and price ceiling are negotiated at beginning of contract. If total costs are less than target costs, contractor makes target profit plus a share of savings up to established ceiling on final profit. If total costs exceed target costs, contractor makes target profit less a share of excess costs. Government and contractor share costs up to cost ceiling. Contractor pays all costs over cost ceiling. This plan is feasible for sharing long-run production programs. Not applicable to research and development or initial production programs.

3. Cost-Plus-Incentive Fee - Government agrees to reimburse contractor for all allowable costs. Target cost, target fee, minimum and maximum fee and adjustment formulas negotiated at outset. When total allowable costs are less than target cost, contractor receives target fee plus increase up to maximum fee negotiated. When total allowable costs are more than target cost, contractor receives less than target fee, but not less than minimum fee. Applicable for development, tooling, and initial production contracts.

4. Cost-Plus-Fixed Fee - Government agrees to reimburse contractor for all allowable costs. Fee is negotiated at outset as a percentage of original estimated cost. Fee remains fixed regardless of cost experience in performance of original contract scope. Fee for contract changes negotiated separately. Applicable for research, preliminary design, initial tooling and production.

5. Letter Contract - Preliminary contractual instrument which authorizes immediate procurement of material and services. Reimburses contractor for allowed costs on a progress payment basis. No fee or profit is earned by the contractor. Letter contract is usually converted to one of other types in order to control costs and earn a profit or fee by a more definitive contract. Applicable in emergency situations, or when the work is of a broad, undefined scope and not susceptible to any reasonable cost estimate.

Contracts and contract proposals are evaluated by the cognizant agency who carefully considers technical superiority, producibility, cost, product growth potential and delivery before awarding a contract to the producer who, in the aggregate and generally, has the superior product.

It is difficult to isolate any particular consideration as most important. In some contracts delivery may be paramount, while in other circumstances cost may be the determining factor. In all circumstances, however, that product which best fulfills the defense needs of the Nation is the one that is selected.

The Renegotiation Act of 1951 is the one major factor that makes contracting with the government for defense projects different from the usual industrial forms of contracts. The Renegotiation Board is responsible for determining whether a defense contractor has made excessive profits. This determination, which may take as long as four years, is made after satisfactory review and scrutiny by the original contracting agency and often leads to refunds by the producer. Some recent contracts have been issued that provide for bonuses and penalties that depend on producer performance measured in many ways. The intent of these contracts is to make it possible for a producer to make a return consistent with the risk involved, at less total cost to the government. These intended benefits, however, are problematical if, on later review, the Renegotiation Board has jurisdiction in the final analysis.

Future Business Trends

The estimation of future business is subject to many unforeseen circumstances. In the defense industries, dependent as they are on the government allocation of funds, the usual problems are complicated by changing world conditions and political pressures.

The trends have been determined by an extrapolation of historical expenditures up to recent times and official estimates for the immediate future. The trends indicate that:

1. Expenditures for the procurement of military airplanes will fall from the annual rate of $7 billion in 1959 to approximately $6 billion in 1961. This reduction will be distributed proportionately among the three services.

2. Expenditures for missile procurement will rise from the expected level of $3.2 billion in 1959 to a level of $4.2 billion in 1961.

3. Expenditures for military research and development will rise from $2.6 billion in 1959 to $2.9 billion in 1961.

4. Expenditures for military airplane procurement and related research will fall from $7.2 billion in 1959 to $6.6 billion in 1960, and expenditures for missile procurement and related research will rise from $5.8 billion in 1959 to $6.6 billion in 1960.

5. Considered on a procurement basis alone, the more conventional aircraft will represent approximately 60% of procurement funds spent in 1961.

Tables IX through XII and Figures 11 through 14 form the basis for the determination of these trends.

The business environment in which the industry operates is determined not by the aggregate needs of many customers, but by the needs of one--the military sector of our government. Total business, then, is governed by one customer whose requirements fluctuate with the relative degree of war or peace that exists in the world. The many companies that make up the industry are not assured a proportionate share of the available business, for changes in military strategy, the requirement for technically different aircraft for different missions, rapid technological and scientific obsolescence, and variations of the capabilities of companies all influence the competitive potential of the member firm.

TABLE IX

MILITARY EXPENDITURES FOR AIRCRAFT PROCUREMENT
(In Billions)

	1951	1952	1953	1954	1955	1956	1957	1958[E]	1959[E]
Dept. of Defense	2.412	4.888	7.417	8.335	8.037	7.146	7.978	7.779	6.989
Air Force	1.812	3.633	5.586	6.254	6.295	5.181	5.817	5.410	5.056
Navy	.594	1.205	1.735	1.998	1.676	1.831	1.996	2.195	1.830
Army	.007	.051	.095	.083	.067	.134	.166	.175	.104

[E] Estimated.

Material Source: Aviation Facts and Figures

FIGURE 11

MILITARY EXPENDITURES FOR AIRCRAFT PROCUREMENT

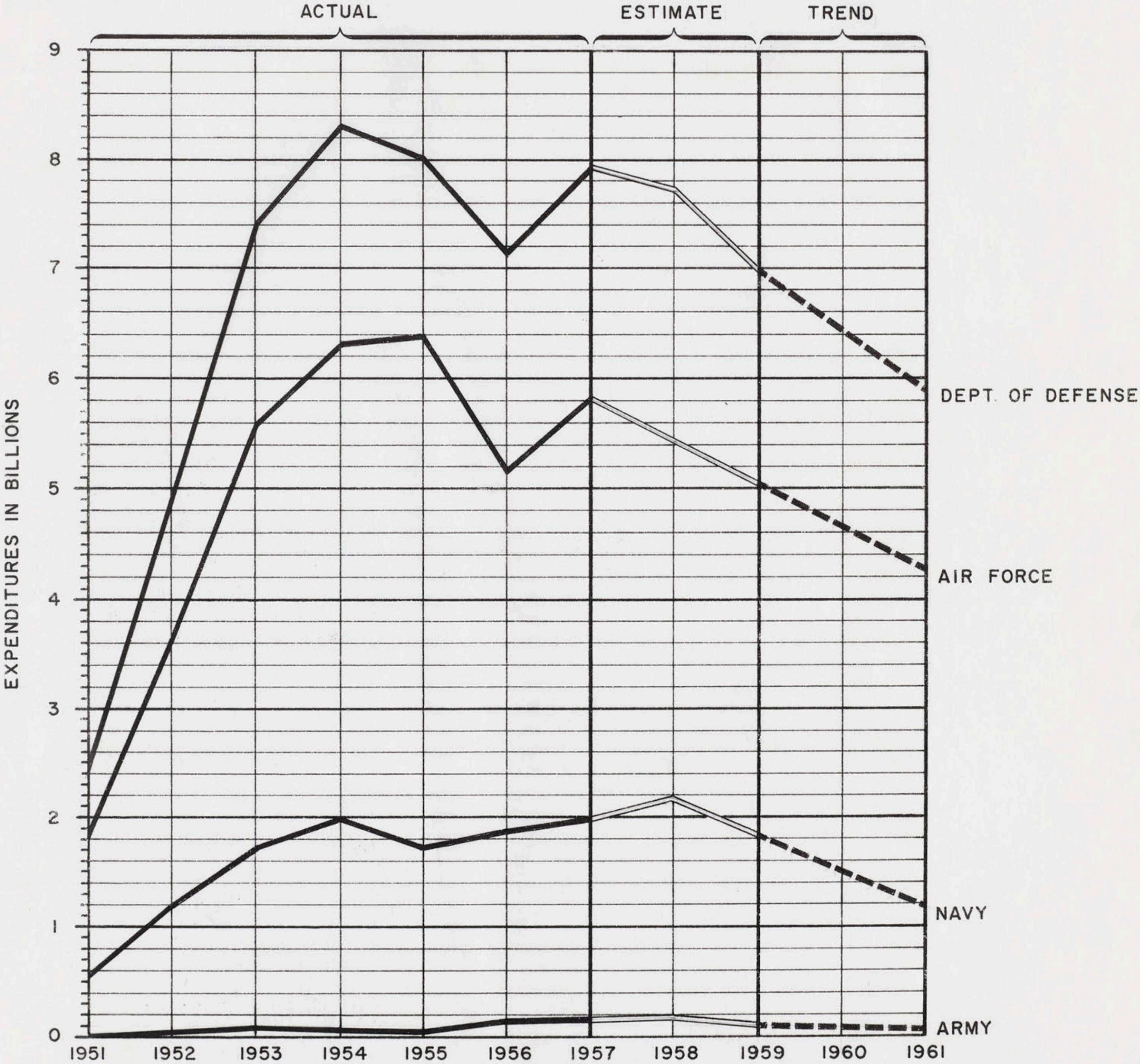


TABLE X

MILITARY EXPENDITURES FOR MISSILE PROCUREMENT
(In Billions)

	1951	1952	1953	1954	1955	1956	1957	1958[E]	1959[E]
Dept. of Defense	.021	.169	.295	.504	.718	1.168	2.095	2.955	3.444
Air Force	.016	.066	.081	.176	.305	.641	1.417	1.970	2.166
Navy	.005	.056	.095	.141	.176	.195	.264	.319	.487
Army	-	.046	.119	.187	.238	.333	.414	.666	.791

[E] Estimated.

Material Source: Aviation Facts and Figures - 1958 Edition

FIGURE 12

MILITARY EXPENDITURES FOR MISSILE PROCUREMENT

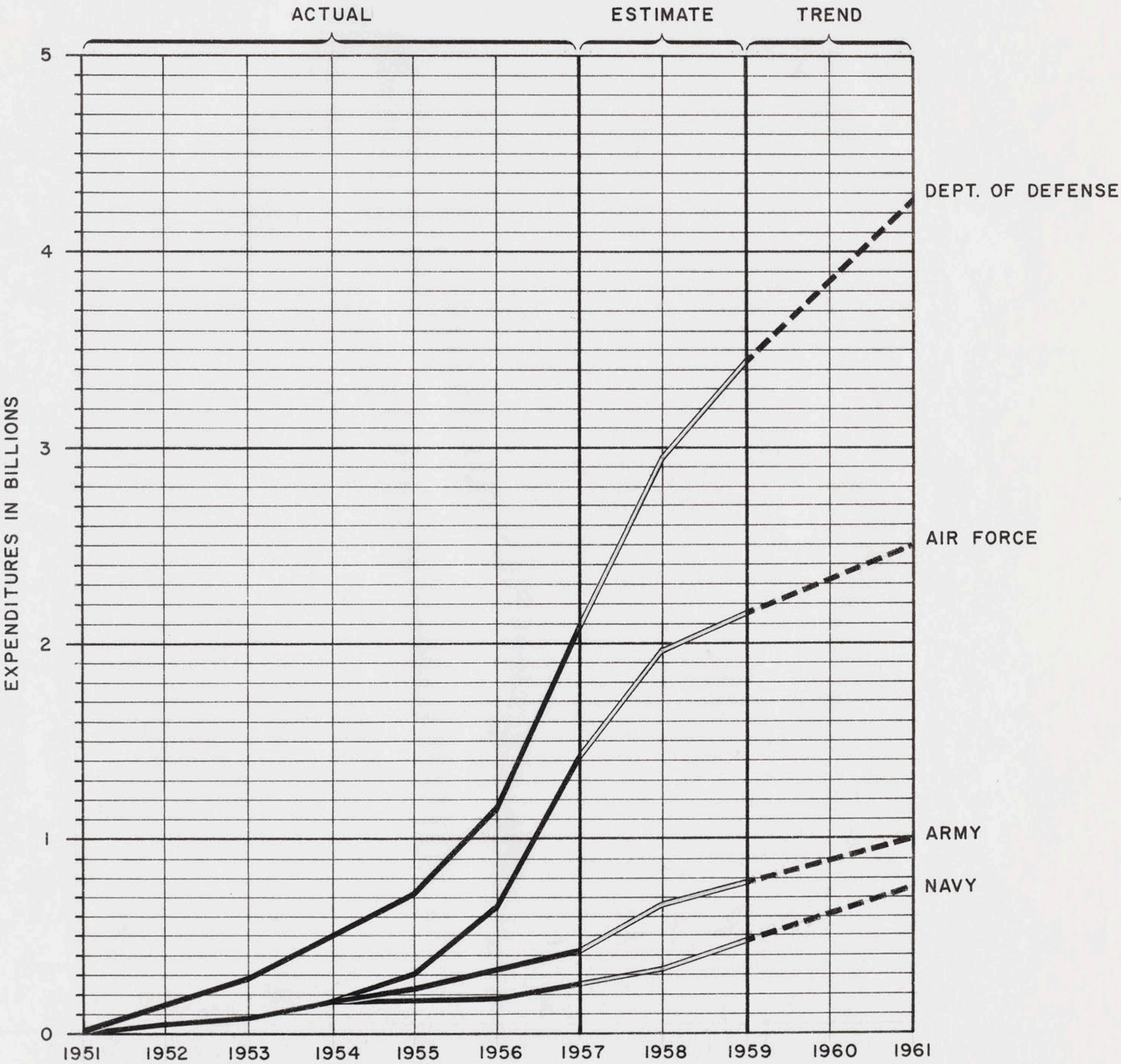


TABLE XI

MILITARY EXPENDITURES FOR RESEARCH AND DEVELOPMENT
(In Billions)

	1955	1956	1957	1958[E]	1959[E]
Department of Defense	1.350	1.539	1.651	1.888	2.588
Air Force	.588	.640	.686	.692	.728
Navy	.395	.496	.538	.527	.751
Army	.366	.404	.427	.457	.494
Advanced Research Projects Agency	-	-	-	.211	.615

[E] Estimated.

