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THE AIRCRAFT INDUSTRY

by

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In the first place, as you probably know, Mr. Brown, our President, was invited to be here today to address you, but he has shown the strain of the times we have all been through, and is at present at home convalescing after being in the hospital having X-ray pictures taken. (I suppose his doctors look for inner defects as do the modern cannon inspectors.) I have, therefore, been asked to pinch-hit for him.

I cannot hope to speak with the long-range association with this industry that Mr. Brown has had. He has had 22 years of it. He originally started in the Crane-Simplex days when they were making one of the country's finest automobiles. Out of that grew the Wright-Martin Company of World War days, manufacturing the Hispano-Suiza engines, and later the Wright Aeronautical Corporation with the manufacture of the Whirlwind. He came to Hartford in June of 1925 with five other men, all former executives of the Wright Company, and they started the new enterprise which has grown today to the Pratt & Whitney Aircraft Division of the United Aircraft Corporation. So he has a very long view of the engine industry and of the aircraft industry as a whole. I am perhaps a little muddled with Ordnance and other things, but I will try as far as I can to confine my remarks to things of which I have first hand knowledge and not get too far off the reservation.

Mr. Brown wanted me to tell you that he considered it a real compliment to have a representative of the United Aircraft Corporation invited to talk to you. My remarks here today are not intended to convey the United Aircraft Corporation's point of view, although they will be confined to examples from United Aircraft Corporation because we prefer to stick to facts, and we have the facts from our own Corporation but not those of our competitors.

The scope of this title is a very broad one and according to your time schedule I have but forty minutes in which to dispose of the whole aircraft industry.

The aircraft industry, as it is known today, had its roots in the post war period of 1918 but its engineering achievements and its development have been particularly accelerated and fruitful in the last fifteen years. I think those of us who are now in touch with the industry in detail will agree that in the last twenty-three years the rate of acceleration has steadily increased. So, for the purpose of our remarks today, we will consider that we are talking in this more recent era and such curves and graphs as I will show on the slides later will cover the last few years because those are of interest to us in view of what might lie immediately ahead.

Two things have grown out of this last fifteen years of develop-

ment, and they are fundamental. One is the growth of the commercial aviation industry with its public and private or pleasure transport. It is not as important in volume as is the national defense demand for aviation equipment, but it is contributing more and more to aviation development and taking an important place in the industry and must be considered, although, as I said, it is very definitely secondary to National Defense.

The second important thing, one which I think would be accepted almost universally, is the proven ability of the aircraft industry to produce in quantity and to a high degree of engineering perfection. This is one of the most important instruments in national policy and international relations, in addition to being an important element in time of war. These two developments have been fundamental and have affected our industry greatly.

Most of us are familiar with the enormous accelerated engineering development of the period we are considering. We have turned from wood and cloth construction to the all-metal ship. We have gone to very high altitudes with extremes of temperatures and barometric pressures, we have seen the marvelous application of light alloys, we have explored metallurgy in new fields (beryllium and magnesium, etc.), we have almost created the science of aerodynamics and aero-mechanics, we have gone to full-instrument blind flying, and we have given in the commercial field the most extraordinary demonstration of safety and reliability of performance. If you measure these accomplishments with those of the older industries, you will agree that this is truly a case of accelerated development and accomplishment.

Two systems of aviation industry development are in use throughout the world with various in-between forms. One is by out-and-out government ownership and direction, and the other is by private industry with government collaboration. I don't think we need spend any time on the question of which fits the American scheme - obviously, with our system of economics and private enterprise, the second one is the only possible system and our results from it are the best justification of it, for today we have probably the most universally accepted high standards of production and technical equipment in the world.

It is true that foreign nations, for national policy reasons, have gone beyond us in the amount of funds they have made available for fundamental research and in the degree in which governments have poured money into development, but I think we can safely hold our heads up with the knowledge that we still keep top rank in technical development. I hope, speaking from the industrial point of view, that our government will continue to recognize its share of the responsibility of keeping this position by appropriating funds for laboratories for pure research, and we should keep in mind the fact that the field of pure research is one in which the private company cannot take a

leading part. Pure research should be extended to all industry and not made a matter of private monopoly for patents and other things. In this way the interest of our national policy very definitely will be promoted.

There should be a sharp distinction in our minds between research and development. Development consists of taking those principles discovered by research and building them into designs possible of economical production. This phase should definitely be left to private industry. Research requires a continuity of engineering progress which necessitates large expenditures of money, and it is in this phase that government can be of most value. In the development field private industry is bound to outstrip governmental operation.

