"The Aviation Industry"

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This airplane business is operating now as a comparatively new business, in that it was about 1930 or only eight years ago that we actually started to build airplanes as we see them today, even experimentally Before that time, the big part of an airplane factory was a wood shop. Now if you go into one of the modern factories, you find a little place in the corner with a small wood shop making plates and patterns. The woodshops have been entirely eliminated It was necessary to change over everything in our way of thinking and operating when we dropped the conventional steel tube fuselage, wood frame wing, cloth covered stuff, and get into a much cleaner type of airplane aerodynamically of an entirely new type of structure and in most cases, of a new material. We were getting this type of airplane in reasonable production by about 1932. The companies were pretty much engaged in research, trying to develop types of structure and working out all the aerodynamical problems Very fortunately for the industry, in one way, it was at a very low point in production. In fact, most of the companies were down almost to the bottom, so that when the need arose to change the type of machinery, to re-educate all the personnel, and rearrange the plants, it was done at a time when the problem created the least difficulty and trouble. This period of about 1932 on was followed by a very rapid expansion in every way. It was about that time that the airlines began to get new equipment and the Army and Navy were putting on accelerated programs of buying a lot more airplanes with the net

result that since 1932 there has been an expansion of plant capacity of probably 250 per cent and a personnel of some 350 per cent. At the present time I would estimate that we have somewhere around 5,000,000 square feet of available factory space It's not all being used at the moment, but there is that available factory space in the industry. This is for the construction of airplanes. The English have a rather nice term - airframes - for the airplane less the engine, propellor, instruments, and equipment which are not ordinarily manufactured by the airplane manufacturer. So it's very much simpler if you can say airframe when you mean that and the term eliminates the other section. There is also about half that much space being occupied by manufacturers, of engines, propellors, instruments, and equipment. We have a total now, I would estimate, of 40,000 people engaged in airplane construction of all types, including engine, propellors, instruments, and accessories. Probably two-thirds of this number are directly concerned with the manufacture of airframes or airframe parts. In addition there are several thousand people indirectly concerned in that many of the companies farm out a great deal of their work and thereby have many people on their payroll indirectly that don't appear directly England at the present time had about 55,000 people employed directly in the airplane business and they are slowly picking it up They hope to increase it rapidly but there was very little increase between June and last week. Germany, however, is increasing at a tremendous rate and I think it's not an exaggeration to estimate that there are 150,000 to 175,000 people directly engaged in airplane, propellor, and engine manufacture in

Germany at the present time. In fact, there is one factory in Germany in which in 1931 there were less than 3,000 employees. Dr. Teiderman who has charge of their personnel expansion in 1936 brought it up to almost 30,000. At the present time it's between 68,000 and 70,000 employees in one organization, which is twice as many as we have altogether.

In large quantity production, which we'll say has orders of from 200 to 500, the tooling has been developed and people become familiar with their jobs. The airplanes of most any type are to be produced for about 3 labor hours per pound. The time wasted in the early stages of a job where there is a lot of time wasted getting familiar with the job, where you have to measure and fit and cut, where it rather becomes automatic, and where there are misfits from tools and many changes of design after the rough period after 20 or 30 airplanes have been produced, it's a safe thing to say that you can run them along at 3 hours per pound.

With 30,000 men engaged in airplane manufacture, about 24,000 would be direct labor engaged in the actual building of the airplane because this gross figure includes the indirect labor and clerical labor, engineering, and so on, which in most cases will represent at least 20 per cent of the total help in any factory for administrative, engineering, and executive purposes. This would represent on the present basis about 3,600,000 hours direct labor per month or about 1,200,000 pounds of airframe parts. If you allow about 6,000 pounds for an average airframe weight, it means that with existing plant and personnel, the equivalent of 200 average airplanes per month could be produced under straight production.

Proper conditions were good tooling and good production design. Now the question is, what is an average airframe weight. They vary from probably the lightest thing being a primary trainer down around 1500 to 1800 pounds on up through the four engine bomber class where it will run 25000 to 30,000 pounds I made a wild guess by roughly assuming the various proportions of airplanes and assuming a weight and assuming a ship of about 6,000 pounds air frame weight would be an average. For instance, our airplane, the O47 which is a 3-seat observation is about 4200 or 4300 pounds air frame weight but it's smaller than your average will be due to the preponderance of twin-engine bombers and larger airplanes. It would be easy to increase this production if it were running by at least 30 to 40 per cent without any great increase in buildings. I know that we could do that because we have had quite a lot of experience in our own plant in as much as three years ago right now we were just starting to build our plant and had a total of 60 employees, and we are now operating with more than 3600. I have been through that expansion program on a relatively small scale but the principles of the small scale expansion should very nicely be applicable to the large scale expansion. In working out such a general statement as that it's rather a dangerous thing because there is always a temptation to take a figure and multiply it and build on it. I tried to qualify it by saying that that would hold only in case of production already organized, the tools ready, the people familiar with their jobs, and everything flowing nicely. There are only a few of the plants that really are