Material Source: Aviation Facts and Figures

FIGURE 13

MILITARY EXPENDITURES FOR RESEARCH AND DEVELOPMENT

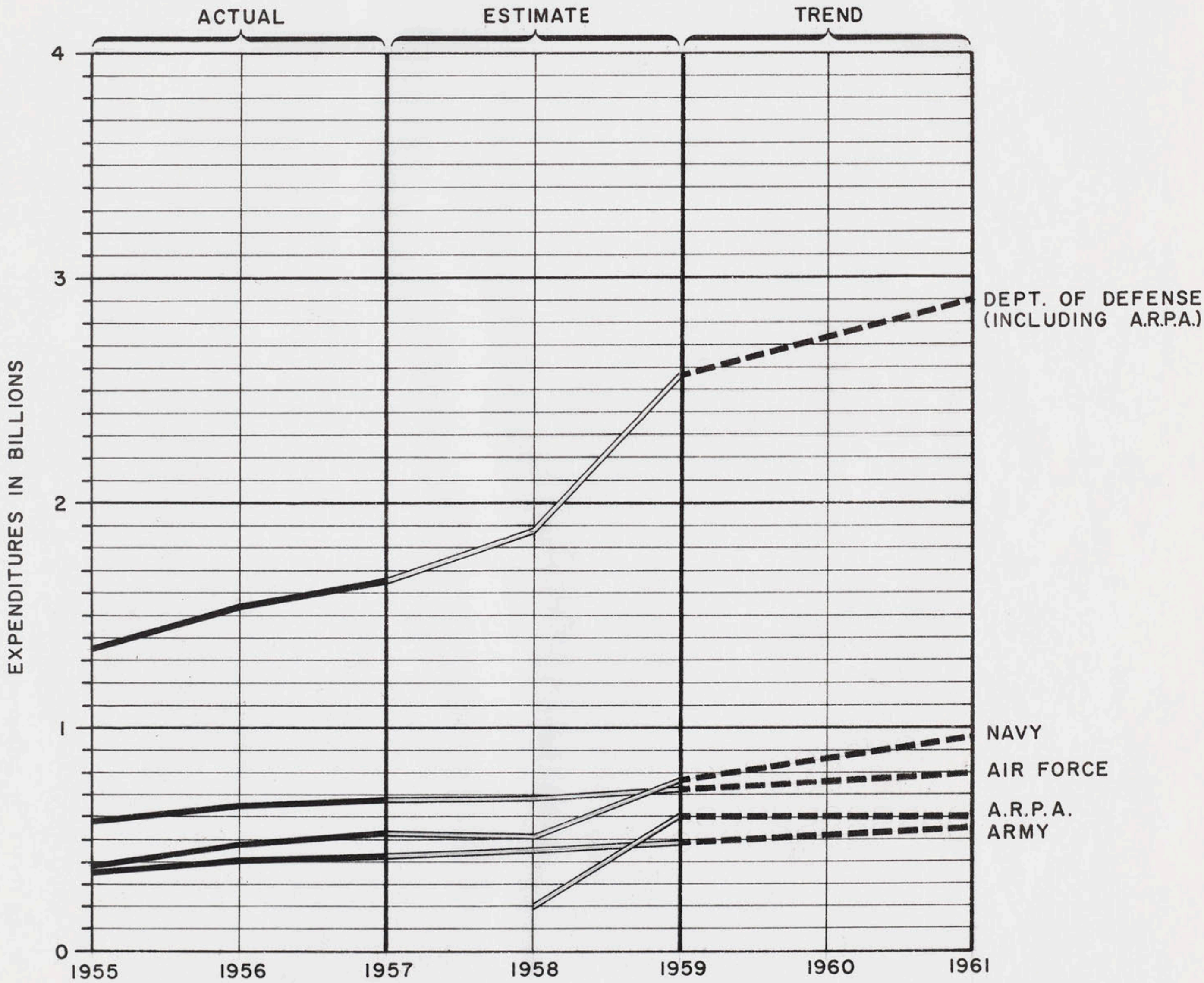


TABLE XII

COMPARISON OF MILITARY EXPENDITURES
AIRCRAFT VS. MISSILES
Including Related Research and Development
(In Billions)

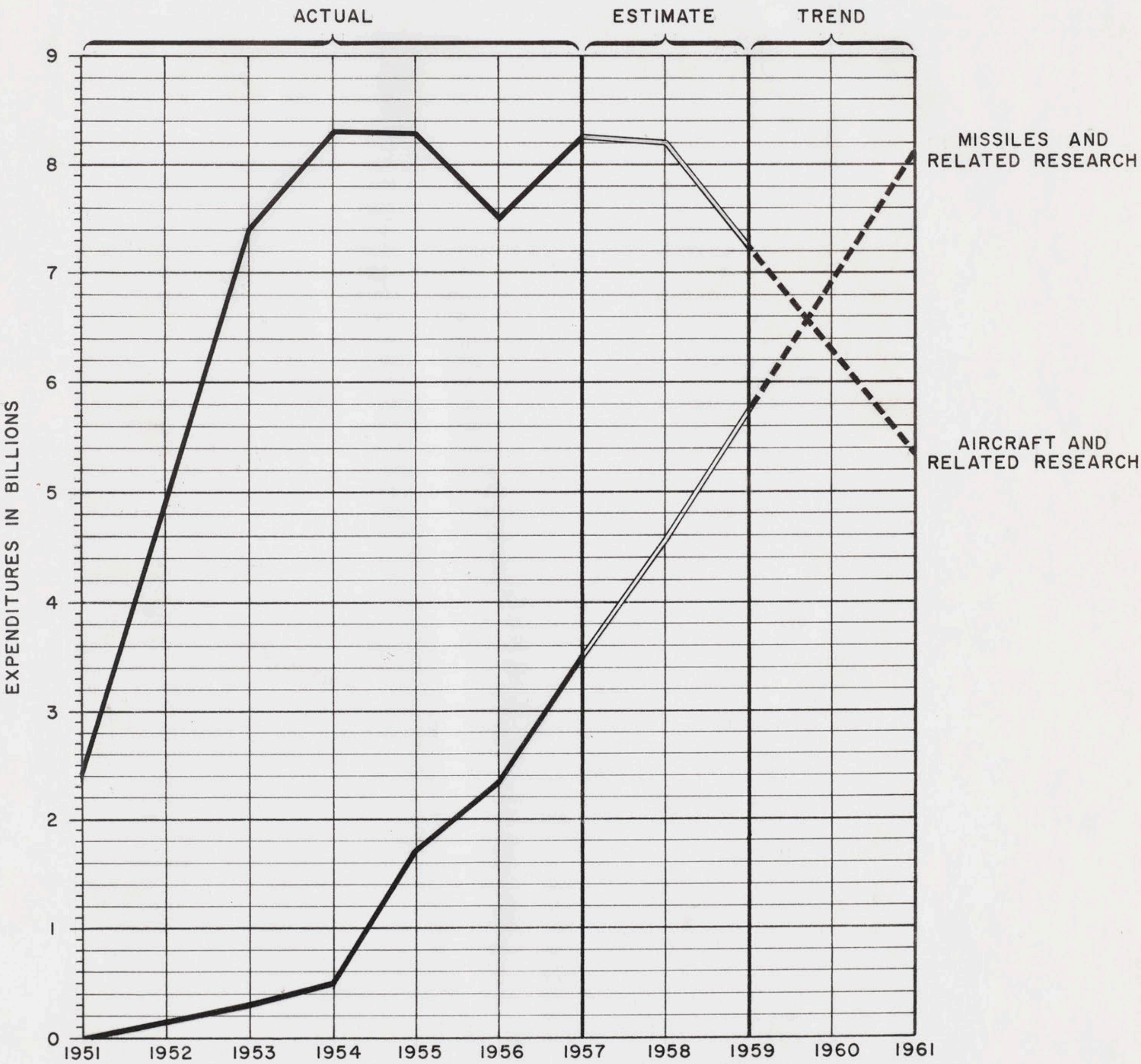
	1951	1952	1953	1954	1955	1956	1957	1958[E]	1959[E]
For Aircraft	2.412	4.888	7.417	8.335	8.037	7.146	7.978	7.779	6.989
For Aircraft Research	-	-	-	-	.294	.352	.273	.273	.260
TOTAL	2.412	4.888	7.417	8.335	8.331	7.498	8.251	8.052	7.249
For Missiles	.02	.169	.295	.504	.718	1.168	2.095	2.955	3.444
For Missile and Associated Research	-	-	-	-	1.056	1.186	1.379	1.614	2.329
TOTAL	.02	.169	.295	.504	1.774	2.354	3.474	4.569	5.773

[E] Estimated.

Material Source: Aviation Facts and Figures - 1958 Edition

FIGURE 14

COMPARISON OF MILITARY EXPENDITURES



FOOTNOTES

CHAPTER II

1. Aircraft Industries Association of America, Inc., Aviation Facts and Figures, 1958 Edition, American Aviation Publications, Inc., Washington 5, D. C., p. 2.

2. Ibid., p. 76.

3. National Archives and Records Service, United States Government Organization Manual 1958-1959, Revised June 1, 1958, (Washington 25, D. C. Government Printing Office), pp. 133, 143, 592.

4. Ibid., pp. 143, 593.

5. Ibid., pp. 158, 161, 594.

6. Ibid., pp. 184, 595.

7. Department of the Navy, Bureau of Aeronautics, Study of Aircraft Procurement Contract Types and Contracting Methods, Dec. 17, 1957, (Washington, D. C.), p. 97 (unpublished).

CHAPTER III

THE NEW AND CHANGING COMPLEX

Depending, as it does, on the vagaries of world peace, the military aircraft industry is subject to wide variations in total sales. Pushed by the urgencies of World War II, the industry grew to a peak employment of 1,350,000 people who built 95,000 airplanes at a cost of 13 billion dollars. The peace that followed created immense readjustment problems. Retrenchment was so drastic that, in 1947, employment dipped to 239,000 people who manufactured 2,122 airplanes at a total cost of 0.6 billion dollars. The combined industry during 1947 showed a net loss of 42 million dollars, 7.7% of its sales for the year.[1]

An External Threat

Early examples of a serious challenge to our Nation's technical superiority were evidenced during the Korean struggle, when the appearance of the highly satisfactory MIG-series of jet fighters demonstrated the excellent capability of Russian aircraft designers and producers. The development of this surprisingly effective airplane took place in the period just prior to the outbreak of hostilities in Korea. Since then, additional evidence has been forthcoming in rapid succession.

The first atomic detonation was produced by the

United States in 1945. Four years later, in 1949, the U.S.S.R. succeeded in producing its first atomic explosion. The first thermonuclear detonation was produced in the United States in 1952. One year later, in 1953, the Soviets developed similar thermonuclear successes. The time differential was constantly narrowing. Intercontinental jet bombers were produced by both the United States and the U.S.S.R. in 1955. The first Earth satellite, the first intercontinental ballistic missile, and the first lunar probe--all Russian "firsts"--attest to the scientific and technical capabilities of the Soviets, and are grim but real examples of the seriousness and magnitude of the external threat that faces the United States.[2]

Additionally the Russians have been able, seemingly, to develop their new projects in less elapsed time than that necessary for like accomplishments in our own country. More than eight years elapsed from the original conception of our B-52 bomber to its production; the comparable Russian bomber, the Bison, was developed and produced in from four to five years. The Russian supersonic fighter, the Farmer, took about four years to conceive and develop compared with the seven years required for our F-102 fighter.[3] These accomplishments provoke sobering thoughts.