Our experience in the World War, as well as that of major foreign powers, has demonstrated another interesting thing - that is that when it comes to the production of this highly technical material, there are certain unique practices which are part and parcel of this industry. There are many who, for varied reasons or because of varied experiences, may say that the principles of mass production can be applied equally well to our industry. If you attempt to apply this, you will find that you come up against some very definite hurdles. I would like to develop this a little if I may.

In the first place, automotive equipment, which is what we think of when we think of mass production, is based on large scale production of a static design which has been fully worked out and is introduced as a yearly model. It is produced in enormous quantities for a direct consumer market and it must be merchandised from the point of view of the direct consumer market. That reaches down into the processes of manufacturing in a very definite way. One reason why the aviation industry has grown so fast is because it is so flexible. It puts engineering improvements into production over night, modifying its production and introducing into its production models lessons learned in service, at the same time maintaining such a flexible manufacturing schedule that it can change its models without throwing its production schedules out of gear. At all times aviation equipment is developed first in the laboratory, then by experimental flying. You have your projects of an experimental nature all during this period. Basic data are being obtained and applied back into design. Then the design is put into production and as these production units are applied to airplanes, they are again flown in service by service personnel. At each step a new set of lessons is learned, and as they are learned, they are applied back into the production design.

This is at direct variance with automotive procedure. The automotive unit is developed in the laboratory and then is put out on the road tests and is practically a final development when it is put on the production line. You can easily see that in an automobile if there is an element about the unit which should be changed, there are so many units which have already gone into the hands of the consumers that the financial burden, as well as the popular reaction of the consumers, would be against the company attempting a policy of replacements. Desirable improvements in the automotive industry are, therefore, kept for yearly model change. This necessarily slows down the process of development. In aviation, however, this development has to proceed at a faster pace and improvements cannot wait as they can in the automotive field. It is very well to keep that in mind.

The automotive product has no serious weight limitation. It has weight limitation - one of price, of course - but it hasn't the weight limitation of the aviation equipment. Therefore, in the automotive field you find a totally different metallurgical background. You find you are working in different materials, but, more important than all that, you find your design is fundamentally a more orthodox design. The automotive designer is limited first by the cost at which the product can be produced, and, secondly, by the metals and the materials which he can use and the cost of them and their ease of procurement in the raw material markets. When he works at his design he uses the well known factor of safety, and I am not trying to shed any somber light on that factor of safety when I say it has often been called the "factor of ignorance".

In the aviation equipment field, the designer must work without the benefit of that umbrella-like factor of safety. He must work with a detailed knowledge of the distribution and degree of stresses in the highly intricate parts. He must make use of the newest form of research technique such as photoelastic investigation and X-ray diffraction equipment which, as yet, the automotive designer has not had to contend with. In the aviation field we find so often that when we strengthen a part, it breaks more readily, and the reason is that we are working with such refined stress conditions that by adding weight at a given point we are concentrating stress at another point, to a degree which the material cannot resist. We have the manufacturing limitation, and the design limitation and we have the necessity of incorporating improvements into the design during production. These all run directly athwart the automotive concepts of production.

Another point of difference between the automotive and aircraft industry is to be found in the volume of production of like units. In the automotive field, production of huge quanti-

ties of the same model and size of unit make possible the utmost refinement of manufacturing equipment and procedure. This is not so in the aircraft industry even under wartime conditions. For instance, in the latest War Plan, the War Department specifies for Pratt & Whitney Aircraft Division four different models, the highest quantity of which is to be produced at 475 per month and the lowest at the rate of 100 per month. These monthly figures are less than the daily figures for the automotive industry and they have a decided bearing on the selection of manufacturing equipment - work conveyors, line assembly and machines designed for one operation only are out of the question for such production.

I have only one more point to bring out on this subject, because time is flying, but I think it is very essential that the form of thinking one meets in the press and in inspired articles at times by engineers (but engineers in other fields) should be thoroughly understood by you gentlemen. I am going to draw on one more fact as an example. We in Hartford - and I realize this is a dangerous statement - do not like to employ automotive workmen. Our reason is sound. They have more to "unlearn", and I think you will all agree that mental inertia is a force and it is harder to "unlearn" something than it is to take a fresh mind and teach it something. We prefer to take workmen with mechanical sense and teach them the aviation requirements, than to take automotive experienced workmen who come to us with preconceived ideas and "unlearn" them. Take inspection, for instance. We say to each one of our workmen, "When you are working on any part, remember that you hold human life in your hands and you are your own inspector." We have other inspection, of course, but it is not the policing force which is the common concept of inspection. Our inspection system consists of representatives of the engineering department, and they report to the engineering department. They and they alone are authorized to decide in a borderline case what is acceptable and what is not. Those of you who have mechanical engineering experience will be the first to agree that it isn't possible to put on a blueprint all of the requirements of a finished article. No one has ever found the standard for finish, for instance. I could go on indefinitely and point out the limitations of the blueprint as an instruction for manufacturing, and these representatives of the engineering department whom we call inspectors are the only ones who can rule on those factors. They, themselves, have strict instructions so that they never step outside their sphere of authority.

