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AIR FORCES PROCUREMENT  
28 February 1946.

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GENERAL ARMSTRONG:

Gentlemen, the talk today was scheduled for Major General E. M. Powers, but he telephoned yesterday that General Kenny was arriving for a conference, which he had to attend this morning, and that he was going to send one of his best-qualified assistants who, he said, had been largely instrumental in preparing his talk.

However, General Powers, who heads up this work in the Air Forces, is anxious to have a few words with us. So, we shall be delighted to grant him the opportunity to talk to the members of this class on certain aspects of the industrial mobilization problems of the Air Forces, which are important.

The speaker this morning is a graduate of the United States Military Academy, Class of 1930. I think he transferred early to the Air Forces and he has had a considerable experience in the procurement side of it as well as the other side. This morning he will talk to us on "Air Forces Procurement." Gentlemen, it is a pleasure to present to you Colonel William D. Eckert, who will talk on that subject. Colonel Eckert.

COLONEL ECKERT:

Gentlemen, it is a pleasure to be with you this morning. General Powers asked me to express his regret at not being able to be here as he originally intended.

With reference to General Armstrong's comments on the subject, I want to say there was far more talent than my own involved in the basic data.

The topic of my discussion today is the problems encountered in the expansion of aircraft production for World War II. The subject is so vast and the problems encountered so numerous that I shall not, in the time allotted to me, be able to do more than touch on the highlights of our World War II experience.

I have divided my presentation into three major parts:

1. The Status of aircraft procurement prior to the announcement of the President's 50,000 plane program in May 1940 (considered by us to be the "go-ahead" date for the World War II aircraft production expansion).

2. The major problems encountered in meeting the materiel requirements of the wartime air forces.

3. And finally, the principal lessons learned from our World War II experience.

Before I begin this discussion I should like to make one observation. I believe the Air Forces' procurement and production problems were at least the equal of those of any other procuring agency. The Bureau of Aeronautics had equally difficult problems. The Army Air Forces consisted of a few partially equipped squadrons of largely obsolescent planes which, as General Marshall stated, "could hardly have survived a single day of modern aerial combat." The combined expenditures of the Army Air Corps and Bureau of Aeronautics for the procurement of new aircraft during the 1930's ranged from a low of 6 million dollars to a high of 70 million dollars per year. By 1944, within the brief span of four years, this was expanded to over 16 billion dollars.

STATUS OF THE INDUSTRY IN MAY 1940--The Nation was rudely awakened to the magnitude of the war program by the announcement of the President in May 1940 of a 50,000 airplane procurement program. Such fantastic levels of production not only exceeded the imagination of the public but far exceeded the potentialities of the aircraft industry as it then existed. As a matter of fact, the President's program was far beyond the sights of the Services. The Army Air Corps, in early 1940, was engaged in a program of "emergency" expansion designed to raise its strength to the modest total of 5,500 airplanes. The Navy's sights were set at 3,000 serviceable airplanes, although plans were in process for a modest increase in this goal. Industrial mobilization plans for aircraft were geared to these goals. Compare the figures of 5,500 or 8,500 with the 50,000 contemplated.

The infant aircraft industry was ill equipped to cope with the magnitude of the job that lay ahead. Thirteen modest sized airframe companies and only three aircraft engine and propeller companies provided the principal nucleus for the expansion. The small nucleus of "know-how" and skills existing at that time is indicated by an employment of 85,000 persons in the airframe industry and 29,000 in the aircraft engine and propeller industry by the middle of 1940.

Contrasted with the goal of 50,000 airplanes, later raised to 100,000 in January 1942, these companies produced only 3,000 tactical planes in 1940, of which 80 percent were accepted for foreign governments; and only 5,900 engines, including small trainer types.

The plant capacity of these companies is indicated by the number of square feet of floor area. Altogether, the airframe industry at the beginning of 1940 possessed not more than nine and six-tenths million square feet of floor area; the engine facilities at that time had only three million square feet in production. Including the manufacture of components, parts and accessories, this floor area was increased to over 200 million square feet within the four years.

Fortunately, the negotiation of foreign contracts with our allies had contributed in some measure to the enlargement of capacity which was then taking place. In the year 1940, as has been stated, 80 percent of tactical plane acceptances were for foreign governments. But this was a mere trickle compared to the stream of production that was to follow. Thanks to these orders, however, a beginning had been made

and the production basis of the future expansion had been greatly enlarged. I do not think we can over-emphasize or appreciate enough the part played by these foreign contracts in the early days.