The emergence of the U.S.S.R. as a contending world power in the race for air and space supremacy, together with political beliefs that differ from our own, seriously challenge not only the technical and military superiority but the world-wide political influence of the United States as well. The "cold-war" situation and the improved technical position of this potential enemy have added impetus to the urgency with which our Nation views this external threat.

Warfare Patterns

The technologies developed since the war have not only added weapons to the arsenal, they have actually altered the manner in which war can be conducted. The awesome death-dealing potential of the ballistic missile-H bomb combination is understood by even the most uninformed layman. The old safeguards of an attrition-type war can no longer be relied on. It runs, at best, a poor second. In a general all-out war, ballistic missiles and H bombs could wipe out the industrial and human resources necessary to wage war on the attrition basis. This could certainly be done by a powerful nation with large resources. It can even be accomplished by a weak nation who, over-stretching the bounds of propriety by design or accident, suddenly becomes the catalyst that sparks the dormant power into action. But what if the bounds of propriety are not over-stretched? This could lead to "brush-fire" war--a long drawn-out affair that erupts first here, then there--with outbreaks in virtually any part of the world that must be quelled. Atomic weapons and ballistic missiles are certainly not the proper weapons for this type of warfare. With additional provocation, though, the "brush-fire" war can grow into a limited attrition-type war fought with all but the most devastating weapons, and limited only by the reluctance or fear of the participants to chance the finality of the most powerful weapons.

There is still another element in the preparedness program. In past wars, the natural barriers of long ocean distances provided isolation and protection to our continent. In a general war, this natural deterrent would no longer be effective.

There now exists, in addition to the requirements for possible involvement in a general war and a limited war, the need for providing a strong continental defense. All three elements of modern warfare must be provided for in adequate, concurrent and timely fashion.

Technology Changes

History indicates that all major wars up to the present day have been won, eventually, by attrition. The nation that could stave off the immediate thrusts of an enemy and manage to remain in operation while it marshalled its resources could, if its total fund of resources over-balanced those of the enemy, eventually win the war. The victorious nation was the one with the ability to replace the exploded shell with a new shell, the worn-out shoe with a new shoe, and the shot-down plane with a new plane. World War II was fought and won on the attrition principle.

The ever increasing pressure for greater numbers of airplanes limited the technological improvements of World War II airplanes. Production flows could not be interrupted while major changes were made. Improvements were generally limited to those that could be introduced without seriously affecting production techniques or delivery schedules. The stress on quantity was paramount. The war ended with the Allies having airplanes that were, usually, somewhat better in performance but in quantities far in excess of those available to the enemy. Although operational speeds, altitudes and ranges did increase during the war, they were restricted by the limitations of the propeller, the piston engine, conventional fuels and the weather.

The discovery and exploitation of new technologies since the war have removed some of the severe limitations that existed. The development of the jet engine removed the propeller and speed limitation, the discovery of new fuel-oxidizer combinations no longer restricts operations to those of dense air altitudes, the development of radar has made operations possible during hazardous weather, and the rapid development of electronics has done much to reduce the human limitations posed by the new heights and speeds. The industry has, just recently, started to use the science of atomic power in aircraft applications.

Recent Products

The incorporation of these new technologies has significantly increased the capabilities of present day products. Speeds of civilian transports have increased to a point where transcontinental crossings are achieved in a little over four hours. Military speeds are even greater. The installation of radar in aircraft has permitted the pilot to select less hazardous courses while enroute and has, hence, contributed greatly to the comfort and safety of modern air travel. Large airborne radar installations in airplanes with long flight endurance capabilities are providing early warning protection against hostile or unidentified aircraft trying to pierce the perimeter defenses of our continent. Similar applications in carrier-borne aircraft supply umbrella protection to our naval task forces.

Radar, with its ability to seek and find objects in darkness, adverse weather or beyond the range of vision provided the scientific breakthrough that was necessary for making the next significant step in the evolution of aircraft as an effective weapon. The successful marriage of radar and electronic guidance systems made the guided missile possible. Now for the first time, a missile on its way to a target could sense the needs for adjustment, make the necessary adjustments in its path of travel, and arrive at its destination with no external inputs.

The combination of increased speed, altitude and range made the intercontinental bomber possible. The addition of the atomic bomb to its complement of weapons greatly improved its power for devastation.

The explosion of the hydrogen bomb proved to be the key scientific breakthrough that was needed to assure the economic and technical feasibility of the intercontinental ballistic missile. This invention provided very high yield warheads of small size and light weight. Technical feasibility prior to the H-bomb depended on a guidance system with pin-point accuracy--a system that was beyond our existing knowledge. The greatly increased radius of effective destruction made possible by the new device simplified the mechanisms necessary to guide the missile to its target.

Other recent product developments include Earth and Lunar satellites, Space-testing vehicles and, now under development, a manned Space capsule. In all there are forty-one different types of missiles inbeing or under development.[4]

During the last ten years, industry advances in aircraft technology have tripled speeds, doubled operational altitudes, increased firepower by seven or eight times, and have extended range by a factor of two or three. Speeds of 2,000 miles per hour are the immediate engineering goal for interceptors and bombers. Speeds of from five to seven thousand miles per hour for manned aircraft are a scientific target for the next ten years.[5]

Complexity and Reliability

The introduction of new and more sophisticated weapons was accomplished by greatly increased interdependent problems in complexity and reliability. Increased speeds required power-actuated booster controls, radar required additional electronic gear, and automatic fire-control required the use of airborne computers. This all added to complexity. Test equipment had to be developed in order to check the new apparatus. This increased reliability but also increased complexity! In manned aircraft, minor malfunctions were often rectified by the pilot or, if this was impossible, the system was by-passed. The complexity-reliability problem was really compounded when the pilot was removed from the aircraft. In this circumstance, complexity was further increased and reliability was even more demanding. The failure of a single inexpensive part could cause the failure of a million dollar missile.

As an indication of complexity, the World War II B-17 required 200,000 engineering man-hours to the point of first production flight. The B-52 required 4,085,000, the B-58 took 9,340,000 and the new B-70 chemically-powered bomber, 14,500,000 engineering man-hours. From the B-17 to the B-70, a seventy-fold increase in engineering effort was required.

Expressed in dollar costs, the B-17 cost $200,000; the B-52 was about $8 million; the B-58 approximately $10 million; and the B-70 is estimated at $12 million each.[6]

For another comparison, the B-17 carried 1600 pounds of electronic gear and 100 electronic tubes, the B-29 carried 2100 pounds and more than 500 tubes, and the B-47 carried 5400 pounds of electronic gear and approximately 1125 electronic tubes.[7]

Mr. William F. Ballhaus, Vice President of Northrop Aircraft, aptly summed the problem when he said:[8]

> ...As we trace the history through the years of World War II, then the post war era, and finally through Korea and post Korea, we see that the almost explosive advance of science and technology has permitted us to increase speed, altitude, radius, payload, or armament capability of all military weapons. With this tremendous increase in system performance, has come a corresponding increase in system complexity and system cost.
>
> Many weapon systems have increased in complexity so dramatically that even heretofore experienced and qualified prime weapon system contractors have found their management capabilities seriously extended with respect to manpower, technology, and facilities.
>
> Each segment of new weapon systems may be more complex than many of the total systems we now know.

Employment Complexion

Since its beginning, and excluding the war years when all defense industries were swollen beyond their natural growth, the aircraft industry has employed a steadily increasing number of people, until today it is the largest manufacturing industry, employing 878,000 people of which 16 percent are women.

The industry has need for skills ranging from laborers to research workers in all of the physical sciences. Not only has the total number of employees grown, but the complexion of employment has changed as well. The recent great strides in aircraft technology was made possible by the increasing technical-employee segment of the industry. Since the war and up to 1953, the engineering element of employment had risen from 4% to 11% of total industry population. Statistically, the industry in 1953 employed approximately 10% of all engineers employed by all industries, 16% of all the physicists, and 14% of all the mathematicians.[9]

When consideration is given to the age of these figures, together with the increased expenditures for research and development in the missile field since 1953, it seems that the figures understate the situation as it exists today.

Inspection of Table XIII, labeled "Distribution of Employment in the Aircraft Industry", and of Figure 15, "Employment Trends in the Aircraft Industry", gives a more recent view of the complexion changes. Figure 16 shows that while total employment is rising, the proportion of production workers to total employment is falling.

TABLE XIII

DISTRIBUTION OF
EMPLOYMENT IN THE AIRCRAFT INDUSTRY
(In Thousands)

Year	Total Employment	Production Employment	Non-Production Employment	Percent Production	Percent Non-Production
1948	237.7	173.6	64.1	73.0	27.0
1949	264.1	194.7	69.4	73.7	26.3
1950	281.8	206.4	75.4	73.4	26.6
1951	463.6	341.9	121.7	73.8	26.2
1952	641.6	483.5	158.1	75.3	24.7
1953	779.1	568.7	210.4	73.0	27.0
1954	764.1	541.4	222.7	70.8	29.2
1955	738.4	504.9	233.5	68.4	31.6
1956	804.1	582.3	221.8	72.4	27.6
1957	878.1	574.6	303.5	65.4	34.6