running on enough production of a type to be in that position. On the other hand, if it's necessary to take a relatively new type, let's say, an airplane that has proven its experiment, has been tested and the changes that are inevitable after flight test have been made and that airplane would be given to a company to produce in quantity would be a miracle if they would have any quantities coming out in less than a year even on a smaller type of airplane and a year and a half on an airplane as big as a bomber starting from scratch and I would say that on a bomber you would have to figure at least two years from a new type to reasonable production. That has been operated a little faster than that in Germany and a lot slower than that in England. I have seen the work two different ways on two different schemes.

Getting into war-time production, it is the problem that is occupying all of our minds at the present time and, of course, it's perfectly obvious that the way to build an effective air force is to build it ahead of any emergency and it is also sensible not only to build your air force ahead of the emergency, that is, your air force that is required to be in operation immediately but there should be at least 100 per cent reserve behind it. That is far less than Germany is building as a reserve and is about what England is shooting at. In fact, various European experts have told me that they expect anything from 80 down to 30 per cent per month in the first few years of the war, losses on their front line which means that it's got to be fed very fast from a reserve because it's obvious that they can't possibly even with their fast production they've got now build them fast enough to replace them

at that rate. In our case we are discussing now in the papers, at least - I don't know know how much beyond that - all I know is what I read in the papers - a very large increase in the air force. Just what form that increase will take I haven't the slightest idea. The idea that it shall be increased is very valuable because our war plans call for far more airplanes in the first few years than they ever could possibly get even with a magic wand and the increase in production rate at the present time will greatly expedite any operations that may be demanded under war time conditions.

The question we faced with the prospect of great expansion in the industry and the demands for many types of ships and many times the normal output of engines, airplanes, and accessories is which of the two most likely methods of increasing manufacturing facilities should be used. The shadow plant idea is followed in the English plan or the expansion of existing facilities as in the German scheme. The shadow plant is one built at Government expense and intended to provide the reserve capacity over and above that of the peace time normal capacity of the manufacturing industry. It's not necessarily made a part of that industry for which it was intended. In other words, the two of the big plants in England's big shadow plants, Root and Austin, have practically no aircraft people connected with their operations at all. They are practically entirely operated, controlled, and managed by automotive production people. In the German system, however, existing plants were increased by adding buildings or even building new plants completely for them and the personnel familiar with the type were used as a nucleus for the

expansion of the personnel demands and they were able thereby to maintain a continuous production that increased rapidly. I was in one of the big plants last week in England and it's one of their newest and finest shadow plants It's a tremendous building - it's 400 feet wide, with a central column 46 feet high under the trusses and 1500 feet long in the main building. It's just simply tremendous. In addition to that there are outbuildings for machine shops. They have a r om for painting and finishing.there that has 40 feet head room, is 400 feet wide, 600 hundred feet long. The architect made a mistake and made it four times as high and long and wide as it was intended but there it is. Over in one corner there are a few people working but they are adding to that huge building just as fast as they can. That particular plant had its inception in just a little over 30 months ago. The man who was charged with doing this job who was in the automotive business came over to the States and was at the plant talking about that long ago and while he was here they were making the plans for the building and they started into operation. They now have flown the first airplane just the first of October. It came out and there are two or three on the final assembly and they are slowly coming down the line in a considerable quantity. Now that airplanes have already been developed and have been in small production at the time,this huge factory was set up to build them. It was given to people from the automotive industry to build and they went ahead to build it just precisely like the Chinese will make you a suit of clothes from the one you send him and if you have a patch on the sleeve he is likely to put a patch on the new suit. They did precisely that. I went along the line with the general manager and I picked up a piece about so long which was a torque arm from the rudder