The state of the arts in the manufacture of airplanes and components had reached only an elementary stage of development. Production methods and techniques reflected the small size of contracts to which the industry was accustomed. Production was organized on a job-shop basis and the final product was essentially a hand-made job, with many of the parts fashioned from temporary tooling consistent with the size of the production orders. Clearly, these techniques were inadequate to the size of the program impending; the airplane industry was on the threshold of big business, and was to become in four short years one of the major industries of the country; with an annual output of over 16 billion dollars, compared to less than a quarter billion in 1940.

Only a limited number of fully developed, tactically useful models were ready for production in May 1940. Of the 19 major airframe models built during the war (accounting for 87 percent of the tactical planes produced from 1940 through 1944) only 3 were in production on that date, the B-17, P-40 and P-4U.

THE MAJOR PROBLEMS ENCOUNTERED--Mobilization planning: The first of the very many problems to arise in implementing the President's 50,000 plane program was the lack of an adequate industrial mobilization plan. Many reasons may be offered for this deficiency but underlying all of them was the absence of the will to be prepared. The Nation was reluctant to face the realities of war and the magnitude of the production effort required to prepare and successfully prosecute a major war. The result was that the Services, the civilian government agencies and industry were totally unprepared for a program of this magnitude.

Plans had to be prepared concurrent with the implementation of the program; government machinery had to be set up to administer the aircraft production program, as well as other phases of the national defense program; government-industry relationships had to be formulated and the necessary legislation put through to establish these relationships; and finally the airplanes to be produced had to be scheduled and contracted for.

It was at this point that a variety of problems arose almost simultaneously each of which I will take up separately.

Engineering development: The President's 50,000 plane program could not be translated into production without tactically useful, production tested airplanes ready to be built. With the exception of two models the air war was fought with airplanes on which design work had been started prior to 1940, but only 3 models had actually been produced in any quantity by May 1940.

The B-24 had been first flown in January of that year and much work remained to be done before it was acceptable for combat and production. The B-25 Mitchell bomber was not flown until August of that year, and

the P-51 Mustang not until October. The B-29 was first tested a year after the entrance of the United States into the war, two and a half years after the President's goal was first announced.

It is obvious, therefore, that rapid translation of new and superior designs from blueprints to production and service-tested airplanes, was the most imperative problem to be overcome. This developmental and production engineering work was greatly accelerated, but the preparation of a new plane for production and tactical use takes years and is really a never-ending job until it is obsolete or replaced by another new one. Accelerating this process by putting models into production before all the latest developments had been completed, or the model completely tested, resulted in a tremendous number of engineering changes which had to be incorporated in the production line. This problem was partially solved by the establishment of modification centers, which took the airplane from the factory and perfected it for combat conditions in the various theaters of the world.

Procurement legislation: The placing of AAF contracts was initially hindered by lack of adequate procurement legislation. Existing procurement legislation, represented by the Air Corps Act of 1926, placed the Army in a legal straight jacket by requiring that contracts could legally be placed only through competitive bids. These rigid specifications imposed serious handicaps in the procurement of new plane types, that is, in quantity production.

The need for more flexible procurement legislation was recognized prior to the enactment of the Act of 1926, but unfortunately it was not translated into law. The basis for procurement is set forth in Revised Statute 3709, - the general purchase statute enacted in 1861, which required the purchase of government supplies upon a basis of pure price competition under formal advertising-sealed bid procedure, except of course in such cases where competition was impracticable (Act of 2 March 1901). Prior to 1926 the procedures relative to the purchase of aircraft under these statutes following World War I, proved to be so cumbersome and restricted that as early as 1919 the American Aviation Mission, in its report of 19 July of that year, stated that 90 percent of the wartime aircraft industry had been liquidated, and that remainder would inevitably disappear under the conditions which then prevailed. To the same effect were statements made by the Lassiter Board in its report dated 24 April 1923.

Numerous other investigations were made relative to aircraft procurement policy prior to 1926. Of these, the reports of the Lampert Committee, appointed by the House of Representatives in 1924, and of the Morrow Board, appointed by the President in 1925, were of special significance. The Lampert Committee findings were in part, and I quote:

"That contracts given to aircraft builders have not resulted in excessive profits, but, on the contrary, the aircraft industry, dependent on Government contracts, has been liquidating and going out of business to such an extent that the statement in the Lassiter Board report that 'it (the aircraft industry) is rapidly

diminishing under present conditions and will soon practically disappear,' is justified." (p. 2 of the Lampert Committee Report, being H. Rept. No. 1653, 14 December 1925).

"Some essential types of service planes have not been developed, especially bombers, attack, and possible pursuit planes." (p. 4 of said report).

"\* \* \* that the aviation industry in the United States has dwindled and is dwindling; and that the principal causes of the weakness of the industry are as follows:

- (a) Lack of continuity in Government orders.
- (b) Losses on Government contracts, both experimental and production.
- (c) Direct competition by Government plants.
- (d) Failure to recognize and protect design rights.
- (e) A destructive system of competitive bidding.
- (f) Discouragement of enterprise and individual efforts as the result of more than 20 investigations of various sorts in a period of 3 years.
- (g) Lack of confidence and mutual understanding among contractors themselves.
- (h) Failure of the industry to develop commercial and export trade." (p. 6 of said report).