Material Source: Aviation Facts and Figures - 1958 Edition

FIGURE 15

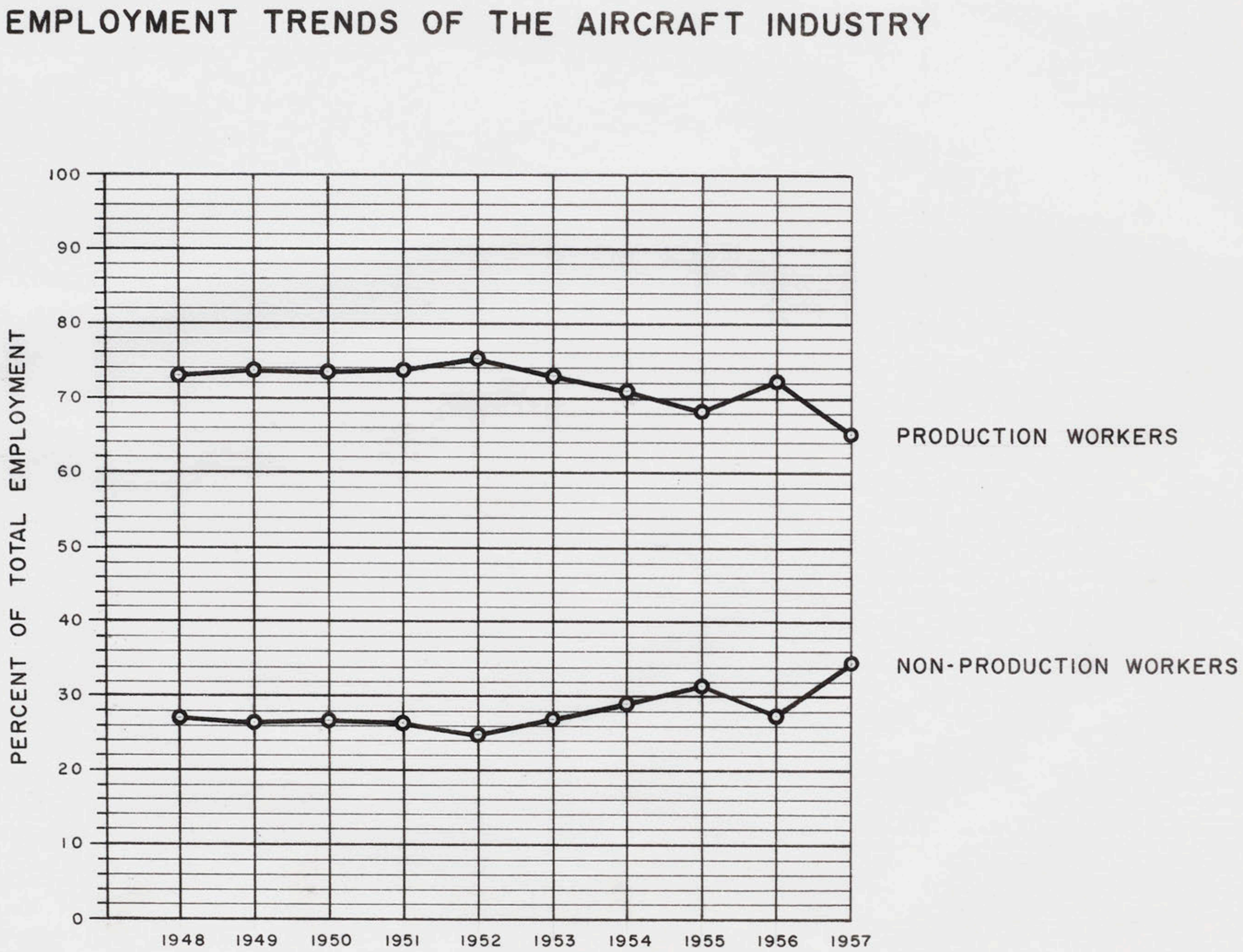
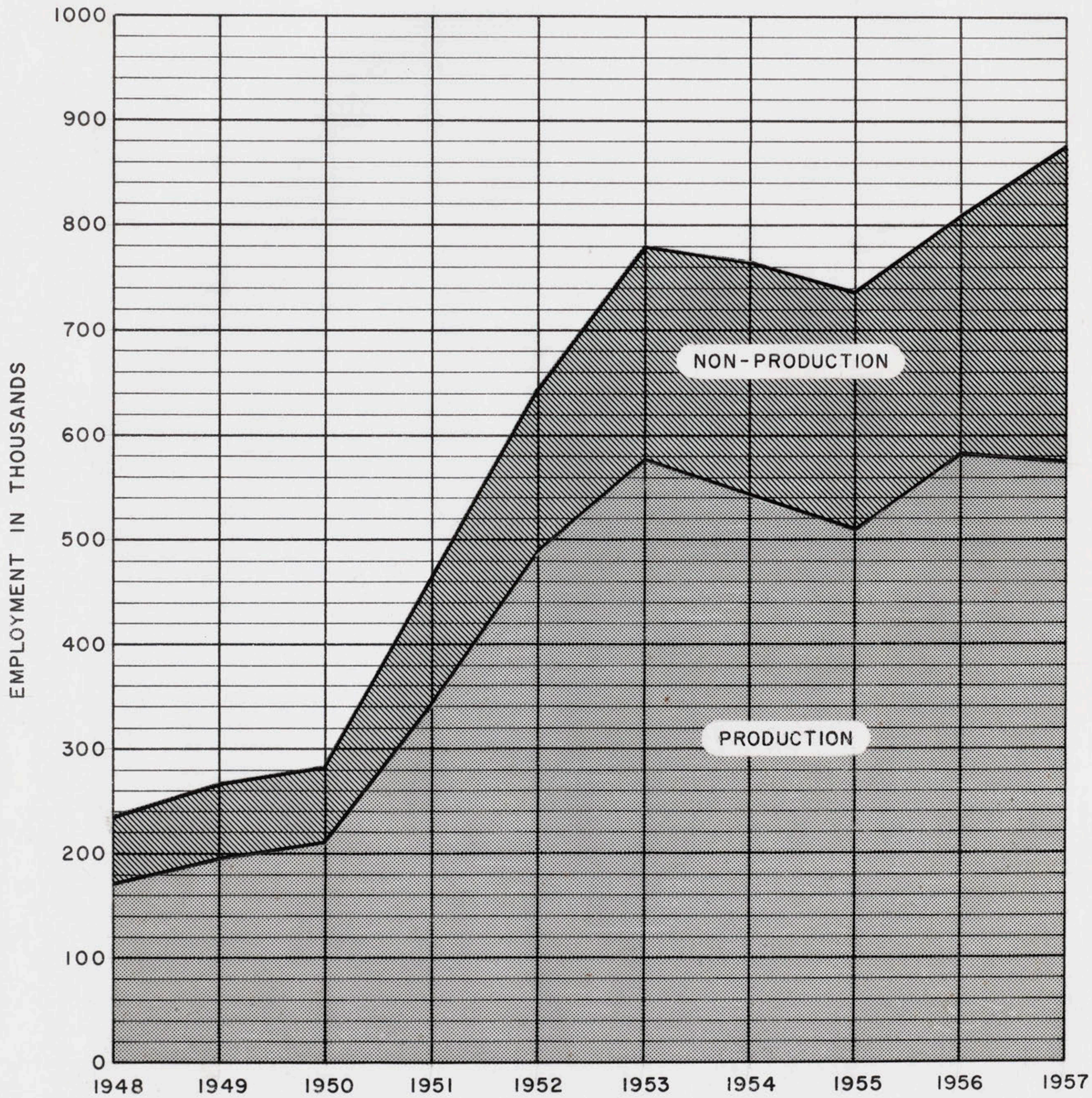

EMPLOYMENT TRENDS OF THE AIRCRAFT INDUSTRY
PERCENT OF TOTAL EMPLOYMENT
100
90
80
70
60
50
40
30
20
10
0
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
PRODUCTION WORKERS
NON-PRODUCTION WORKERS

FIGURE 16

EMPLOYMENT DISTRIBUTION IN THE AIRCRAFT INDUSTRY



The past actions of the Department of Defense indicate a shift in defense policy from one of quantitative superiority to one of weapon superiority. Emphasis on the development of a large variety of missiles coupled with the problems of unproved science and increased weapon reliability indicates a continuing demand for scientific and technical personnel. On the other hand, the introduction of new complex products dictates a build and test program requiring small rather than large quantities of products. Since production at this stage is low, the need for production workers is low. The reduction in production personnel was mainly in the semi-skilled and unskilled categories. There is, however, a critical shortage of highly skilled mechanics and craftsmen.

Employee Training

In recent years, the industry has been confronted with a lack of adequately trained personnel. This has made itself apparent, not only in the field of engineering, but also in the physical building methods used in present day aircraft. The exacting demands of highly sophisticated products have required the development of completely new methods. These new methods demanded the generation of new skills. In an attempt to overcome this deficiency, the industry utilizes many educational means and job training techniques to improve the caliber of its employees.

A recent survey, conducted by the Aircraft Industries Association, determined that the aircraft and missile industry is spending almost $135,000 each working day on formal training programs to teach the wide variety of new skills and techniques required in the development and production of today's complex air weapon systems.[10]

This industry-wide survey of A.I.A. member companies, covering 650,000 employees, revealed these facts about the scope and size of training programs: (1) More than 5,400 different courses were offered during a year. (2) More than 330,000 course completions were recorded. (3) Approximately 12,000,000 man-hours were devoted to the courses. (4) The cost of the training programs was more than $30,000,000. The courses covered factory skills, office skills, subprofessional skills, apprenticeships, management development, and engineering training. Routine orientation or on-the-job training was not included. The survey also covered courses of study in which the company reimbursed educational institutions for tuition and laboratory fees or paid for all or part of company-sponsored courses of study. This portion of the survey indicated that 60,174 employees spent almost 4,000,000 man-hours in courses at a cost of nearly $4,500,000.

In summary, the period since World War II is noted for the tremendous upsurge in technical and scientific progress that is continuing at an unrelenting pace. Shortages of technically oriented personnel, caused by increased weapon complexity, are being improved by industry-sponsored educational and training programs. The satisfactory translation of new technologies into practical weapons is evidenced by many new products with improved characteristics and increased capabilities. Modern weapon capability has altered the concepts of warfare and, because of the "cold-war" situation that exists, requires the United States to maintain both an offensive and defensive military posture.

Mr. R. A. Smith, in his article "The Manned Space Station", described the fundamental issues as they exist today. He said:[11]

> ...When the transmutation of the atom was first announced, there were few who realized the fundamental changes in the military and political world that would result. It seems that the rate of technological progress has been so greatly accelerated that the lapse of time between the acknowledgement of a theoretical possibility and its translation into fact has become dangerously small. It is now possible to do things before we have had time to consider whether it is wise to do them. For this reason, a realistic survey of possible developments, if set against a factual background, is of vital importance.

The pressures of the military needs of our Nation and her allies; the fascination of a Space-age science that has merely cracked its technological shell; and the determined competition of a technically proficient adversary are but a part of the kaleidoscope of problems that confront the aircraft industry now and in the future.

FOOTNOTES

CHAPTER III

1. Aircraft Industries Association of America, Inc., _Aviation Facts and Figures_, 1958 Edition, American Aviation Publications, Inc., Washington 5, D. C., pp. 20, 28, 54.

2. J. Sterling Livingston, "Decision Making in Weapons Development", _Harvard Business Review_, vol. XXXVI, No. 1, p. 128.

3. _Ibid_., p. 129.

4. From President Eisenhower's Radio and Television Address to the Nation - March 16, 1959.

5. Aircraft Industries Association of America, Inc., _op_. _cit_., pp. 2, 21.

6. _Ibid_., pp. 20, 48.

7. J. W. Colopy, "Weapon Systems and the Weapon System Concept", _Air University Quarterly Review_, vol. IX, Spring 1957, p. 107.

8. W. F. Ballhaus, "Applications of Weapon System Management Principles", _Proceedings of the National Midwestern Meeting-Weapons System Management (Unclassified Papers)_, Institute of the Aeronautical Sciences, Nov. 1957, pp. 55-56.

9. Aircraft Industries Association of America, Inc., 1957 Edition, _op_. _cit_., p. 52.

10. Aircraft Industries Association of America, Inc., _op_. _cit_., pp. 55-57.

11. Arthur C. Clarke, _Space Research and Exploration_, (New York: William Sloane Associates, 1958), p. 152.

CHAPTER IV

WHAT IS WEAPON SYSTEM MANAGEMENT?

Military aircraft of just a few years ago consisted, generally, of Government furnished engines, armament, instruments and other special equipment installed by the industry in an airframe designed and built by the industry to military specifications. Coordination problems were small. It is no longer adequate to concentrate on the air vehicle alone. Consideration must be given to all interdependent factors that contribute to satisfactory operation. The air vehicle that lacks a trained crew or proper ground support equipment adds nothing to the offensive or defensive potential of our Nation. Modern military aircraft, with its dependence on the successful integration of multiple skills, equipments and agencies has ceased being an airplane and has grown into a weapon system. The complexities and growing importance of weapon systems have demanded changes in the conventional organizational modes that were sufficient in the past.

Early Evidence of a Weapon System

The United States entered World War II with air vehicles that were greatly improved over the World War I vintage, but whose effectiveness as weapons were limited to the potentialities of the early style machine gun and small bomb.

Improvements in the weapon had lagged far behind the improvements in the airplane. The heat of war soon forced realization that the airplane and its weapons must be considered as an entity and not as separated individual items. The many combat techniques that were developed and used during the war depended on the analysis of the airplane/weapon combination as a whole, not on individual analysis of its units. This realization was, perhaps, the foundation of modern weapon systems.

Definition of Terms

Trade magazines of the industry, military journals, and even daily newspapers have had, in recent times, a liberal sprinkling of terms like "weapon system", "weapon system concept", and "weapon system management". The terms connote elemental changes in the weapons themselves and in the manner in which they are conceived. In official parlance, the present-day weapon system is described as:[1]

> A composite of equipment, skills and techniques that form an instrument of combat which usually, but not necessarily, has an air vehicle as its major operational element. The complete weapon system includes all related equipment, materials, services, and personnel required solely for the operation of the air vehicle, or other major operational element of the system, so that the instrument of combat becomes a self-sufficient unit of striking power in its intended operational environment.

This definition includes the air vehicle with its airframe, power plant, and fire control; bombing; navigation; flight control; electrical, ground and training equipments; and personnel training programs.

Critical comparison of the definition with intrinsic understandings of weapons in general shows no difference in fundamental purposes. Both serve as a means of inflicting hurt and damage. The difference lies in the magnitude of their destructive power. The problem, however, is not contained in a definition, for it can only state what a weapon system is or should be. The real topic is raised when consideration is given to how a weapon system is conceived and created.