I would like to enlarge a little on this question of finish. The finish in the aircraft power plant is so different from that of the automobile power plant that they are in two completely dissociated categories. Our finish is high, not to impress the cus-

tomer, but because we know that the quality of the surface is generally an index of stress loading for fatigue failure, and if the surface is irregular with minute scratches (which are of no importance at all under the safety factor type of design) they can lead to fatigue failure in the highly stressed parts of the aircraft power plant which does not have this safety factor. It is very difficult to teach workmen that little distinction. We can't handle parts on conveyors because those little scratches might lead to failure. We are dealing with parts that cost, in some cases, almost as much as a completely finished automobile and one scratch, insignificant as it may seem, can make the part unfit for use. There is the little matter of rounding a corner which is of tremendous importance and those little radii are specified in thousandths of an inch. There is no importance, or only minor importance, attached to these radii in an automotive design. I am, perhaps, bearing down on this point but it is because so often I hear the statement made by men, for whom we all have great respect, that the principles of automotive design and manufacture can be applied directly to our industry.

Our workmen are taught that if they produce a part which later is found to be defective, they are warned - if they do it again, they are fired. No such philosophy applies in the automotive industry, where men work primarily on some system of measured production and where pay bears a definite relationship to that, and where the tools presumably will furnish a satisfactory part if the standard instructions are followed. Our workmen are provided with their own inspection gauges and become their own inspectors and therein is a fundamental departure in the thinking of the workmen on the machines in our industry.

Now, from the design point of view, as I mentioned before, automotive design is dictated by consumer market where the merchandising technique and a price level are all important whereas aviation design is dictated by the demand of the ultimate in performance. Those two are not parallel, gentlemen, - they are different systems.

In the equipment used in the two industries you find another basic difference. The tools such as we buy - and I'm referring to machine tools - are of a type which you would broadly call toolroom equipment. We are the first industry of comparatively large size to manufacture, in quantity, parts to toolroom tolerances. If there were an automotive man present, he might rise and object and say, "We make our piston pins to ten thousandths of an inch. You do no better." I wouldn't quarrel with that statement, but I'd say, "We make our master rods to ten thousandths of an inch, not on one dimension, a mere diameter, but on interlocking dimensions, so that there may be on one part dozens of

tolerances in ten thousandths of an inch. And it is well to remember that if you have a part with two dimensions in ten thousandths of an inch, it's twice as hard to make as a part with only one dimension in ten thousandths of an inch." There, again, you can be reasoned to an erroneous conclusion. The change in shape of a metal part upon the removal of chips by the cutting process becomes an important factor. It requires stabilization of the metal during process. Even the heat of the hand in handling must be eliminated or it will cause temporary distortion. It requires toolroom and gauge room technique carried into production.

The next great problem is that of meeting the demand. How shall the industry expand to meet the unusual conditions which now present themselves? The problem, naturally, is that of having a balanced industry, as you will see from certain data which I'll show you at the expiration of this part of the talk. I prefer to have you get the conclusion from that data because it is factual and you can carry the picture in your mind. I think you will come to the same conclusion we have, that there has not been a period of expansion in any major industry similar to the one which the aviation industry is now going through. It is a marvelous test of war-time planning of the problems that this school is directly interested in, two of which are - to expand the industry to the required amount, and, to keep the industry balanced within that expansion.

The first difficulty you meet on the second phase of that problem is the fact that in expanding an engine, propeller, or accessory plant, you are confronted with the limitation of the precision tool market and the limitation of the supply of tool makers who can make these extreme precision gauges and tools. That is a minor factor in airframe or airplane construction. The airplane manufacturer of today whose product contains so many of those gadgets that we call accessories, finds himself more and more in the position of buying those gadgets from gadget specialists, and the reason is sound. Industry, even though large, can make substantial savings by having one specialist doing one thing for everybody, or maybe two or three competing specialists doing one thing for everybody, than to have every airplane manufacturer make his own landing gear, for instance. The airplane manufacturer found that out some time ago. He is now finding out that it is necessary to have many of these complex fittings and devices, necessary in all of the operations of large airplanes with indirect forces and control systems, made by specialists who have full toolroom equipment and the required types of personnel, and thus confine his design work to stress analysis, to aerodynamics, and the producing of a finished structure. So in this accessory, engine, and propel-