"We find instances in which the time allowed bidders to prepare and submit plans and designs has been entirely inadequate for the presentation of the best designs of which the bidders were capable. The limited time allowed has caused bidders unnecessary expense and an insufficient opportunity to work out most desirable designs. The limited periods allowed for offering designs favored bidders with developed types and worked to the disadvantage of those desiring to present new developments. The limited opportunity afforded tended to deny to the Government the privilege of fully availing itself of the inventive genius of the country in the development of superior airplanes." (p. 21 of said report).

The 23 recommendations of the Committee included:

"5. Congress should at once pass a law permitting the procurement of aircraft engines and aeronautical instruments and accessories without requiring competitive bidding under restrictions that promote the best interests of the Government.

"6. That Congress authorize the procurement agency to recognize rights in designs of aircraft, engines, and accessories." (p. 8 of said report).

The Morrow Board recommendations while not coinciding in all respects, also urged that the competitive bidding system be modified. Moreover, with regard to the procurement of aircraft engines and aeronautical instruments and accessories, as distinguished from complete aircraft, the Lampert Committee went so far as to recommend an outright elimination of the requirements for competition.

In 1926 the War Department had drafted and caused to be presented to the 60th Congress, a bill (H. R. 10287) dealing with the Air Service, but containing no provisions relative to procurement. Responding to the suggestions of the Lampert Committee and the Morrow Board, the Senate, after H. R. 10287 had been passed by the House, added the following amendment as section 9:

"Hereafter, when in the opinion of the Secretary of War the interests of the United States will be best served thereby, aircraft, aircraft engines, aircraft accessories and equipment may be purchased without competitive bidding. That in placing contracts for any or all of such material preference shall be given to contractors who maintain engineering and design staffs of reasonable size and keep them active: Provided, that the Secretary of War may purchase at an agreed price proprietary or unpatentable design rights, or in placing contracts for such articles the value of such proprietary or unpatentable design rights may be considered as an additional item over and above the production price of such material and the contractor may be paid an agreed sum to cover the value to the United States of such rights. In all cases the decision of the Secretary of War shall be final and conclusive in the absence of fraud or collusion."

So, we see that as far back as 1926 it was conceded that the aircraft industry could not remain healthy and serve the needs of the Nation under a system of competitive procurement. Unfortunately, however, the proposed section 9, which I mentioned above, was blocked when sent to conference. Instead, the provisions of a bill, which later became section 10 of the Act of 2 July 1926 (Air Corps Act), were substituted. The provisions of section 10, while recognizing that competitive bidding is unsatisfactory for accomplishing an experimental and developmental program for military aviation, almost completely ignored the recommendations of the Lampert Committee and the Morrow Board in that a system of design competition, in lieu of a negotiated authority was imposed for the procurement of aircraft in quantity.

Section 10, when applied to the procurement needs of the Air Corps from 1926 to the enactment of emergency legislation in mid 1940 proved unworkable except in connection with experimental and developmental work. By its terms it not only failed to sufficiently liberalize the strict requirements of earlier statutes as to competitive bidding, but also made provision for a new system of statutory competition, namely, paper design competition, a method calculated to obtain for the Government new inventions and types of aircraft. The success of this method of acquisition of designs was not outstanding and the procedure was rarely used. In consequence, the War Department found it necessary to investigate the advantages of various procedures under the act, to discard some and to formulate others which, although not in strict compliance with the provisions of section 10, were held to be within the spirit of the act under numerous interpretations, misinterpretations and reinterpretations.

The rigid specifications for procurement mentioned above imposed serious handicaps, and as a result it was possible to place contracts

immediately for only a fraction of the 50,000 airplanes scheduled. By mid-August 1940, four months after the President's 50,000 airplane program had been announced, approximately 40,000 planes had been scheduled but of these only 16,000 actually had been placed on contracts including orders already placed by the British.

The principal obstacle was removed in July 1940 with the authority to contract through direct negotiation rather than by open competition. Other enabling legislation, not definitely established until September, authorized cost-plus-fixed fee contracts; the furnishing of government-owned facilities; advance payments on contract, and other provisions essential to the implementation of the President's program. The point of all this is that had we had more liberal procurement legislation prior to 1940 our problems would have been greatly simplified in obtaining this tremendous number of planes.

Facilities (Plant and machine tools): The industrial facilities expansion program of World War II should not be overlooked in any study of procurement policies in view of the magnitude of the legal and administrative load it imposed on the Armed Forces and the effect it had on the war economy of the Nation.