The term "weapon system concept", a natural extension of weapon system, bridges the gap between the static definition of a weapon-in-being and the requirements of a weapon-to-be. It recognizes the need for consideration of things like purpose, funds, plans, construction, evaluation, and control of all the dynamic factors that influence satisfactory achievement of prescribed capabilities on a timely or scheduled basis. The focal point is not just the recognition of needs, but is, rather, the generation of a weapon system that answers all aspects of the recognized needs. This is accomplished by "weapon system management", where various segments of the total system are assigned or contracted to an agency considered capable of allocating both the human and physical resources necessary for satisfactory execution of the assigned or contracted task.

Superficial analysis at this point would indicate no striking differences between weapon system management and more conventional forms of management. A deeper analysis, however,--one which includes system costs measured in billions of dollars and gives proper emphasis to weapons that are by far the most complex machines yet devised--suggests the type of difference that does exist.

Areas of Activity

The joint responsibilities of the military and industry combination embrace the entire life span of a weapon system and extend from the conception of the idea until the last aircraft is retired from the active inventory. Individual major effort, which may possibly be termed responsibilities, reflects the peculiar talents, capabilities and duties of the contributing military or industrial organization. The joint responsibilities, although they do not exclude contributions from other sources, include:

1. Initiation of ideas
2. Establishment of requirements
3. Planning for development
4. Initial development
5. Initial evaluation
6. Inventory production
7. Deployment
8. Operational use
9. Major modification
10. Maintenance
11. Retirement

Both organizations have an interest in all activities, but each contributor, when measured by the majority of effort expended, has particular areas of major activity. For the industry component these are:

1. Planning for development
2. Initial development
3. Initial evaluation
4. Inventory production
5. Major modification

For the military component these are:

1. Initiation of ideas
2. Establishment of requirements
3. Deployment
4. Operational use
5. Maintenance
6. Retirement

For the sake of clarity and understanding, it must be repeated that this general division of activities does not in any way denote sole responsibility, but does signify major participation in the particular endeavor.

Weapon System Management Re-defined

The exact meaning of the term "weapon system management" is elusive and is not prone to immediate and universal understanding. It reflects, through interpretations, the background or area of major concern of the agency that is actively engaged in actual weapon system management. The interpretations of industry and military viewpoint, although emphasizing different aspects of the total, complement one another and are, in themselves, another indication of the magnitude of the problem. The viewpoint of industry is illustrated by a statement made by Mr. August C. Esenwein, Convair Vice President and Fort Worth Division Manager. He said:[2]

> Obviously, the sum total of these management responsibilities can be taken on only by the Air Force. However, there is nothing to stop the Air Force from delegating some of these responsibilities. This is exactly what has been done in the case of the B-58 program.
>
> Convair was given a contract with the Air Force for the study of an entire weapon system--not only for the development of the airframe but also for the integration of all the components, including bombing and navigation system, armament, the reconnaissance system, the cooling system, communications, the war-head system; for personnel training; for ground support equipment; and for logistics. We call this "weapon system management".

The military viewpoint is illustrated by an excerpt from a speech given by General Orval R. Cook, USAF (ret.). He said:[3]

> Weapon systems are designed for military purposes, to be used under military control. Who has the responsibility for producing an effective weapon system? The weapon system prime contractor or the military service for which the system is created?
>
> The real manager is the one with paramount responsibility. There can and should be assistant managers, one of whom in reality is the weapon producer. The real management of a system has to be and must be in the military, unless at some time in the future the conduct of war is to be by contract.

Although these viewpoints appear, on the surface, to stress the dominance of one agency over the other, the underlying common denominator in the viewpoints really is that each agency recognizes and understands its own role and respects the importance of the other. The military needs the engineering and productive capabilities of the industry so that it may have the proper equipment with which to fulfill its assigned missions. The industry, in like fashion, needs the military so that it may stay in business. Since either is powerless without the other, they are, fundamentally, one unit.

Complete weapon system management is, then, the intimate combination of two separate and distinct organizations, one managed by the military and one managed by industry. Each with its own peculiar talents and resources, each dependent on the other for realization of their own objectives, and who, if they are to serve their own best interests, must act as one.

The duality of this combination, and, in fact, the weapon system concept itself, is not entirely new. However, the reappraisal and apparent reallocation of the traditional roles of the military-industry partnership, forced by the changes in modern weapons and modern warfare, is new. The weapon systems of the past consisted of an aircraft designed around the special equipment furnished by the military. The design and construction of the special equipment was coordinated by the military. This arrangement, though satisfactory while weapon systems were relatively simple, lost its effectiveness as aircraft became more and more complex. A more intimate integration of the total system was necessary. The present tendency, though not universally applied by the services, is toward more industry coordination of the technical and procurement aspects of subsystems in total systems, with the military providing a monitoring function rather than one of direct action.

Changes in Organization - Military

The changed complexion of business and its products has been accompanied by changes in the modes of organization. Both the military and the industry are making structural changes in order to cope with their changing roles.

The military services are, basically, a composite of many functionally-oriented departments, with each department responsible for a particular aspect of all weapon systems. As an example, the contracts branch of each service is responsible for the contractual activity on all programs, and the maintenance department is in charge of maintenance on all programs. When the number of functional units was expanded in an attempt to keep pace with both the growing complexities of modern systems and an increased number of projects, coordination between the functions became more and more difficult. In the functional organization, where approval is essentially a sequential operation, the services found that the time required for processing even routine matters had increased significantly. The problems of functional coordination required the attention of the head of the functional unit; and timely approval of important matters required special effort to expedite an action through the numerous functional departments. The military agencies have taken steps to relieve the situation. The Navy, through the services of a class desk officer in the Bureau of Aeronautics, has provided for the coordination of the technical aspects of individual programs. The Air Force has done the same through joint project offices of the Air Research and Development Command (ARDC) and Air Materiel Command (AMC).

While this action tended to relieve the problems of technical coordination, it did not provide for the coordination of non-technical functions, nor did it provide for the integration of technical and non-technical activities. These shortcomings have been partially alleviated by additional changes in the military services.

The Navy, recognizing the need for greater coordination and better program control, established the program manager as a vital part of the Bureau of Aeronautics activities. The program manager coordinates and expedites all Bureau effort connected with such things as development, production, delivery and operation of a particular weapon system. To help with the task, the program manager has assistants in many of the important functional activities. These assistants are located within their respective departments and are supervised by their respective department heads. The efforts of the program manager are in addition to those of the class desk officer.

The Air Force has approached the problem somewhat differently. The original joint project offices of the ARDC-AMC have been expanded in scope and are called weapon system project offices (WSPO). They are physically located in one office and were established to manage the development and procurement of a particular weapon system. In addition to development and procurement activities, the WSPO provides for the production, maintenance and supply needs of a weapon system. In the early stages of a program, when problems are of a highly technical or developmental nature, the major responsibility rests with the ARDC segment of the WSPO. After the development and original evaluation programs are over, and the weapon system is ready for the production phase, the major responsibility rests with the AMC portion of the WSPO. During this phase, ARDC serves as a technical consultant on problems that arise during the production period. At still a later date, when the weapon system is a part of the active Air Force inventory, the operations of the WSPO are transferred to the AMC field supply and maintenance system.

The project manager of the Navy, and the WSPO of the Air Force are fundamentally the same type of organization. They were both created to perform coordinating and expediting activities and do not supplant the regular functional organization of their respective service. The principal advantage of this type of organization is that it provides a single gathering point for all problems that pertain to a particular weapon system. The basic difference between the two is that the Navy organization is geographically spread throughout the functional departments, while the WSPO is concentrated into one centralized office. Of the two, the WSPO approach of the Air Force seems to be the most effective. At present, the Navy is considering the possible advantages that might be gained from an organization plan based on a weapon system rather than on a functional basis. The Air Force has taken steps in this direction.

In the critical field of ballistic missile development, the Air Force has centralized the activities of all its WSPO's under the guidance of its Ballistic Missile Division (BMD) which has full control over the entire program from development to initial operational status. Representatives from the Strategic Air Command (SAC) and the Ballistic Missile Office (BMO) are included in this arrangement but are not responsible to BMD. Their role is to become thoroughly familiar with all phases of the weapon system and to prepare for operational use of the system. Where the usual WSPO appoints an industrial concern as prime contractor for a project, the BMD does not. The role of prime contractor is performed by the BMD itself, with industry involved on an "associate" basis. The reported results from this arrangement show striking reductions in the time required for the development of new ballistic missiles. While these reductions are asserted to be a result of the system, proper consideration must be given to the fact that the commander of the BMD is also deputy commander of ARDC. This may raise some doubts as to the effectiveness of the new arrangement. Were the results due to the BMD as an organization or were the results largely due to the authority that is connected with the post of deputy commander of ARDC? Either the organizational form is very good, or significant improvements require the guidance of a person with singular authority.

The Government has recently formed two new agencies. The Advanced Research Projects Agency (ARPA) is concerned with the military aspects of Space and is particularly interested in using satellites as communication relay stations, as navigational aids, and as early warning reconnaissance stations against enemy attack. The National Aeronautics and Space Agency (NASA) is concerned with the non-military aspects of Space.

The military services will continue to make the organizational changes that are required to maintain the military posture of the United States. Particular attention will be focused on increasing technical excellence, reducing the development time required for new weapon systems and reducing the cost of new weapon systems.

Changes in Organization - Industry

The changing nature of modern weapon systems is affecting not only the organizational structure of the military, but of the industry as well. Increased weapon complexity has required the incorporation of skills alien to the traditional aircraft field. Although a part of the new skills were generated within the industry, a large portion of the new skills were supplied by representatives of other major industries that have recently entered the aircraft field. Notable among the recent entrants are companies from the electronics and chemical industries. This is particularly true in the missile field. The net effect has been to broaden the base of the aircraft industry. In general, present activities involve combinations of companies dealing with the military rather than the single company dealings of the past.

The procurement practices of the military agencies influence the manner in which the composition of companies is assembled to undertake a particular weapon system.

The Navy's Bureau of Aeronautics selects its suppliers through the medium of an open design competition.

Under this method, qualified companies are invited to attend meetings where the general requirements of the new weapon system are explained and discussed. After the briefings are over the interested companies submit proposals for evaluation by the Navy. In those instances where the scope of the proposed project exceeds the capability of a single concern, two or more companies combine their resources and submit a joint proposal. The joint proposal, in addition to describing the many important aspects of the product itself, also indicates the areas of responsibility for each of the contributing firms and suggests one firm to act as prime contractor. This arrangement permits industry to play a large part in the selection of its own partnerships and in the definition of each partner's responsibilities. It is not uncommon to have fifteen or more teams of companies submit joint proposals in answer to a Navy design competition. The design award and contractor selection is made after careful analysis of all the submitted proposals. This design competition approach has been criticized as being wasteful of critical scientific and engineering manpower, for of all the carefully prepared and costly proposals submitted, only one is eventually selected. In addition, the time required for the lengthy process of proposal preparation and subsequent evaluation has also been criticized.

The Air Force has switched from the design proposal method to one of pre-selection. Under this method, a very limited number of qualified companies that have been evaluated on such criteria as technical capability, past experience, design approach and economic performance are awarded initial contracts for preliminary designs and mock-ups for a proposed new weapon system. Relatively simple weapon systems may result in the initial selection of just one contractor, while the more complex systems may have three or more separate contractors working on the problem. The Air Force provides concurrent evaluation of the contractors' efforts and, as rapidly as it can, eliminates all but the single most promising program. While this method was adopted with the avowed purpose of reducing the wasteful elements of the open design competition, it has been severely criticized as tending to blunt the competitive spirit of the industry and to be subject to political pressures. This arrangement, while it does permit industry to participate in the selection of its own partnerships, does not provide as broad a span of possible groupings as does the open design competition approach, for the number of contending teams is limited.

Both the Navy's open design competition and the Air Force's pre-selection approach result in the selection of one team with one prime contractor who, acting as the industrial focal point, supplies the necessary direction for satisfactory execution of the industrial aspects of a single weapon system.

In the field of ballistic missiles, industry's role with the Air Force is different. Here, industry acts as an associate contractor and the Air Force's BMD is the prime contractor. In its dual role of customer and prime contractor, the BMD must guide not only the government activities, but must provide the direction of the industrial segment as well. Since the BMD does not have the facilities required to assemble and test ballistic missiles physically, it delegates the integration and testing responsibilities of an entire missile to one of its associate contractors. And, since the BMD does not have sufficient technical manpower to furnish the necessary technical direction, it has delegated these responsibilities to the Space Technology Laboratories (STL), a division of an industrial firm. The STL provides technical direction for all ballistic missile programs and is responsible for insuring the technical accuracy of subsystems, the resolution of all technical controversies, and the continual guidance of all phases of the research and development efforts of all associate contractors.