ler question a separate problem appears. In a recent study we found that to carry out an expansion requires an appropriation of something over $4 a square foot for building space suitable for installation of this complex mechanical equipment, and then requires five times that amount in addition, in the form of mechanical equipment to be installed. In the airplane or airframe field, we found that it is commonly said that the buildings can be put up for $2 a square foot and very little equipment need be installed, and an inspection of an airplane factory will show you that their tools, and their jigs, are made up largely from structural steel forms, blocks, lag screws, pipes, simple brackets and, in many cases, soft drilling templates. That type of equipment can not only be put together by men who do not work in precision tolerances as we understand them, but who can be recruited readily, and the value of this equipment in the final form is not as expensive as in the engine industry and the accessory and propeller industry. In the latter industries you have to buy these elaborate tools which are toolroom equipment and then you have to equip them with jigs and fixtures which demand the services of the most skilled of workmen. In every wartime expansion those have been bottlenecks.

To expand the production, then, of these mechanical devices in the industry is at some point a more serious problem than expanding your airframe production. We have already had a test of that in the countries of Europe and while this country has not as yet felt that problem directly, there will be an effect which will indicate that it can easily be a problem. I refer not to the fact that this country has been called upon to expand the industry for its national defense. Its commercial airplanes are expanding at an unheard-of degree. It has its oldtime normal customers of the world to supply - those are our regular customers. It has the warring nations with tremendous demands, and now it has the little neutral countries who formerly purchased from the warring nations but who can no longer purchase from these nations and who add a greatly increased demand on top of that already existing. In one way this is a fortunate circumstance, - a test of wartime expansion. But it carries in its wake the responsibility of not expanding our industry to a point which will kill the industry when normal conditions return and therein lies a responsibility for which no one member of the industry can be responsible, for which no governmental body can be responsible, but which must be a cross section of the common sense of the nation. If we repeat the last World War experience you will have the two extremes - from the factories which underexpanded to the factories which overexpanded, and you'll find that many financial structures cannot support such expansion in the normal times to follow and thus there will be a tremendous weeding-out process. It isn't to the interest of our government to have that weeding-out process hurtful to our industry at large. Nothing can pre-

vent the stock promoter, the "wildcatter", and the experienced designer, who has a following, from going out and getting capital and creating new enterprises in order to get on the bandwagon. There can be no control of that except a voluntary control, but a voluntary control is needed and as you will see from the figures which will be shown to you on these charts, the real danger lies not very far ahead.

I'm skipping through some of the subjects I have prepared because time has caught up with me a little faster than I expected. My remarks are extemporaneous. What I am most desirous of doing is showing these slides and they will illustrate the practical examples of what I have tried to give you. It's much more important that you yourself can visualize these forces than that you take second-hand from anyone that such forces exist. I might say that I can't speak for the industry, but I don't know of anyone in the industry who doesn't more than welcome visits from you people into our factories so that you may see at first hand these things which are so important to you in your technical activities. We only wish it were possible for such studies to be made right in our factories, which I am sure would impress you far better than any possible amount of reading about the workings of our industry. Major Brophy said to me this morning that it is becoming realized more and more that the army behind the lines is perhaps a little underestimated, and that the complexities of this problem have not been understood or worked out, and yet we can't wage any form of war, either defensive or offensive, without such a well organized army behind the lines. One lesson has certainly come out of France - and I have talked with a number of men just returned within the last few days and is in a position to know - and that is that the nationalized factory has been a complete failure. We have as an example the comparison of Potez and Breguet. Breguet is going ahead by leaps and bounds with great latitude of action. They have gone out and secured many sub-contractors. Potez, which has been nationalized, is still struggling in an effort to find out how to do its job. So in these lessons of Europe we can find a laboratory for our own government planning for the kind of problems you're all working on. I know you've given these problems a lot of thought and I know you have sources of information which are not available to me in industry.

And now I want to generalize on two or three important matters and then we'll try to go through these picture exhibits and see if we can follow the argument in what we have just heard.