The Army Air Forces sponsored or provided almost four billion dollars worth of government-owned plants, machinery and equipment in order to provide the productive capacity that was necessary to meet our peak requirements.

The expansion of the aircraft industry for military purposes during the first part of the emergency period was made principally under Allied auspices. After the neutrality laws were modified so as to permit exports of munitions to the Allied powers on a "cash and carry" basis, England and France placed large orders which resulted in the expansion of existing privately owned aircraft facilities with private funds or funds supplied by the Allied countries.

The overrunning of France and the Low Countries made America realize the extent of the danger with which we were faced. Our own armament program was then greatly enlarged and in June 1940 the "A" and "B" aircraft programs were devised. Legislation passed in June and July 1940, as already mentioned, enabled the Army to dispense with competitive bidding in placing orders for specialized articles, enabled the use of letters of intent, letter contracts, partial payments, and cost-plus-a-fixed fee contracts. This legislation permitted a great acceleration in procurement and thus increased the need for additional facilities. The legislation also provided funds to expedite the production of equipment and supplies for the Army for emergency national defense purposes, or "expediting production funds" as they came to be known. These funds were specifically provided to procure the industrial facilities necessary to meet the procurement schedules.

Under the provisions of the aforesaid legislation, the RFC organized the Defense Plant Corporation in August 1940. The function of this corporation was to purchase, lease, build or expand munitions plants and

lease them to private corporations for use. It was the DPC which, as events proved, was to provide the greater part of the financing for all war plants.

In October 1940 Congress enacted the tax-amortization plan, which in effect enabled a concern to reimburse itself for all or part of the cost of emergency plant facilities through tax deductions which amortized all or part of the cost of the facilities over the period of the emergency or five years, whichever should prove shorter.

Even before the tax-amortization plan was enacted into law it became apparent that most companies were unwilling to take even the limited risks involved. In the case of the aircraft industry most companies did not have the capital resources to attempt such financing. It became necessary, therefore, for the Government to directly finance new defense plants on a much larger scale than had been anticipated.

The National Defense Advisory Commission in collaboration with lawyers of the War and Navy Departments and the Bureau of Internal Revenue worked out a "bankable" facilities contract, which became known as Emergency Plant Facilities or "EPF" contracts. The contractor, under this plan agreed to construct or acquire facilities and be reimbursed by the Government for the actual cost, plus interest, in 60 equal monthly installments. The title was vested in the contractor until he was fully reimbursed, when title then passed to the Government. With an EPF contract as security the contractor usually could borrow the necessary construction funds from private banks.

In order to give the contractor an incentive to keep costs down and build well, it was usual to include an option to purchase the facilities from the Government at the end of the emergency.

The EPF contract had serious defects, in that it required the payment of interest to the banks loaning the money. The Government had an equity in the facilities but did not have title or direct control. After several brushes with banks over interest rates and difficulties with state and local governments over taxes, the Air Corps modified most of its EPF contracts to provide lump-sum payment with transfer of title to the Government as soon as the facilities were completed. In spite of the defects mentioned, the EPF contract was the medium through which the early expansions of major aircraft manufacturers was effected.

The DPC plan was held up for a time by the National Defense Advisory Commission and the War and Navy Departments because of strong opposition on the part of bankers and a general distrust of government ownership on the part of manufacturers. This plan, however, later proved to be the most popular with manufacturers, and the Air Corps financed the bulk of its program through the DPC.

Under the DPC plan of financing, the Air Corps became the "sponsoring agency." The sponsor decided what facilities should be provided and requested DPC to enter into a lease agreement with the manufacturer who was to operate the facility. If DPC approved the project, a "take

"take out" agreement was signed with the War Department. This "take out" agreement provided that the War Department pay DPC a portion of the estimated cost at once, usually 40 or 50 percent, and at the end of the emergency, if Congress provided the funds, the remaining portion less whatever sums DPC should have realized from rentals or sales. Having signed the "take out" agreement, DPC then entered into a lease agreement with the designated contractor. The lessee then undertook to construct or acquire the facilities as an agent for DPC and according to plans and specifications approved by DPC and the sponsoring agency. DPC lease agreements in most cases gave the lessee the option of buying the facilities at the end of the emergency at cost less a stated amount of annual depreciation. Title to these facilities was vested in the Defense Plant Corporation.

Another plan for financing industrial facilities was direct War Department construction and acquisition. Under this plan construction was accomplished by the Corps of Engineers, and either the Engineers or the Air Forces acquired the machinery. The complete war plant was then leased to a designated private operator by the Corps of Engineers. The plans and specifications were jointly approved by the Corps of Engineers and the sponsoring supply service. The lessee was not given an option to purchase these plants. The Air Corps plants built under this plan were largely intended to be retained as stand-by factories or depots after the war. They were strategically located in the interior of the country for that reason.