Under this method, where pre-selected companies are permitted to bid on certain portions of a program, industry does not participate in the selection of its own partners. In addition, industry receives general guidance from one source and technical guidance from another.

There is another form of company grouping where partnership selection is entirely within industry's control.

Here, a group of companies with complementary talents propose a new product to the cognizant military agency, not in answer to a design competition, but as their solution to a problem of pressing military importance. Under this arrangement, if their efforts with the military have been successful, the group may select one company to act as prime contractor, or may arrange for a governing body made up of members from each company.

The impact of weapon systems and weapon system management has changed the traditional singularity of the individual company dealing with the military to a collection of companies working with military agencies whose organizations have grown more involved and intricate.

For successful operation in today's aircraft industry, the individual major producer must be prepared to participate as a prime contractor, as an associate contractor, or as a subcontractor. He must be prepared to provide major guidance or to receive it. He must be thoroughly familiar with the practices and capabilities of all military agencies and of the other companies in the industry. And, since a major portion of his work may come from associations with other companies in the industry, he must be able to demonstrate his abilities, not only to the military as was the case in the past, but also to the satisfaction of a critical industry as well.

FOOTNOTES

CHAPTER IV

1. J. W. Colopy, "Weapon Systems and the Weapon System Concept", Air University Quarterly Review, vol. IX, Spring 1957, p. 106.

2. August C. Esenwein, "Weapon System Management and the B-58 'Hustler'", Sperryscope, vol. XIV no. 6, 1957, p. 6.

3. Orval R. Cook, "Concept of Weapon System Management", Proceedings of the National Midwestern Meeting Weapons System Management (Unclassified Portions), Institute of the Aeronautical Sciences, Nov. 1957, pp. 9-10.

CHAPTER V

REVIEW AND SYNTHESIS OF MANAGEMENT PRINCIPLES

The change in the status of aircraft, from a curiosity to a universally accepted means of civil and military transportation, has changed both the size and importance of the industry. Small individualized operations have grown into large business organizations, well integrated with industry-at-large and governed by the principles that apply to all business enterprises. The recent advent of weapon system management has not changed the governing principles. It has required, however, a more rigorous application of these principles.

Review of Literature

Peter Drucker, in his book "The Practice of Management", states:[1]

> If we want to know what a business is we have to start with its purpose. And its purpose must lie outside of the business itself. In fact, it must lie in society since a business enterprise is an organ of society. There is only one valid definition of business purpose: to create a customer.

He continues:

> Because it is its purpose to create a customer, any business enterprise has two--and only these two--basic functions: marketing and innovation. They are the entrepreneurial functions.

About objectives, he says:

> Objectives are needed in every area where performance and results directly and vitally affect the survival and prosperity of the business.

> There are eight areas in which objectives of performance and results have to be set:
>
> Market standing; innovation; productivity; physical and financial resources; profitability; manager performance and development; worker performance and attitude; public responsibility.

In building the organizational structure, Drucker describes the problem as:

> The first concern in building a management structure is the requirements it has to satisfy. What are its typical stresses and strains? What performance does it have to be capable of?
>
> There are three major answers to these questions.
>
> 1. It must be organization for business performance. This is the end which all activities in the enterprise serve. Indeed, organization can be likened to a transmission that converts all activities into the one "drive", that is, business performance.
>
> 2. Hardly less important is the requirement that the organization structure contain the least possible number of management levels, and forge the shortest possible chain of command.
>
> 3. Organization structure must make possible the training and testing of tomorrow's top managers. It must give people actual management responsibility in an autonomous position while they are still young enough to acquire new experience.

He continues:

> To satisfy these requirements organization structure must apply one or both of two principles:
>
> It must whenever possible integrate activities on the principle of federal decentralization, which organizes activities into autonomous product businesses each with its own market and product and with its own profit and loss responsibility. Where this is not possible, it must use functional decentralization, which sets up integrated units with maximum responsibility for a major and distinct stage in the business process.

Harold Koontz and Cyril O'Donnell, in their book "Principles of Management",[2] describe, in the early parts of the book, the thoughts and findings of other men. Notable among these are the principles described by Henri Fayol, who, after a successful career as an industrial executive, devoted much time to advancing his principles of management.

Briefly stated these are:

1. Division of work
2. Authority and responsibility
3. Discipline
4. Unity of command
5. Unity of direction
6. Subordination of individual interest to general interest
7. Remuneration of personnel
8. Centralization
9. Scalar chain
10. Order
11. Equity
12. Stability of tenure of personnel
13. Initiative
14. Esprit de Corps

Fayol regarded the elements of management as its functions. He perceived these to be planning, organizing, command, coordination and control.

The remainder of the book is devoted to a comprehensive study of the authors' own considerations of management principles.

They cover the aspects of:

1. The basis of Management
2. Organization
3. Staffing
4. Direction
5. Planning
6. Control

William H. Newman's book, "Administrative Action",[3] though it rearranges the order and names of principles, covers, essentially, the subjects of the book by Koontz and O'Donnell. The major subdivisions, called processes, are:

1. Planning
2. Organizing
3. Assembling resources
4. Directing
5. Controlling

The book, "Top-Management Organization and Control",[4] by Paul E. Holden, Lounsbury S. Fish and Hubert C. Smith, is a research study of the management policies and practices of thirty-one leading industrial corporations. The study is noteworthy for it provides an impression of how top management approaches its basic functions.

Top management is described as including three groups of executives. These are:

1. The board of directors.

2. General management, consisting of those executives who are concerned with the business as a whole.

3. Divisional management, comprising those executives who are directly responsible for the major departments, divisions, or subsidiaries of the company.

Further conclusions are that the primary responsibilities of top management are to provide:[5]

1. <u>Farsighted planning and clarification of objectives</u>, visualizing the needs of the business and determining its most advantageous future course.

2. A sound plan or organization, enabling all of its parts, individually and collectively, to function most effectively in reaching the common objectives.

3. Fully qualified personnel in key positions, insuring each individual's proper contribution to the whole program.

4. Effective means of control, permitting top executives to delegate wide responsibility and authority, thereby freeing themselves of administrative detail in order to concentrate on broad planning and direction.

In general, most of the literature describes the interactions of organization, staffing, direction, planning and control. In established enterprises these functions are in constant use. No one action precedes the others, but a change in one causes changes in the other. The various functions are described as:[6]

1. Planning. Planning is the executive function which involves the selection, from among alternatives, of enterprise objectives, policies, procedures, and programs. Since the decisions in planning uniquely affect the enterprise in the future, those who plan must have the ability to visualize the enterprise as they wish it to become.

2. Organizing. The organization function of a manager involves the determination and enumeration of the activities required to achieve enterprise purposes, the grouping of these activities, the assignment of them to a subordinate manager and the delegation of authority to carry them out.

3. Staffing. The function of staffing comprises those activities which are essential to manning, and in keeping manned, the executive positions in the enterprise.

4. Direction. The executive function of direction embraces those activities which are related to guiding and supervising subordinates. Although

the concept of direction is simple, there is extraordinary complexity in subject matter and methods.

5. Control. The control function includes those activities which are designed to compel events to conform to plans. This formulation of the concept embraces the idea that the planning activities must precede control and that plans alone are not self-achieving.

Synthesis of the Principles of Organization

Using the goals of the business enterprise as a critical focal point or target, management performs many functions in attempting to attain its goals. Plans must be made, people must be assembled and their actions must be guided and controlled. Activities must be determined, activities must be grouped, and activities must be related one to the other. This is organization. Since all business enterprises are constituted somewhat differently and may have different goals, the individual business enterprise must strive to build that organizational structure which minimizes its weaknesses, maximizes its strengths, and helps to create the company posture that is most likely to succeed in reaching its goals.

How effective an organization is in meeting the objectives of the enterprise is a measure of its efficiency. If the enterprise meets its objectives the organization may be considered satisfactory. If the objectives are attained with little waste and also generate good individual and group satisfactions, the organization is exceptional. The measures of efficiency must be applied not only to the organization as a whole, but also to the contributing segments, for they, too, have objectives. If the objectives of one contributing segment are achieved in a manner detrimental to other contributing segments, efficiency has been lowered.

The work of the business enterprise should be divided into the least possible number of dissimilar functions. This is the principle of specialization. Further breakdown may be necessary if this primary division results in a work force that exceeds the number of persons an individual manager can effectively supervise. This subdivision is best accomplished by grouping the activities into departments fashioned in a manner that maintains the effectiveness and efficiency of the original division. This type of departmentation requires clear functional definition, a clear specification of duties and the granting of authority consistent with the assigned role. Departmentation establishes the need for the scalar principle. This provides a chain of direct authority relationships from superior to subordinate throughout the organization.

Departmentation with its granted authority, and the scalar principle with its chain of command, when combined, provides the organization with the opportunity for utilizing the exception principle. Here, all matters are decided at the lowest organizational level that has the authority to make the decision. Since only those subjects that require greater authority are referred to the next higher level, managers do not waste time deciding a matter that could be satisfactorily answered by their subordinates. The scalar principle implies that each individual has but one superior who assigns all duties and delegates the authority necessary to achieve the assigned tasks. The delegation of authority does not absolve the superior from responsibility for the actions of subordinates. However, once having accepted both the task and the authority to execute the assignment, the subordinate is entirely responsible to his superior for the performance of his duties. A person should not be held responsible unless he has been given the authority to carry out the assignments. In similar fashion, a person should not be granted authority unless he will be held responsible.

The manner in which individuals carry out their assigned tasks and how well they achieve their objectives, all contribute to the over-all efficiency of the enterprise. The organizational structure should be designed in such fashion, that individuals who have demonstrated facility in meeting objectives will be afforded opportunities for continued demonstration on an even greater scope.

Finally, the organizational structure must stress flexibility. With flexibility established, the enterprise can quickly grasp opportunities as they arise or can rapidly adjust to business reversals if the occasion so demands.

The organizational structure, once determined, is usually described through the aid of organization charts. However, charts are not the organization but are, instead, pictures of the organization as it is thought to exist. Care must be exercised in their preparation, for, if misinterpreted, rigidities may be assumed that were not intended, and which may limit the flexibility of the organization itself. Typically, charts show the various levels in the structure and provide a means for tracing the lines of authority. While charts show the formal relationships that exist among various elements that comprise the complete enterprise, they cannot describe the multitude of informal relationships that depend on the personality reactions of the people and their functions.

FOOTNOTES

CHAPTER V

1. Peter F. Drucker, The Practice of Management, (New York: Harper and Brothers Publishers, 1954), pp. 37, 63, 202-205.

2. Harold Koontz and Cyril O'Donnell, Principles of Management, (New York: McGraw-Hill Book Company, Inc., 1955).

3. William H. Newman, Administrative Action, (Englewood Cliffs, N. J.: Prentice-Hall Inc., 1951).

4. Paul E. Holden, Lounsbury S. Fish, Hubert L. Smith, Top-Management Organization and Control, (New York: McGraw-Hill Book Company, Inc.).

5. *Ibid*., p. 3.

6. Koontz and O'Donnell, *op*. *cit*., pp. 34-36.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The preceding chapters have developed information that describe the governing factors of the past, an estimate of factors that are likely to govern in the future, and an understanding of the problems and circumstances that will influence the future actions of the aircraft industry.

This chapter is devoted to determining how the individual company may evaluate the recently changed conditions, and how it may best combine its efforts to meet company objectives and the demands of a changing technology.

Summary of Developed Information

The material developed in prior chapters covers information concerning (1) the product, (2) the industry, (3) the customer, (4) expenditures, (5) weapon system management, and (6) the principles of organization. This information, restated in summary form, is:

1. The extremely complex nature of present and future products demands the accurate integration of all system elements. As a result, new products require increased proportions of technically oriented effort.

2. The recent increases in the rate of technological development, and the rapidity with which these are translated into new products, have increased the rate of product obsolescence and has materially shortened the effective life span of any particular product.

3. Since the industry is dependent on the military for 85% of its business, the industry will continue to operate in an atmosphere that reflects the cyclical nature of military needs.

4. The industrial base has been broadened and now includes representatives from other major industries.

5. The limitations of technical capability available within a single company have created the need for combinations of companies who can, as a whole, provide the required effort.