control system which had 14 pieces in it. I asked him why, inasmuch as there was at least 8 hours labor on it and all these pieces and tooling were very elaborate, they had half a dozen jigs and fixtures and regular steel automotive type dies to black out the piece and I asked him if it had struck him that a forging, a simple aluminum alloy forging, would have cost less for tooling and probably 5 to twenty-five cents labor a piece than the eight or nine hours. He said, "No," it hadn't, he was only building what they gave him and if he asked any questions, it would take a committee from the Air Ministry and probably an act of the Air Council in about a year they'd hear, "No, you better not do that; we didn't do it in the beginning." Another thing is that they have built tools of a type that we would never even think of building. For in the airplane business we are faced with the job of building in a semi-production manner relatively small quantities of airplanes, and furthermore, we are faced with the job of getting them out very fast. We have taken several old well-known schemes of operating with sheet metal and carried them to a very high degree of perfection and operation. For instance, in the automotive industry, they are going to make a die for a simple fitting in a fuselage. We are going to have quite a lot of ring bulk heads which in sections would be probably like that with this riveting and with holesthrough here for stringers.

Now when you make a die for shearing metal, the cost goes up almost as a part of the lineal dimension. It's not very costly to make a die so big but when you're making dies to shear ring bulk heads of that type out of one piece of metal that are four and five feet high and three feet wide, you go into phenomenal costs of $10,000 or

$15,000 for the piece because the accuracy has to be so great that it runs into that. In our operations in this country and I find that Germany is doing the identical thing that we are doing in fact, you never know whether you are in our plant or the Henkel plant from the way they are doing things. Their method of tooling, their method of assembly, their method of operation. We would cut that into possibl- four parts in the first place because even though they are very short on material they persist in blanking that one piece out which means that out of a big sheet that is all lost and most of it inside is lost because it's almost impossible to get a piece to fit it. In this country we have several schemes for doing that same blanking operation. The one we use in our own plant - a proper filing machine which is a vertical milling cutter running at about 20,000 r.p.m. which will cut out about 20 pieces at a time. We'd take a piece like that and cut it in with another piece like that and so on so that we have the width of the milling cutter in between. In England this waste is about 39 per cent of the sheet. We are running the plant on about 15 per cent, sold to scrap, as against 39 per cent. Every pound is worth about 50 cents and that sort of scheme will very likely pay for itself. The only tool that is required to do that job is a piece of ordinary 5/8 inch ply wood cut to that shape on a band saw which is used as a guide for the cutter which follows it around and cuts out 20 at a time. The same tool in the automotive industry is made in England today. I know that on that bulk head they have got $50,000 worth of tooling in addition to a huge blanking die, they have a forge which is like this. The metal is laid in here, a ring goes around here, and here,

held down by springs from above to hold that in place, then registering perfectly with this is the punch which comes down and shoves that in; that is just a section of something that is just tremendous. In this country and in Germany we wouldn't even consider that sort of die even for small stuff. Our principle is to use hydraulic presses; we'd take a piece of masonite following the same scheme. Masonite costs about 4 cents a square foot and is a very hard bakelite impregnated wood fiber they use for the top of desks and that sort of thing. It is very easy to work when we saw those out with a band saw and smooth them up on a disc sander and with a file and to make it maintain its shape it is molded on another piece so that it looks like that section through here is merely a piece with that on it. That is the entire tool. If we have to have holes in here we can put them along and lay little steel disks there and they will automatically shear the hole with the rubber pressure coming out With a think like that we have a container up there that is full of rubber like that. We will lay on here the metal - the sheet metal - to be formed. The press comes down and of course that rubber is trapped inside of that form and it's held very firmly here on the die from the beginning and the rubber flow in here almost as a liquid and it will produce parts that are better as a matter of fact in most cases than with produced with an extremely elaborate die of the automotive type as were used in England in their set-up. Because after they had gone to the expense of making these elaborate forming dies, they found that the variation in their aluminum alloy gauges was so great that they had to press about 5,000 to 6,000 which meant that when they had the

thing gauged it made a fairly decent forge job but if by accident they got on the low limit and a thinner gauge came in it frills up like a piece of crepe paper and has to be beaten out by hand anyhow. This will make a very fine form and the cost of that die for a piece so high would not be over $25. The blanking set up would not be over $15. It would be determined today and tomorrow we can be making the pieces in production and actually the labor required to run 100 pieces through this set up here is about two-thirds of what it is on the automotive type die set up simply because this set up does not involve any time for the setting up of the tool, that is, registration of the punch press because as you can see you can shove that block of masonite any where under the rubber. The rubber, in fact, can be a half a dozen there It can register a shearing arm forming die of 3 or 4 feet in length as a day's work.

In Germany also they use the same scheme that we use to a great degree here which is what we call a breakdown assembly. In other words, if we are building a fuselage, the expensive operation on that and the expensive tooling on that is the final jig, the big jig, which registers everything and turns out the big final unit. In order that we don't have to make more than one of them and simply because when you make the second one you have some troubles that are not incident to the first one.