I have outlined the major methods that were used in providing government-owned industrial facilities during World War II. Let me briefly go over them by the Plan numbers that were generally used to designate between them, in an effort to point out the value or weaknesses of each in order that you may evaluate them in the light of industrial planning for the future. In Plan I, or War Department financing, the plants were built under the supervision of the Army Engineers and no options were given the lessees. The costs of constructing these plants were usually slightly higher than others due to the more rigid specifications used by the Engineers, and perhaps also because the contractor-operator had no option and therefore no interest in keeping cost down. The construction of these plants tied up considerable Army personnel, although it utilized the existing Division Engineer organization. Because of stricter army control of the project there tended to be more friction with manufacturer lessees. Due to title being vested in the War Department for all equipment the Army had a bigger job to do on property accountability, etc., and after World War II is having more trouble in the disposal of this property because of the disposal agency's inability and reluctance to rapidly take accountability and custody of surpluses. However, this type of financing is recommended for any installation of the type that may be desirable to hold in the Permanent Military Establishment either for active use or stand-by inasmuch as title is already vested in the War Department.

In Plan II, or the Emergency Plant Facilities Contract financing, the contractor acquired the facilities and was then reimbursed by the War Department over a period of five years. Because of the unattractive features such as interest rates, tax laws, and other administrative

complications, this type of contract is not recommended for future use. A minimum of army personnel, however, was needed to implement Plan II, and a revised form of the EFP contract, known as a Special Facilities Contract, removed many of the objectionable features. Because the contractor had an option and was solely responsible for supervising construction, slightly lower cost is possible. The revised Special Facilities contract form is deserving of further consideration. The accountability problem, however, is the same as in Plan I.

In Plan III, or private financing with tax amortization, the contractor provided his own facilities and received tax deductions through accelerated amortization. This was a very attractive method of financing for strong corporations that had plans for future utilization of additional facilities. However, such a system provides a windfall at the government's expense and should be allowed only under strict administration and in cases where government financing is not feasible, such as non-severable additions to privately owned plants, or for leasehold or other improvements or additions to private property that are necessary for the performance of a war contract, and which would have little or no postwar value.

In Plan IV, or DPC financing, the DPC or Office of Defense Plants, RFC as it is now known, at the request of and after entering into a "take out" agreement with the War Department, and receiving 40 to 50 percent of the estimated cost of the facilities, entered into a lease agreement with a contractor for the use of the facilities for a specified period of time or for the duration of the supply contracts. The contractor acted as an agent for DPC in building or acquiring the facilities and in most cases was allowed an option to purchase. This form of financing permitted flexible operation on the part of the contractor, with "staff supervision" by DPC. It required a minimum of army personnel and did not involve army property accountability. After World War II the property disposal problem was simple so far as the Army was concerned inasmuch as title for all machinery and equipment was vested in RFC, and there was, therefore, no problem of transferring custody and accountability to the disposal agency. This was the most desirable form of financing from our point of view. However, the "take out" arrangement whereby the War Department advanced a percentage of the estimated cost to RFC has proved unnecessarily complicated and is productive of paper work. If this plan is ever used in the future, legislation should provide that only a "contingent take out" agreement is necessary with no actual transfer of funds between the two government agencies.

Machine tools in particular were a serious bottleneck and delays were encountered throughout the entire period particularly for special purpose machines and other critical tools in greatest demand. Thanks to high priorities, allocations, aggressive expediting and improvising, the requirements of the industry were met and no serious interference with the program was experienced.

Subsequently other problems limiting the acceleration of aircraft production arose.

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Materials--Shortages of materials did not become a serious problem until 1942. By this time many facility expansions had been completed and actual production was accelerating in an increasing volume. In late 1942 and early 1943 a number of critical shortages threatened to limit the rapidly expanding program. Shortages began to appear in aluminum forgings, extrusions, magnesium castings, special alloy steels, and many standard parts such as elastic stop nuts.

Competitive bidding for materials and suppliers pyramided the demand and a serious mal-distribution among manufacturers accentuated the problem. While shortages did not account for any extended work stoppages, the over-all limited supply situation set a limit on aircraft schedules in relation to tactical requirements.

The need for corrective government action in the mal-distribution of materials was recognized early and a priority system established. This was followed by allocation plans. Not until the introduction of the Controlled Materials Plan in 1943, however, was an effective allocation system adopted, and this took many months to achieve its objective.

Components--A similar situation developed in components. The method of attack adopted on this problem was to place under direct government procurement all items in short supply. The Services then controlled directly the procurement and distribution of these so called GFE items. Even so, some serious GFE shortages developed, especially where new models were involved. The fire control system for the B-29 was a case in point.