6. The product span of the industry has changed and now includes a variety of missiles and Space vehicles in addition to the more conventional aircraft.

7. The industry will continue to have problems with the growing complexities and changes in the military organizational structure, and with their methods of contracting and financing.

8. The military delegation of some of its procurement responsibilities to individual industrial concerns is changing the role of the typical major producer. In the past, he sold his products directly to the military. Now, he may sell a major portion of his products to other major producers.

9. Total military expenditures for aeronautical products will continue to grow for the next few years. Expenditures for research and development, and for procurement of missiles are increasing. Although expenditures for the procurement of more conventional types of aircraft are declining, they still represent approximately 60% of all procurement spending.

10. Increased system cost, when coupled with the practical limits of fund availability, indicates a reduction in the number of projects that will be under development at any one time.

11. The military and the industry will both be hampered by financial problems. The military will be limited by fund availability, and industry will be limited by its ability to generate earnings.

12. Weapon system management is not entirely new. The complexities of modern products have not changed total duties but have, rather, expanded duties which forced a reappraisal and reallocation of the duties. Industry is playing a larger part in the technical and procurement aspects of new systems, and the military is providing a monitoring function rather than one of direct action.

13. Weapon system management has not changed the principles that govern sound organizational practice. Industry's changing role, however, requires a continuing re-evaluation of organizational structure to insure a high degree of flexibility.

14. Aircraft companies may be organized on the basis of federal decentralization, functional decentralization, or on a combination of the two.

15. The industry must continue to provide opportunities for the training and testing of new managers.

Company Considerations

The limited amount of funds that are available to military agencies, together with the desire to supply their operating branches with the most effective weapons available, can create pressures within the military that may lead to the cancellation of aircraft whose performance characteristics are marginal.

The aircraft company that is working on just one project is in a very vulnerable position. If the contract the company is working on is cancelled, it is out of business. Realizing the possible consequences of such a position, companies try to expand their operations to include effort on many different projects. With proper program diversification, the cancellation of one project will not have a catastrophic effect on the company. All programs, however, are not abruptly cancelled. Most of them run out to completion. Programs may be extended or reduced, depending on the desirability of the present aircraft and the availability of new and better products. Companies try to arrange for as orderly a succession of programs as is possible. To achieve this, company objectives must include a product viewpoint that creates the desire to produce excellent products without stifling the atmosphere that is conducive to the generation of innovative ideas and new products. Both are essential, and both influence the future prospects of the company. The organization should provide a capability that permits a flexible balance to exist between the requirements of present products and the needs required for the generation and development of new products.

Under the present circumstances, it is highly unlikely that any one company will be chosen as prime contractor for all military systems. It is more likely that the individual major producer will be prime contractor on some programs and a major subcontractor or associate on others. In the role of prime contractor the company is the responsible party for the entire project. The company has signed contracts wherein it guarantees, within strict limits, such things as performance, delivery and cost. Toward this end, the prime contractor must direct the actions and efforts of his own company, and the actions and efforts of all the associate and major subcontractors as well. In the role of a major subcontractor or associate, the company must adjust to the needs and over-all direction it receives from the prime contractor. How well or how poorly the company meets contract guarantees affects its future chances for work of similar nature. The company organization should be capable of executing both types of work.

Major contracts usually include terms that define the work that is to be performed; when the work is to be completed; the progress that must be achieved at certain stages during the time period; and the target costs for the work. In addition to a total definition, contracts include similar definitive terms for all major company activities that make a direct and vital contribution in achieving the requirements of the contract. Typically, these are the activities of engineering, tooling, and production. This viewpoint does not overlook the need for other functions, but does support the position that the major functions have a direct influence on the generation of a satisfactory product and are of primary importance. Other functions, necessary as they may be, do not directly affect the product and are, hence, of secondary importance.

Major contracts are the result of estimates, and the future business of a company depends on the accuracy of its estimates. Low total cost estimates may result in a contract but provide no profit. High total cost estimates may result in no contract at all. In either event, the future economic performance of the company is jeopardized. Since the total estimate is the sum of its individual parts, inaccuracies in any single part will not necessarily cancel the company's chances for a contract. However, inaccuracies will affect the efficiency of its performance. It follows, then, that each major activity should prepare and justify its own estimates and should be evaluated on its individual performance. To do this properly, each major activity should control those inputs that affect its performance. The company organization should provide each major activity with delegated authority consistent with its role and should demand responsible action at all times.

Where the company with one product faces extinction, the company with two or more programs faces the problems that are associated with multiple products. Each program will require the coordinated effort of the three major activities, and each program must be adequately supported by a force of service groups and competent major suppliers. In addition, each program will be confronted with its own problems and administrative detail. The company organization should provide the means for separating and satisfying the many needs and demands of each individual program.

It would appear, on cursory examination, that the company could organize its efforts strictly on the basis of program requirements. This arrangement enjoys all the benefits that can be derived from a well integrated group devoted solely to a single program and managed by a single responsible person. It also has defects. Essentially, it breaks the company into autonomous groups and subjects each group to the same vulnerability that a company with one program is subjected to. Given time, this arrangement will create duplication of effort within the company; will increase total overhead costs; will create fierce inter-program competition detrimental to the company; will require greater rather than less direction from top management; and ultimately, the decimation of the company's engineering forces will ruin its capability to generate innovative ideas and new products. Obviously, proper company organization would not permit this type of action.

Many of the detrimental qualities of the autonomous program-oriented organization can be eliminated by modifying its form. Rather than establishing only autonomous groups, the company may attempt to organize program groups that purchase the services of functionally organized groups maintained by the company. While this arrangement eliminates some of the poor features and reduces others, its effectiveness as an organizational type is in constant jeopardy.

If the program-oriented group purchases its services from the three major activities and exercises direct control over specific personnel, the group is, in effect, responsible for the execution of contract guarantees made by others. This action absolves the major activities from further responsibilities, and the total organization is, once again, confronted with the problems of separated autonomous groups. If, on the other hand, the program group does not exercise direct control of the personnel but is merely charged for their services, the program group has, in effect, redelegated its authority to the three major activities. While this arrangement could be made to work, it introduces serious shortcomings. Under these circumstances, since each program group is primarily interested in its own program and will be evaluated on its performance, all groups will want the most capable people from each functional activity to be assigned to their program. This arrangement creates friction, is subject to constant bickering and favoritism, and does not satisfy the company's total needs in the most efficient manner. Obviously, the company organization should not permit such a misdirected application of authority and responsibility.

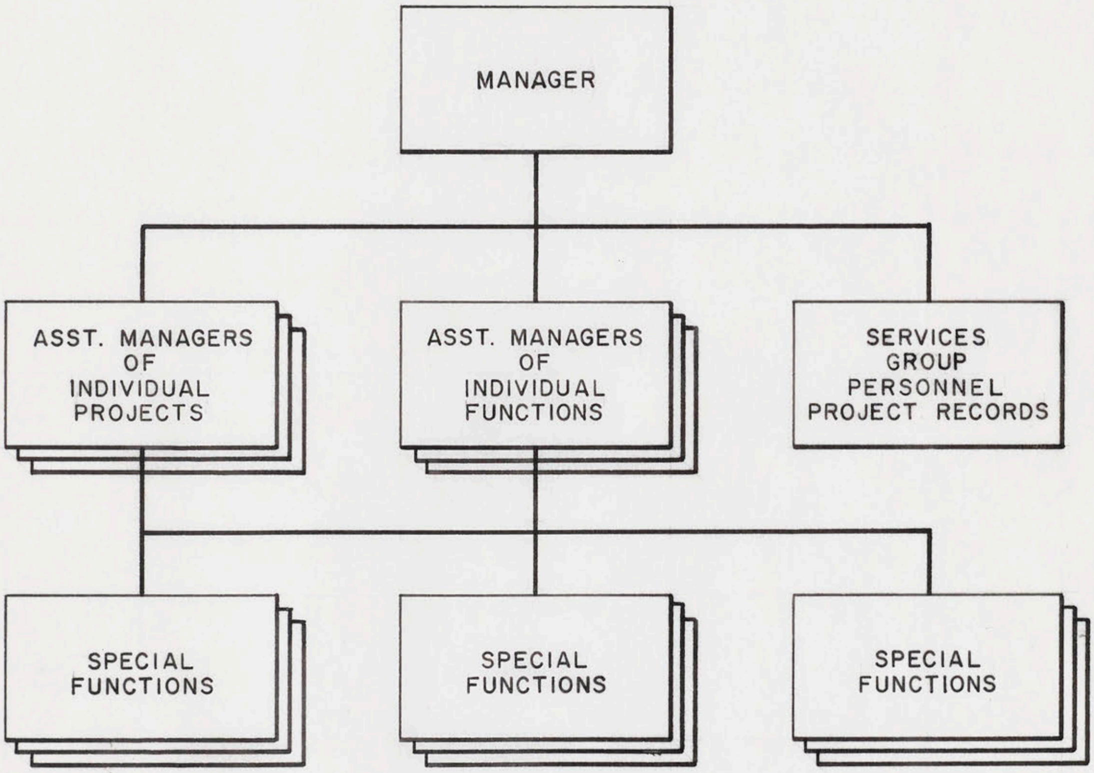
Suggested Organization

It appears, then, that the optimum solution to the problem lies in the proper combination of the benefits that can be derived from both the federally decentralized and functionally decentralized forms of organization. Its success will depend on the proper distribution of work and consistent authority.

The three major activities should be authorized to perform all functions necessary for satisfactory execution of its portion of all contracts. This should include the planning, staffing, organizing, directing, and controlling functions. With this arrangement, each major activity is held responsible for all of its actions on all contracts. The manager of each activity can provide individual program coordination by dividing the operational work into units designed around program needs. This may be achieved by appointing assistant managers for each project and providing them with clear instructions and the necessary authority to carry out their responsibilities. The actions of the many functional departments of each major activity must also be directed and coordinated. This may be achieved by appointing an assistant manager for all functions and providing him with clear instructions and the necessary authority to carry out his duties. This arrangement permits the total activity to specialize by functions, to coordinate by departments, and to integrate by programs. Figure 17 portrays this type of organizational structure for a typical major activity. While it appears that this structure

FIGURE 17

TYPICAL MAJOR ACTIVITY
ORGANIZATION CHART



subjects each special function to the receipt of directions from two sources, consideration must be given to the fact that the directions cover different matters and should not be in conflict.