When we come out of this period, our most serious problem will be to prevent a let-down of engineering development. We have already learned that every company supports the development of engineering programs of its own. In the case of Pratt

& Whitney Aircraft – and I must be forgiven for referring to it – our engineering program for the year 1939 required over $3,000,000 in funds. At this time a year ago Pratt & Whitney didn't have enough production to support that program and didn't know where it was going to come from. As many of you know, we had planned on additional Pursuit business which we lost, and, had it not been for foreign demand which appeared early this year, our directors would have been forced to have underwritten that program for the year 1939, but would have had a problem to have underwritten it again this year. Now, out of that program came the development of the 1850 horsepower engine which is the highest horsepower engine in the aviation field that has passed all the flight test requirements, and is therefore your most important motive power at the moment. Now, there are other important engines under design which will come out, we hope – one in 1940 and another in 1941 – and let us remember that these engineering programs are of about the same duration as it takes to build a battleship. We lay down the design today and you see it in production anywhere from three to five years from today. That is one of the reasons why one of those engines performs, because it undergoes such a rigid development and is tested so thoroughly before you are permitted to fly it in the air. But the time factor is the important thing, and it is also important to carry in mind that it takes millions of dollars to develop such engines and the only source of support for this development at present is through a volume of production. It forms a certain part of every sales dollar and therefore when this period is over we should all think, and think before it reaches us, how engineering programs are to be maintained to keep ourselves always, as far as the design of our production material is concerned, in the high place that we now occupy and which was for a time seriously threatened in certain directions.

However, there is a ray of sunlight in the picture. After the last war you all remember that the automotive industry had practically taken over world commerce outside of the warring nations. During the war the warring nations had all they could do to equip themselves with automotive equipment and the other markets naturally fell to the United States so that the automotive industry came out of that period with a premier position in the world markets. No one can prophecy what the economic situation will be like at the end of this period but it is possible that our aviation industry will occupy the same position with respect to world markets as the automotive industry did after the last war. We can only hold such a position, first, if our product continues to justify the high rating which it does today, and, second, if it can be sold – in other words, if there are currencies which can purchase it, and, lastly, if the world economic struggle permits the normal flow of commerce.

These barter agreements about which we have heard so much cut through the normal interchange of world goods so it cannot be said with certainty that our American Industry will enjoy a given amount of export business, but it is hoped that the export business which should result from all these splendid contacts being made by the industry today and from the use of our equipment and the familiarization of that equipment in these foreign lands may furnish the means of carrying the future engineering load. But, if not, then it should be a matter of concern in your planning in the government's interests to think how the engineering programs may be sustained if demand sinks to a point that will not support them.

I want to close this part of the talk with one very cheering conclusion. As you will see from these slides, you will have a reason to be proud of the way in which your aviation industry has met the demands now placed upon it. In the final analysis, the proof of the pudding is in the eating. We have had the sympathetic cooperation of the Army and the Navy in this accomplishment. However, it is interesting to note that prior to this year sixty per cent of Pratt & Whitney business was with the government in one form or another, - this year eighty per cent is not with the government. Now for a time that nearly endangered our engineering program because of the sudden change in the distribution of engine business in this country, but it has worked out happily and it merely is brought out at this point to illustrate a typical problem of private industry. Speaking for our company, we have no desire to get so much business that our competition cannot live. Competition is essential and necessary and this applies as much to companies competing with us as to us as their competitors, and, in closing this part of the talk let me say again that it has been government cooperation with private industry that has produced what has been this outstanding achievement of our entire industry.

FRENCH AIRCRAFT INDUSTRY

Mr. J. Carlton Ward, Jr.
President, Fairchild Engine
and Airplane Corporation

DISCUSSION

Colonel Lewis Gentlemen, we are ready for your questions and comments.

Q. Mr. Ward, may I ask that, since your Commission decided that Mr. Ford cannot keep his promise, to what extent they thought he might be able to?

A. That is a tough spot, gentlemen. I will try to alibi myself somewhat as we did to the French We explained that we were a mission sent to advise the French on French problems We had no official status on this Ford problem and, therefore, our discussions with the French were entirely off the record with respect to that problem. Now if you will recall, at first he says he can build a thousand airplanes a day Your first question is, what kind of airplanes? If you take a modest pursuit plane which we will call a $40,000 plane, if you like -- that means he produced $40,000,000 worth of product a day. Now, on 250 days a year you can figure out what that is If you put it in terms of workmen it means he must have millions of workmen. He has around 230,000 workmen, so that doesn't work If you are taking training planes, it is something else He doesn't have the equipment

The General Motors Company were asked to help Pratt and Whitney Company at the early stage of our program I am not with Pratt and Whitney now, as you know. In good faith they sent a staff of their very best talent. We laid out every part of an engine on the bench with the blueprints and specifications and asked them what they felt they could make. They said Mr. Sloane had offered to take their latest and newest unit, near Buffalo, at Tonawanda, I believe, for producing chiefly parts and turn them over to Pratt and Whitney It is a very large unit of a very recent design. They went back and made a study of the brand new machine tools in that factory and found only 18% could be used at all on airplane engine parts and of the 18% about 9% of it had to be rebuilt to a little finer tolerance. That reduced it down to the fact that they could only offer us an empty building and perhaps a pool of labor because the supervision was unskilled in that article and the joint conclusion was we had better do it ourselves Now you can apply as much of that to Mr. Ford as you like.