Manpower--The general over-all manpower problem did not become acute until the latter part of 1943. After that time the realization of tactical airplane requirements was limited by the ceiling placed on manpower, and schedules were generally adjusted to the supply available in particular areas.

From a working force of around 150,000 in May 1940, employment in the entire aeronautical industry expanded more than thirteen fold to a peak of over two million workers by the end of 1943. The recruitment, training and organization of these workers into a smooth functioning machine presented one of the most serious and continuous problems faced by the industry.

From the beginning, shortages of skilled personnel were experienced by most companies. Engineers, skilled machine tool mechanics, tool-makers, supervisory foremen and a variety of highly specialized personnel were in short supply.

These deficiencies were overcome essentially in two ways. First, large scale training programs were inaugurated, either in vestibule schools or on the job. Secondly, the introduction of mass production techniques broke the job down into various skills which unskilled men--and women--could perform with little or no training. This enabled the absorption of hundreds of thousands of women from the home and men from the farm who had never entered a factory before.

New plants were located in areas of surplus labor and contracts were adjusted to minimize the impact on areas where the supply of labor was tight. Constant review was made of the labor supply situation to eliminate labor hoarding and to insure maximum utilization of those available. Housing and transportation was supplied to alleviate areas of high pressure and to attract workers to new jobs. The migration of workers, attracted by employment opportunities in this new industry, reached high proportions, of which you are all no doubt aware.

Many agencies of the Government contributed to a solution of these problems. Employment agencies were established, labor troubles were alleviated, wage rates were adjusted, labor priorities were established, workers trained, houses built, and transportation facilities provided. Despite the drain of manpower into the Army and Navy, exemptions were granted which protected those skills deemed most essential to war production.

Management and production organization--The all pervasive problem of management made itself felt early in the expansion program and became increasingly critical in direct relation to rate of expansion. Management is not easily defined. We often refer to it as production know-how, but it is more than the knowledge of building of airframes and engines. The term management as I use it here refers to that team of specialists which forms the nucleus of a manufacturing organization. It is that group of personnel which is responsible for bringing together the factors of production, organizing these factors for mass output and controlling and directing the entire operation.

What know-how this country had for building airframes was located in the aircraft industry. Consequently the major burden of the expansion in airframe production rested on the specialized industry itself and represented a terrific drain on its managerial resources. The expansion of home plants and the construction of new branch plants stretched existing management in the aircraft industry to such a point where management became perhaps the most important factor limiting production by the beginning of 1943.

The problem of aircraft management was partially solved by bringing in management talent for mass production industries such as automobiles, washing machines, refrigerators, etc. A second approach to the problem was the licensing of non-aircraft manufacturers for the production of designs developed by the specialized industry. This was especially true in the case of engines and other components. But largely because of the unique production methods peculiar to airframe production only three important licensees were brought into the picture, including Ford, General Motors and Goodyear.

Supplementing the prime aircraft producer, however, was a carefully evolved system of subcontracting, which exploited to best advantage the existing management of companies engaged in peacetime manufacture of stoves, automobiles, refrigerators, washing machines, band instruments, and a host of lesser products. All in all, these companies made an invaluable contribution to the program, but did not entirely relieve the

prime contractor of many headaches involved in coordination, inspection and expediting.

Closely related to management and production, know-how is the development of production techniques. The production techniques of the prewar aircraft industry, as I have previously indicated were pitifully equipped to cope with the production goals established by the industry.

Existing production methods had to be completely revolutionized. Long assembly lines and conveyor systems replaced the job-shop plan; the plane was broken down into thousands of parts to adapt it to make production possible. Tooling became the byword of the industry. Hard dies, permanent and moving jigs and fixtures, and countless innovations were introduced.

These methods, to be sure, were based upon techniques well tested in such mass production industries as automobiles and refrigerators, but it was only by a long process of trial and error that they were adapted to aircraft production.

LESSONS LEARNED--The main lessons learned, I believe, are as follows:

First, research and development must be pushed with all the vigor at our command to maintain our technological superiority over rival nations.

But, equally important, research and development must be projected into the production phase for all key items of aircraft and equipment included in the mobilization plan. That is to say, a wartime air force must be in token production at all times. These will be the models upon which our first phase of production expansion will take place.

The Nation must sustain a going aircraft manufacturing industry. A strong nucleus aircraft industry must exist as the basis for a future wartime expansion and its mass production know-how retained in so far as possible. That nucleus, in terms of numbers of aircraft, has been developed in the Aircraft Coordinating Committee Report and comes to the sum of 3,000 aircraft.