We have a very intricate structure here incident to the nature of the airplane Here's a wing section and here's a very heavy bulk head that will take the main strength Those bulk heads which are shaped like that with the wing beams coming out go through about

ten jigs each, moving from jig to jig, each time picking up a little bit more. The way those jigs were built is by taking one of these bulk heads which we have built and say, now that is perfect, and setting it up in space and building a jig to match it. Then we took it apart and made a jig to match that and so on so that without any great trouble we can move up the other way and each jig has only a small amount of work done on it and the pieces when they come up to the final jig are in bigger and bigger assemblies so that they can be laid on and finished. We built the entire first fuselage in this jig, including all this front end here and the back end back here and it was in the jig 46 days. Of course, we were feeling our way a lot. They were in the jig nine hours now and that is because we build them down in smaller assemblies and progressively assemble the same thing as is done with the wings. Now that means that the tooling is very much less expensive because that big jig is very expensive but the small jig to build the part over in the corner is comparatively inexpensive. The work is much easier to do because by breaking it down into smaller parts it's possible to set them up so that a man can work on them conveniently. By a lot of study you'll find that a man has two natural centers to work from - his elbows either in a sitting position or a standing position. So if he is standing up like this working he can go from here to here. If he is sitting down he has another radius of action for the natural position of his arm. If he has to crouch he gets tired in an hour and stops working. We want him to be happy and work on for ever. We have built our jigs on that basis again. Furthermore, it's very simple to teach a man to do one

thing and if he is good, he'll go on to other things of his own accord but by practicing all this stuff and breaking it down into smaller sub-assemblies-for instance, on A we get a wing which insection is like that. There is a beam that is a simple structure made with an angle like that and a flat plate like that and another angle and some stiffeners. There is a jig set up here about as long as from here to the door that those beams were built in. The boys that work on that work from this point to here don't go over there at all but they know precisely how to pick up and stick every piece on there. They could shut their eyes and reach for the right piece. They could talk about the gal they were out with last night and continue to drive those rivets. If they had to think they wouldn't get as much work done and it would take twice as long to train them. It's quite important that boys trained that way get more work done than the old time craftsman who wants to argue about every piece he puts in.

English systems for building that fuselage as they are doing on their battles and their plants is to build a big jig and bring all the individual pieces over and have a locating point on this jig and do all the work on this big jig for a small twin-engine bomber weighing about 12,000 pounds gross. They have 11 fuselage jigs in this plant and they hope to get up to 1 and 1/2 a day of those eleven jigs. They have a complete set of outer wing jigs and they have 14 complete sets of center jigs and I'd certainly like to have a contract to get one and one-half out with a set of two jigs and by asking a few questions, how many man do you employ, how many hours do they work a week, - if you ask them all at once they won't tell you anything -

I estimated that the Germans are building their airplanes for almost identically the same number of hours per pound as we are here The English are running about fifty per cent more hours per pound than we are. I would be willing to bet that it takes them five hours to assemble the pieces to go on that fuselage jig before they start to rivet and after they had assembled it a man has to wiggle his way down there through a little hole about that big and disconnect all these holding points and it takes six hours to get it off the jig again. It should have been built in eight hours complete. That is the reason for the number of jigs. So I'm absolutely of the opinion that you can't apply--and if you do apply it it will be a terrific mistake in time and money and everything else - the automotive principle to airplanes. They just don't work together. That doesn't mean that you can't use the automotive industry for making a lot of component parts and machine parts or forge things of that nature but on the assembly and the breakdown the manufacturer of aluminum alloy parts - no, I don't think they ever will do it -/ In considering the various parts of this airplane business, you have got practically four naturally made divisions. There is your engine, propellor, airframe - rather engine, propellor, instruments, and accessories. Now in accelerative production each one of these things will have to be handled quite differently because by nature they are very different. I should say that the engines could very well be farmed out into the automotive industry because they have machinery and equipment and experience and actually are working to closer tolerances in the automobile business today than they are in the airplane business, so there's no reason to believe that we can't take some advantage of them. The propellor is a very much more specialized