Q Mr. Ward, did you have a chance to find out what materials were used in the permanent molds for casting of cylinder heads in the French factories?

A Yes. That is an aluminum alloy very similar to Y.

Q. Is there any evidence coming to hand that the Germans may have also recognized the superiority of the French

aircraft product and may attempt to facilitate part of their redesign in that direction?

A It would be quite a problem in my opinion I can't answer your question directly, except to say that I have no evidence other than the fact that the minute they got into France they siezed one of the Wright (?) aircooled radial engines and dragged it off to their laboratories. The Allison Engine, which was on trial was brought down to Marseilles when I last knew of it and was so set up that it would be smashed or thrown overboard before they could get their hands on it. They have plenty of the Pratt and Whitney engines but they are all liquid-cooled in-line jobs. I should say it would be a real problem for Germany to set up to make an air-cooled motor to be competent unless they adopted the Japanese method of a facsimile copy.

Q. Earlier in your discussion you spoke of some type of cylinder head that the French had that we should have tried if we had it here Is there any basic reason why we can't have one here?

A. Perhaps you are referring to the cyclone super-charger. I have made efforts along that line, looking in that direction I won't know for a little while whether I am successful or not.

Q You have given us some idea of the relative efficiency of privately owned plants in France as compared

with government plants. Are you in a position to give us a similar comparison with respect to Germany?

A No. My knowledge of Germany is so second-hand that I prefer not to use it This information I have given you here has all been from things I have seen or from direct statements from responsible French authorities.

Q. In our present emergency do you recommend that we take steps to expand our factories as they are presently located or begin to establish shadow plants?

A I think I saw a statement that England has so far bombed 215 objectives in rural districts with some thousand bombings. Now in America that would still be a relatively small percentage. I think the answer to your question is We first should study the causes of actual damage from bombings - they are not so severe as we think of them Even in the _____ factory when I made a study at midnight of the night of the bombing the French midnight shift was back at work The thing you have to watch is loss of man hours, loss of morale and these are things I think important in this direction. A system of alerts must be set up so that factories do not disrupt production on a civilian alert ring. Second, the alert system only functions at time of direct attack. Your bomb shelters have to be disposed within your structures so the workmen do not have to walk outside to exposed places to bomb shelters Factory buildings al-

ready in existence would be very expensive to change except to do everything possible to prevent leakage of light. I am convinced that that can be done. I have made studies with architects that show that curtains can be adapted for winter operation - exterior as well as interior. I should say that a factory should be sealed against night illumination When war is imminent an alert system should be worked out whereby individuals who are to watch for alerts are trained. Bomb shelters should be convenient to workmen and that will improve the morale and act as a precaution. Should have excellent fire protection and that is often overlooked Buildings can be camouflaged -- roof lines, etc There is an article in the Architectural Record If you are interested look through the files of the Architectural Record and see some of the means by which you can camouflage existing buildings. In a future building a great deal can be done to build bomb proof buildings With regard to location I don't think any present factory should be abandoned/ I think factories in the future should be built away from heavy commercial concentration I don't mean by that in Waterloo, Iowa, to use a recent recommendation, I really mean in rural areas The German method of camouflage is well known The shape of the building and the design of the buildings have a lot to do with improving the situation In this building I am talking about

(Hagerstown) all wire glass will be used. Wire glass will only break on a direct hit Every sheet of glass will be wire glass It will all be on an incline down so that the dispersion of moonlight or twilight will be down and not up to the sky It is the best type of glass to use If curtains are put on the outside of the building they can be printed in canvas so that they camouflage very well Inside of a building I have figures now that show that complete blackout can be done in a modern building for 27¢ a square foot. Buildings should be designed without overhanging roofs and without any interior wells. The old box well construction such as you have in the buildings in Washington is extremely bad because the pressure from bombs is confined. Multi-story buildings are bad Two story buildings with one story underground are good with precision machinery etc on the lower floor The lower floor can then be a semi-bomb shelter.

There are two kinds of bomb shelters - those for a direct hit and those for everything but a direct hit. Those in France having been of the second type There was a very interesting thing in the protection of a factory in France. The factory was very valuable and important They built a dummy factory, lit it brilliantly and blacked out the real one. The Germans bombed the dummy factory successfully.