Perhaps most important is that a rapid mobilization of industry for war cannot be achieved without the existence of a carefully prepared and comprehensive mobilization plan ready for immediate use. All persons responsible for the industrial mobilization of the Nation in time of war, both in the Government and in industry, must be thoroughly familiar with that plan, in its broad outlines, and understand their particular roles in it.

Manufacturers producing for the Armed Services must always think in terms of wartime scales of production. To the extent that funds permit, the Armed Services can assist in this direction by paying for mass production planning by manufacturers of key items in their mobilization plan.

So far as security considerations permit, the major aspects of the industrial mobilization plan should be brought to the attention of the public and their representatives in Congress so that precious months will not again be lost in heated debate on legislation essential to defense preparations.

A nucleus organization, responsible for both current procurement and industrial mobilization planning, must exist in the Armed Services, ready to place the plans it has prepared during the peace years into action at the moment the threat of war looms upon the horizon.

We cannot depend on the conversion of existing civilian capacity to meet the total requirements of a war production program. Additional plants and equipment must be provided or held in stand-by. Plans for these new facilities must be prepared before an emergency arises. On the other hand, we cannot depend solely on the aircraft industry proper for all our needs. Conversion of civilian industry to aircraft production has supplied not only additional plants, equipment, and labor, but also that extremely scarce commodity--management.

Mass production of aircraft, because of the complexity of the products involved, cannot be achieved rapidly on the rigid competition or bid basis in use prior to World War II. The Services must be free to negotiate contracts using cost-plus instruments where necessary.

We have reviewed here today the lessons learned in World War II. This, however, is but the beginning of the task that lies ahead of us. These lessons must be intelligently applied in planning a future industrial mobilization, keeping well in mind that the next war, if it should come, may be as different from World War II as was World War II from World War I.

**GENERAL ARMSTRONG:**

Colonel Eckert, probably there will be some questions from the floor. I would like to inquire about the organization for procurement in the Air Forces. Was that satisfactory at the beginning of the war, or was it necessary to modify it? Do you think you have an effective organization at the present time for procurement?

**COLONEL ECKERT:**

Naturally, since we started from such small beginnings, our organization was inadequate when the war began, in terms of personnel. However, by bringing in highly competent personnel from the business world we were able to accomplish the task at hand.

**GENERAL ARMSTRONG:**

What I had in mind mostly, Colonel Eckert, was the organization. The reason I put this question is that I went to Chicago in 1939, and next to me, in the Post Office Building, was the office of the Air Forces Command. Along about September 1939 the Air Forces closed up

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the Chicago office and brought everything back to Dayton, where the work was completely centralized, which seemed to me to be putting an excessive burden on one place.

Now what happened? I am not familiar with the events in the Air Forces subsequently. Was it necessary to reestablish branch or district offices and decentralize?

COLONEL ECKERT:

That is correct. Our small volume in peace years permitted a centralized procurement organization--in other words, largely at Wright Field. We found out almost immediately that we would have to decentralize our procurement, especially our letting of contracts. The districts, which we called them, were organized and our contracting and other procuring activities, inspections, and so on, were decentralized to the district organization.

Following the war we will retain not a district organization but a regional organization similar to it but naturally on a much smaller scale because we do not have the volume of contracts now and naturally do not have the allowance in terms of personnel.

GENERAL ARMSTRONG:

Do you think you can safely contract that thing too much? In other words, take the Ordnance setup I was in--we had no business. All we were doing was planning. It seems to me that if you are going to count on establishing offices following the outbreak of war that you are undertaking something that is really impossible and something that puts an excessive burden on the Air Forces.

COLONEL ECKERT:

Well, there is a great deal of danger, of course, in contracting the organization to too great an extent.

GENERAL ARMSTRONG:

What does your plan contemplate in the number of district offices for peacetime?

COLONEL ECKERT:

We contemplate eleven procurement field offices and in addition seven plant representatives which is not quite so sizable as the district organization. There will be more centralization at Dayton, so far as contracting is concerned, than we had during the war. We will maintain during peacetime years an organization similar to that of Ordnance.

GENERAL ARMSTRONG:

Any questions, gentlemen?

A STUDENT:

Colonel Eckert; I have a Selective Service-manpower question to ask. I gathered from your discussion that you were satisfied with the Selective Service; that they gave you exemptions or deferments for key employees. Is that correct?

COLONEL ECKERT:

Not to our entire satisfaction, naturally. There were many requests that we made for deferments which were not granted and the fact that we could not retain all of the qualified people desired was reflected in our production of aircraft.

A STUDENT:

Well is it true that out on the west coast in 1943 aircraft production almost broke down; that the Director of War Mobilization, Mr. Byrnes, had to step into the picture and give the Director of Selective Service in California the authority to stay the induction of key employees; and the Army had to furlough some 1260 men back to the west coast and shoot some 200 more experienced aircraft men from the Army to the Wright Aeronautical Corporation?