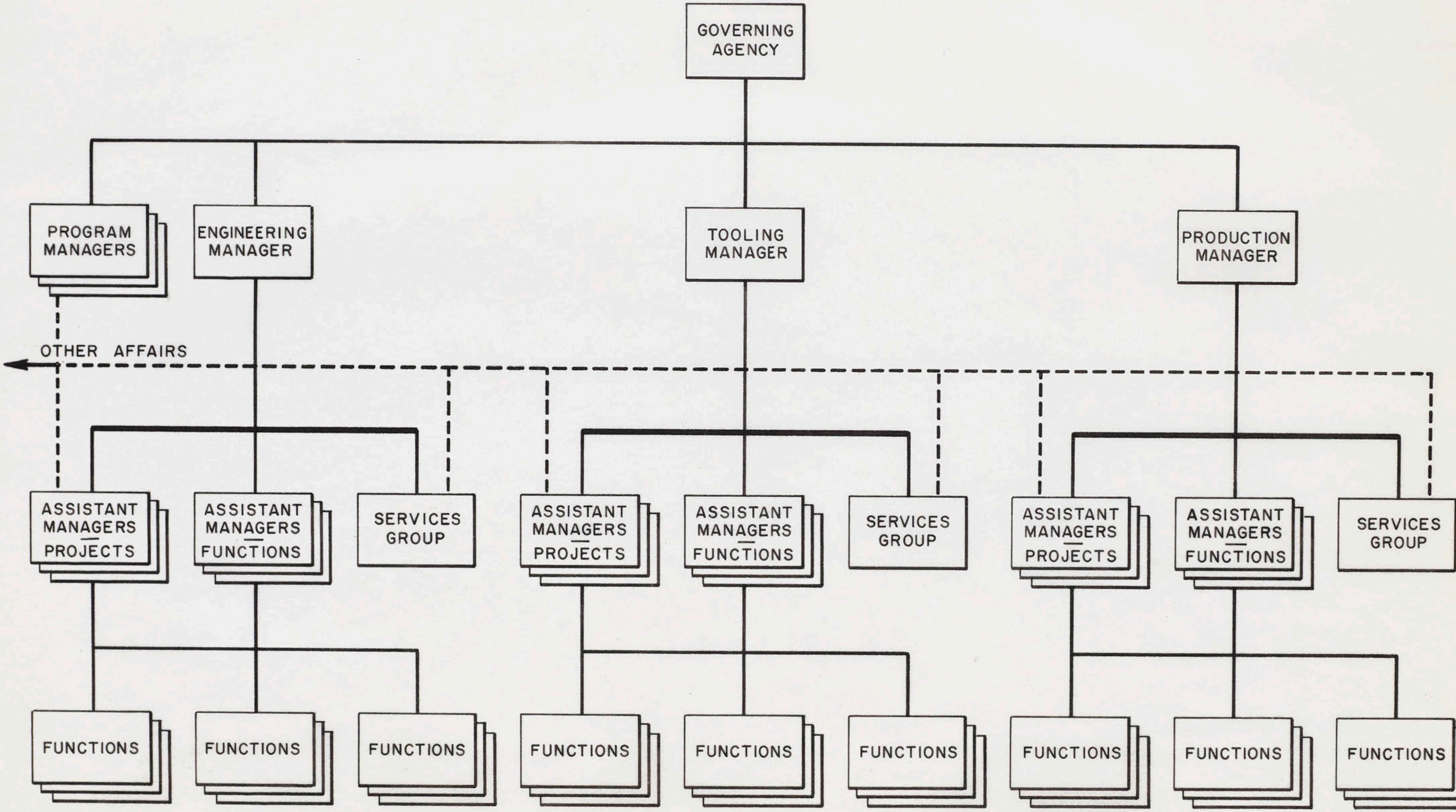
The need for over-all coordination of each program still exists. While this may be provided by direct action on the corporate level, the numbers of programs involved will necessarily influence the effectiveness with which any one person coordinates all programs. Proper coordination requires an intimate association with all aspects of the program. A more satisfactory solution would be to delegate the over-all coordination task on an individual program basis and then coordinate all programs at the corporate level by utilizing the exception principle. This may be accomplished by appointing individual program managers. However, care must be exercised in the definition of duties and in the delegation of authority. Propriety would indicate that the manager should be established at the same level as the managers of the three major activities, and should be responsible for those actions not specifically included in the duties of the major activity manager. While the program manager does not control the actions of the major activities he does view them critically. From his intimate knowledge of all portions of the program he can provide the necessary guidance to keep the program in balance. Proper program balance requires the coordination of external affairs as well as internal affairs. Coordination also requires the assembly of critical information, reports, discussions, and meetings concerning the individual program. These are some of the duties and areas that the program manager is responsible for. Figure 18 describes the suggested organizational structure. The solid lines represent the direct authority and responsibility relationships, while the broken lines indicate the relationships that provide for the coordination of the activities on all programs.

This paper has described the basic organizational structure required for the operating division of a company involved in the field of weapon system management. It recognizes the need for proper guidance from top management and proper support from service divisions. However, its position with respect to top management, its position with respect to other operating and non-operating divisions, and its position with respect to possible geographic dispersion demand further investigation on an individual company basis.

The suggested organizational structure reveals many advantages. Total work is properly divided. This provides simple responsibility patterns that are straightforward and well defined. Each activity is in a position to control its inputs and to plan for the future with intelligence. The structure's flexibility provides the possibility for rapid contraction if necessary, or for ready expansion to include

FIGURE 18

SUGGESTED ORGANIZATION



new programs. Organizational levels are few in number and provide for the evaluation of all its people. It permits top management to concentrate their efforts on more important matters, and provides them with a broad field in which to train and test possible future leaders of the company. It is an operating organization designed to meet company objectives, to perform economically, and to provide its part to the defense of our Nation.

The Thesis Reviewed

This thesis has presented a broad background picture of the fundamental elements that influence the actions of present-day aircraft producers, and has suggested an organizational pattern that should help the individual company to meet its objectives. The closing paragraphs that follow offer a synoptic retracement of the material developed in the study.

In a half century the aircraft industry has grown from an infant to a giant. Its products have passed through a metamorphosis from small, flimsy, kite-like contrivances to sturdy, highly efficient machines. Constant development of aircraft for military applications has altered the haphazard combination of flying machines and antiquated guns into weapon systems that depend on the accurate integration of all the elements that contribute to satisfactory attainment of predetermined military objectives. Increased mission difficulties have created a demand for new aeronautical products with improved characteristics and expanded capabilities. Satisfaction of this demand has created products that replace one another in, it seems, an unending cycle. The industry thrives on technological obsolescence, and the generation of new products is the very life stream of all aircraft companies. The industry and its products have made profound changes in the economic and temporal aspects of the world.

Technological advances in recent years have increased the demand placed on both the industry and the individual company. The military and the industry are changing their methods of organization in an endeavor to provide the most modern weapon systems at reduced costs and within shorter elapsed time. Functions that were reserved for the military in the past are now being performed by the industry. This increase in industry responsibility is being discharged by syndicated assemblies of companies whose complimentary talents permit proper division and logical assignment of the many factors that constitute a complete weapon system. The rapid growth of both product complexity and syndicate organization has been accompanied by many problems. Individual companies must now provide and maintain a well-coordinated and versatile organization, capable of balancing the changing factors of present programs and future products.

Individual companies may achieve this by the proper separation and authorization of those basic task elements that vitally influence all of its products. A strong functional organization develops well-established responsibility patterns and, through the addition of coordinating agencies, provides a ready means for integrating the activities of individual programs. This type of organizational structure permits top management to concentrate on the problems of creating new and strengthening old ties with its many customers and publics, and provides a testing ground for possible future top managers.

Organizational structure is not static. Future changes in world conditions and their influence on military needs must be assessed by the industry on a continuing basis. Each individual company must be willing to make alterations in its structure commensurate with the new governing factors.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Barnard, Chester I. The Functions of the Executive. Cambridge, Massachusetts: Harvard University Press, 1954.

Clarke, Arthur C., (ed.). Space Research and Exploration. New York: William Sloane Associates, 1958.

Dale, Ernest. Planning and Developing the Company Organization Structure. Research Report, No. 20. New York: The American Management Association, 1952.

Drucker, Peter F. The New Society. New York: Harper and Brothers, 1949.

Drucker, Peter F. The Practice of Management. New York: Harper and Brothers Publishers, 1954.

Follett, Mary Parker. Collected Papers of Mary Parker Follett. Edited by Henry C. Metcalf and L. Urwick. New York: Harper and Brothers Publishers, 1940.

Holden, Paul E., Lounsbury S. Fish, and Hubert L. Smith. Top Management Organization and Control. New York: McGraw-Hill Book Company, Inc., 1951.

Koontz, Harold, and Cyril O'Donnell. Principles of Management. New York: McGraw-Hill Book Company, Inc., 1955.

Machiavelli, Nicolo. The Prince. New York: E. P. Dutton and Company, Inc., 1908.

Newman, William H. Administrative Action. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958.

Pigors, Paul and Charles A. Myers. Personnel Administration. New York: McGraw-Hill Book Company, Inc., 1956.

Richards, Max D., and William A. Nielander. Readings in Management. Cincinnati, Ohio: South-Western Publishing Company, 1958.

Whyte, William H., Jr. The Organization Man. New York: Doubleday and Company, Inc., 1956.

B. PUBLICATIONS OF THE GOVERNMENT LEARNED SOCIETIES, AND OTHER ASSOCIATIONS

Aircraft Industries Association of America, Inc., Aviation Facts and Figures, 1958 Edition. Washington: American Aviation Publications, 1958.

Economic Report of the President, January, 1958. Washington: United States Government Printing Office, 1958.

Institute of the Aeronautical Sciences. Proceedings of the National Midwestern Meeting Weapon System Management. New York: Institute of the Aeronautical Sciences, 1957.

National Archives and Records Service. United States Government Organization Manual, 1958-1959. Revised as of June 1, 1958. Washington: Government Printing Office, 1958.

C. PERIODICALS

Bridges, James M. "Improved Management of Military Development Programs Needed to Conserve Engineering Manpower", Institute of Radio Engineers Transactions on Engineering Management, Vol. EM-1, No. 1, pp. 20-24.

Colopy, J. W. "Weapon Systems and the Weapon System Concept", Air University Quarterly Review, Vol. 9, Spring, 1957, pp. 105-114.

Esenwein, August C. "Weapon System Management and the B-58 Hustler", Sperryscope, Vol. 14, No. 6, 1957, pp. 6-9.

Haugen, Victor R. "Changing Times in Weapon Systems Management", Signal, Vol. 12, June, 1958, p. 31.

Hull, Seabrook. "Budgeting for the Space Age", Missiles and Rockets, Vol. 3, April, 1958, p. 102.

Hull, Seabrook, "U. S. Readies Missile Makers' Planning Forms", Missiles and Rockets, Vol. 4, August, 1958, pp. 12-13.

Irvine, Clarence S. "Air Force-Industry the 'Must' Partnership for Defense", Sperryscope, Vol. 14, No. 6, 1957, pp. 2-5.

Irvine, Clarence S. "Buying and Building", Air Force Magazine, Vol. 41, April, 1958, pp. 52-54.

Lewis, Craig. "AMC's Procurement, Production System Undergoing Realignment", Aviation Week, Vol. 68, October, 1958, p. 99.

Lewis, Craig. "Industry Team Bids on USAF Project", Aviation Week, Vol. 68, June, 1958, pp. 68-70.

Livingston, J. Sterling. "Decision Making in Weapons Development", Harvard Business Review, Vol. 36, January, 1958, pp. 127-136.

Metcalf, George F. "Engineering Development Challenge in Weapons Development", Institute of Radio Engineers Transcript on Engineering Management, Vol. EM-4, No. 2, pp. 82-84.

Miller, William O. "AF Revises Contract Procedure", Missiles and Rockets, Vol. 4, July, 1958, pp. 49-50.

Novick, David. "Weapon System Cost Analysis", Institute of Radio Engineers Transaction on Engineering Management, Vol. EM-3, No. 3, pp. 67-73.

O'Connor, Edmund F. "How AMC Manages the Weapons", Air Force Magazine, Vol. 39, September, 1956, p. 134.

Roth, Ludwig. "Why Teamwork is Needed in Guided Missile Development", Armed Forces Management, Vol. 4, January, 1958, pp. 15-17.

Schlager, Kenneth J. "Systems Engineering--Key to Modern Development", Institute of Radio Engineers Transactions on Engineering Management, Vol. EM-3, July, 1956, pp. 64-66.

Senter, William O. "How Air Weapons Management Works", Armed Forces Management, Vol. 4, April, 1958, pp. 26-29.

Simmons, Henry T. "Defense Takes Over", American Aviation, Vol. 21, December, 1957, pp. 27-28.

Simmons, Henry T. "Here's How to Cut System Lead Times", American Aviation, Vol. 20, September, 1956, pp. 29-30.

Simmons, Henry T. "Lead Time--Industry's Big Question Mark" American Aviation, Vol. 20, March, 1957, pp. 21-23.

Smith, Lloyd C. "Wanted: A Realistic Industrial Readiness Program", Society of Automotive Engineers Journal, Vol. 65, No. 8, July, 1957, pp. 87-88.

Stambler, I. "How BMD Directs AF's Ballistic Missile System", Aviation Age, Vol. 29, May, 1958, p. 18.

Stambler, I. "New Procurement Methods for AF's Ballistic Missiles", Aviation Age, Vol. 29, June, 1958, p. 18.

Stambler, I. "Scientific Management of Ballistic Missiles Systems", Aviation Age, Vol. 29, April, 1958, p. 18.

Stannard, Louis P. "Spares for Weapon Systems", Aero/Space Engineering, Vol. 17, August, 1958, pp. 53-56.

Strickroth, Giles J. "Weapons System Management", Institute of Radio Engineers Transactions on Engineering Management, Vol. EM-4, No. 1, pp. 1-3.

Witze, Claude. "Industry Role in New Weapons Increased", Aviation Week, Vol. 65, August, 1956, pp. 86-91.

D. UNPUBLISHED MATERIAL

"Study of Aircraft Procurement Contract Types and Contracting Methods". Bureau of Aeronautics, Department of the Navy, 1957.