It is necessary to maintain sanitary pumps running and interior factory power plants so when you want to black out all your street and exterior lighting and when you wanted a complete blackout the power system could shut the street and exterior lighting off.

Q. Is there any indication that the Germans do have an efficient super charger system?

A. I don't think so. I think that all the foreign countries pay more attention to altitude and weight and probably all of them basically have better designs than we have.

Q. What about instruments and the idea that a certain percentage of German planes do not carry instruments ?

A Not true Have never found any plane without instruments/

Q. You indicated that our factories -- our defense factories -- should have independent power plants That would put a tremendous load on our plants to turn out these additional units Don't you think with these net works of power lines that that would be unnecessary in this country where they are all hooked up.

A I didn't say a second power plant. If you have a net work properly designed it is two sources. As a matter of fact you know the effort it is to put a central power plant out of commission and, of course, if you do that, your net work is liable to fall down and in an emergency it should send its emergency source to the factories and not the residences.

Q We see in the papers that considerable quantities of American aviation equipment were captured by the Germans in France. Have you any ideas of whether any large or important quantities were taken in that manner?

A. No I can only give you my understanding. I have learned from some former members of the French ministry in this country that in general there hasn't been any raiding of that type of material As far as we can see there isn't a great deal of French equipment being found in the attack on Britain. That is what we learn from reports I understand a lot of British bombs are being used but that is about all they have found.

Q You mentioned when the French were analyzing the German motor captured that they found certain evidence of certain alloys missing in the manufacture of that motor Can you tell us what they were missing?

A. Yes. The Germans are short of all of the ferrous alloy type. In other words, take chromium. They haven't any sources of chromium. All of the ferrous alloys not indigenous to Germany are problem items. Chromium, nickel, steel combinations were forced to be substituted In aluminum they are all right, magnesium excellent, copper bad.

Q. (Unable to hear question)

A. No It is understandable You can criticize something and still realize there is a good reason for criticizing it. Fundamentally it is impossible for government procedure to duplicate the latitude, the shifting of responsibility which is possible in commercial work Now the French came over here with deliberate directives that the equipment should be identical as the Army's in this country French statutory laws stood in the way and also there were American statutory laws that stood in the way. If the commission in this instance had waited until the French Congress had acted there would have been no French procurements. . . . Private industry should step out and do things which are utterly out of the question as far as govern mental activity is concerned so when you come down to an honest appraisal of the facts you have to admit that private industry can do things that government cannot do and vice-versa. If each one fulfills his part you get your over-all best results.

Q. Can you tell us how much of the French aircraft production is now available to Germany?

A. That is a question I cannot answer. All I can say is that in discussing that question with former members of the ministry they have stated that there isn't much.

But, I have no basis to either accept or reject that statement.

Q. In what way did contract procedure impair production - you mentioned that that was one of the difficulties.

A. Profit limitations, the lack of getting contractual procedure with respect to liquidated damages, prevented French industry from stepping out and expanding. Private capital unlike government caoital can never make a mistake -- to make a mistake is suicide. Government capital makes a mistake but the taxpayers always come through so things which in the government side of the fence - I say this ~~xxx~~ without any pressing of a point - although it will seem unreasonable from the contractors side of the fence -- are really because of lack of understanding of the other fellow's problems What can be a detail in government procurement can be the sine quo non of contractor's point of view and this is what we are going through today in this country. I don't want to get into details because that gets into politics.

Q. (Did not hear the question) (Pertained to trouble with the communications system.)

A. The communications system was never put into really operating condition To begin with, even in normal France we would call it a bad system. What further made difficulties

was the fact that they were preventing fifth column activities and unless you had government permission there were a great many things you could not do without that permission

Q We are all interested in the problem of plant location from strategic view point You were speaking of your new factory in Hagerstown I understand that it could not be located adjacent to the present factory because of limited space Would you give us the factors that would cause you to locate it where you did -- what are the elementary factors in plant location?

A. That question is a beauty I will try to answer it reasonably and yet I can't do justice to it. I would like to start off this way. The Army has made a map of what it chooses to call "strategic areas" or what would be better "areas that are not strategic". You can't build in it That map except for New England is like coming in from the border of the country a certain distance and drawing an area Experience in Europe does not indicate that that is a true analysis Speaking personally, I would rather work in a factory right on the sea coast in North Carolina than I would a factory in Wichita, Kansas. In Europe no successful or maintained bombings came from a sea base. Carriers are very vulnerable and not entrusted with that type of mission Therefore, an enemy with no land bases doesn't operate very successfully. On the other hand, if you want to assume