COLONEL ECKERT:

That is very true. As I mentioned in the discussion it was only through such action that we were able to continue the level of production. The major limitation on our production schedules, which were developed by the Joint Aircraft Committee, was manpower.

A STUDENT:

What actually happened is that Selective Service did play the devil with you and if some drastic action had not been taken you would have gotten into serious difficulty on manpower shortages. Is that right?

COLONEL ECKERT:

That is very true. They had very difficult problems; there is no question about that. Whether to put people overseas into combat or to keep them in the factory is a very difficult one.

A STUDENT:

I just did not want you to go away leaving the impression that all was peaches and cream between the Army Air Forces and Selective Service.

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A STUDENT:

You mentioned you had to revise some of your production schedules downward due to manpower shortages. Can you tell us how much you had to revise downward, and if you did make such reduction do you feel that that revision was necessary due to a shortage in the nature of outright manpower or was it the fault of management to utilize that manpower efficiently?

COLONEL ECKERT:

The answer to your first question, as to the extent: I do not know the exact figure; I can get it. I would estimate probably some 10 to 15 percent increase in war production could have been obtained had manpower been available.

A STUDENT:

From your own observation of events, did management utilize the personnel they had sufficiently well to say that your revisions were caused by lack of manpower?

COLONEL ECKERT:

Using hindsight you can easily say that management did not fully utilize the workers they had because management had been accustomed to turning out about 100 to 200 airplanes a year. They then went to a rate of something like 9,000 per month.

Well, the turnover from so-called job-shop methods to production methods naturally meant there would be inefficiency in the utilization of manpower--considering the management know-how we had, and even considering we brought some automotive management in that was very capable. In other words, if we had to do it over again we could have more production by utilizing the same number of people we had in the plants. I think at one time Douglass found the average time workers were in their plants was some six months. You did not mention turnover but in the latter days there was a serious turnover of people. The percentage of women, I think, ran 30 to 40 percent. That is a rough estimate. I have forgotten the exact percentage. It is high, any way.

The answer to your question is that better utilization could have been obtained from the people available if we had had the experience we now have.

COLONEL BROWN:

I think that is a very good answer.

A STUDENT:

Was not the experience, know-how and the service to be rendered by the airframe builders, engine builders, and so forth, more nearly comparable to the problem of engineering and development in time of war than it was to the over-all production?

The point I am getting at is this: From a previous lecture we had here, it was explained to us the index of production in the over-all aircraft industry rose from an index of one to 101, which is absolutely fantastic and I think explains a lot of the difficulties that have been smeared out over the headlines of the papers and through our investigating committee reports, and all that sort of thing.

It seems to me we certainly could have gotten away from that a whole lot if we had left the aircraft industry, the peacetime industry, more nearly in the field in which they were accustomed, namely, as you brought out, engineering and development, job-shop methods, in the building of airplanes. Usually it went up to the point where they were possibly semi-standards--leaving some flexibility as to what you call "semi-standards"--but absolutely getting away from this point of where the aircraft manufacturers are competing with, say, the automobile people or the refrigerator people, who were brought into the field and who were going to disappear from the field after it is over. They were trying to embarrass the automobile people. They were saying, "You can't build airplanes by mass-production methods", and all that sort of stuff. There was actually an awful lot of heat and very little light in that controversy.

I would like to hear your comments on that.

COLONEL ECKERT:

In other words, you would like to achieve the idea of using your management where it can perform the best. You would take your aircraft management and keep them in the engineering part of the game and your automotive management, or other mass-production management, and let them turn out the production quantities.

Ideally, that sounds all right. But if you go back, in terms of time, you will find that we had a war on our hands. We had to turn out airplanes. The first place you would go to get airplanes is naturally to the aircraft companies. You cannot--or not very easily, any way--immediately transfer the managerial talent of mass production into those aircraft companies, for obvious reasons. Perhaps we should have injected the mass-production industries into the picture at an earlier date, although I do not think that is desirable. You had to have the engineering development in any event and mass-production people were not in a position to design aircraft.

Your point is well taken. I think we should realize that, wherever possible we should bring production talent into the picture at as early a date as possible.

A STUDENT:

Was it your thought then that with proper planning, educational orders, and so forth, in the future that that is worthy of consideration?

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COLONEL ECKERT:

I think definitely part of your industrial plan should include provision and studies in concrete form for producing the number of aircraft that we think we will need in the future. In other words, you would have the number of companies selected, not only aircraft but such other companies as are necessary, to produce our estimated requirements.

COLONEL BROWN:

Any further questions, gentlemen? If not, Colonel Eckert, on behalf of the Commandant, I wish to thank you for a very able lecture.

(19 March 1946--200.)