that he can fly from Europe to South Carolina you might just as well be there as Wichita So, looking at the new Hagerstown plant. It happens to be inside the strategic area just inside is all, to be sure, but actually it is a wonderful location from the point of view of protection. We have a factory in Long Island, I think it is wonderfully protected. Many people think "what a terrible place you have - water all around." Can you imagine being bombed from Long Island Sound, from Sandy Hook where our fleet is in evidence. If we have no fleet I don't think it matters where your factory is so from a practical realistic point of view the more you think of this question of location the more complicated it gets. I can tell you a lot of things not to do but not so good to tell you things to do. To locate from areas may look fine from a map point of view but you run up against difficulties of operation There are two kinds of factories and for one the problem is relatively simple and for the other it is very complex The first is a shadow factory where you only produce -- those can reasonably be located geographically with certain limitations but factories which have to engineer production as well as build it require totally different types of locations. One thing which would upset operations in time of war is for people in California and New York and Washington and Atlanta

Georgia to have to all get together on short notice to find out what to do about a service complaint. In other words, you have great laboratories, fountain heads of many important engineering activities. It is very convenient to have engineering personnel adjacent. That looks silly from the West Coast point of view and if you knew the difficulties of manufacture on the West Coast in respect to that. So, if I located a factory I would want it convenient to Langley Field, Dayton, to Washington, D.C., Naval Aircraft Factory at Philadelphia, great metallurgical centers of the east where in two or three hours I can get a plane and get to my destination or where I can work closely with suppliers and representatives because, taking an airplane engine, about 70% of the work is done outside of the factory, Pratt Whitney 50%, Wright Aeronautical 35%, Any subcontractor can shut you down, when you find you are using his shop you have got to keep up a production program control. So, I repeat, for an engineering organization which does manufacturing too, you have got to consider operating factors, from a shadow point of view you can put the factory a long way off because your engineering is taken care of by the parent. In France the parent engineering organizations were close to everything and the shadow factories scattered around. This problem is so complex that I can only hit on a few high spots.

Q. In your travels through France did you see any other defense industry affected by - - - (unable to hear the rest of the question)

A. I think it is common knowledge what happened and the attitude of the workers is very clear. In the case of the S.N.C.M. factory - government engine factory -- the prevailing politics in the House of Deputies was communistic Men were hired under civil service regulations but no one was hired who wasn't a member of the communist party. The resulting situation was very bad. Men had no control, management had less, workers ran the shop. When Pratt Whitney tried to run type tests because of French need it was agreed that we would work two shifts a day. This was under the Front Populaire The engineers went over and proceeded to run but after about four hours the power was suddenly shut off Engineers went to operator and said, "We are running tonight"and said, "Why shut off " He was told, ""e are only running on one shift " "Here is the directive calling for two shifts " "Here is directive from Labor Council calling for one shift " Engineer in charge said, what can I do? That occurred to Pratt Whitney in the government's own laboratory.

Q. With reference to the German raw materials, is there a shortage of tin which affects the babbitt metals and have they any substitute?

A. I am not an authority on that, and I prefer not to really attempt to answer except as far as I know there is no substitute for tin as a metal. There are other barring metals but if you follow aviation engine practice in Germany a little tin is used along with lead Those are the high barring metals.

Q. (Could not hear question)

A. I will use the Army as my authority now. I went over with five special observers of the Air Corps and the it seems to be the opinion that the German and British bombings were equally bad at the start of it German bombings have gotten better The belief exists that the Germans have an improved high altitude bomb sight Some people are beginning to assume that they have worked out a oomb sight Word spread around that they had gotten it from Russia and Russia got it in this country. The value of rumors is pretty low and I don't vouch for any statements -- I merely give you what I have been told.

Q. (Did not hear question)

A. Not after the war situation developed. The French people from what I could observe were deadly in earnest. The French people were not prepared for the collapse of the Army. I believe that is one reason why the trials are now being held. People placed quite high in civil life and industrial

life were not prepared. Certain moves of factories were done on a moments notice The French people believed that one French soldier was as good as 2 Germans They believed the Maginot line was their Atlantic ocean. The French campaign was supposed to have been defensive. Gamelin is an apostle of offensive warfare. Belgians had no plan, for the French, no contracts between the staffs. Put through the little Maginot line. Gamelin still felt he could hold that line with the French army but when he took his best troops under pressure from England to keep Belgium as a buffer state, he pulled experienced defenders of the line and failed to discount that Germany was profiting by previous campaigns through Ardennes so German soldiers came through, well equipped, in quantities against second line reserves The result of that whole thing which I have only put in its broad scope is that he had a plan but departed from it under pressure with disastrous results and, secondly, he underestimated the enemy, as does everyone.