item and I doubt very much if you get a lot of help except maybe from forging and machineing hubs out of your automotive industry. Instruments and accessories like starter, generator, and electrical items of that nature most certainly the automotive industry can turn out, but for instance, up at Rochester, there is a Delco Appliance Corporation which holds to be the largest manufacturer of fractional horse power motors in the world. I have seen them in operation there and there has been no difficulty whatever in their turning out any amount of that stuff; actually their production facilities on that sort of thing are unlimited. I don't see why they can't do a very good job with a lot of instrument parts. They make fifty per cent of Ford's speedometers, General Motors speedometers, while they are not as delicate an instrument, not as accurate an instrument as the present aircraft instrument, there is no reason why they can't do that job and I'm sure there is no great problem there. If the problem is organized, it is behind it. However, the airframe is simply not going to lend itself to General Motors building 5,000 in the first year or anything like that and I have argued with the people in Detroit on it and they more or less agree and they say they'll do anything they are told to do and put all their pressure against it but they don't know what they are up against. I went over it from that angle and he admitted that it was not applicable to their type of operation but they could do a great deal of detail work but they didn't think they could build up and do assembly work and finish airplanes and I doubt if they could do it as fast as some of the people said they could. Each of those groups considers it as a separate group. You have got problems of personnel, plant, and equipment

and materials. The important group first, I think, is personnel - where are they coming from and what are you going to do about them? Your executive and administrative personnel in time of emergency are already set - you can't create them in a hurry. You are going to use what you have got. But with proper organization behind and a little help there is no reason why that isn't adequate because the job of putting out a thousand airplanes, if the planning is good, is no more than a hundred airplanes. I am not worrying greatly about the administrative and executive angle of personnel, nor am I so much worried about the technical personnel. Practically all of the companies are developing here now two and three experimental models at one time along with production work and in time of emergency a lot of these plants are going to stop development and go completely into productive work, releasing a lot of this experimental engineering for a definite program of development work that must continue for the same time and must not stop. I can not imagine that being of such a shape that we'd be very badly off for technical personnel.
The point that is going to hit us hard is supervisory personnel - superintendents, assistant superintendents, foremen, general foremen, lead men, or what have you - the top sergeant and the squad boss and corporal - those are the people we don't have enough of now and they are the hooks on which you are going to hang your entire expansion of your personnel of the common labor crew. Therefore, it's very important that training programs be continuously carried on in order that every factory you can develop a more or less skeleton organization of men now working who have had enough training in handling

shop orders and doing an executive job that you can use them when and if and as you have to expand, and that is the most important group developed. It's no great job to put in plenty of men and put them to work on well-designed airplanes. Of the 3600 men we have there are about 2700 men actively engaged in the work in the shops. More than 1000 of these men never saw an airplane before, never had worked at any job before, were put to work by a simple little school system we had out there with two weeks' training and every one of them we have put to work has clicked. We haven't had to fire a single one of them. This system is certainly simple. In the first place we didn't want people whose heads were so thick it wouldn't work, so we got the State Board of Education to help us with a test, just a simple psychological test which, while not accurate is at least intended to indicate their ability to think. We didn't want people who could think and not work either, so we developed another test which deals with bent nails in a board, etc. As a matter of interest, one small school in town had gotten hold of this thing and were charging ten dollars to guarantee him to answer these questions and get a high grade on the test and entrance examination. By the testing of these boys with their pegs and what not we find that we can get an index to their manual dexterity, whether they can work their fingers around or whether they can't and whether they are people with good brains who can't work their fingers. We wanted a little of both and not too much of either. Inasmuch as we are doing this we had great numbers of applicants and we took as many as twenty a week. They came to work and were given a little sheaf of mimeographed sheets telling them what was what and in most cases were taught to rivet. Now they weren't taught to rivet all

kinds of rivets in all kinds of conditions. They were taught to rivet a type of rivet in a certain condition and given lots of practice on it. They were, of course, given training in how to drill a hole, register the rivet head it up, and drive it. They worked hard at that for two weeks. They were then given at their noon hour which came at an odd time so that they could be taken in when the rest were at work. They were given a thorough training in the paper work of the shop because it takes a tremendous amount of paper work to handle material from the car outside to the airplane out in the other end of the plant and they were given this instruction in blueprint reading but only two weeks of it at the most. They they were put into action on a jig to do that operation A man who had been there working at that same operation for three weeks had learned enough to do another one also so we kept feeding these people in at fifteen or twenty a week and rapidly increased our organization with people--with a lot of people - that are really trying to get along and strangely enough our foreman in requesting additional help nine times out of ten will ask that they get a boy from the school rather than somebody from the outside that they have to un-learn. They don't want to have to break them of habits they want to teach them habits on a nice clean slate. It's perfectly possible to use a single skilled type of training, teach him one thing and let him pick the rest of it up and put immumerable people to work. It's simple.

It's very fine and very vital that along with that a definite apprentice course be carried on which is quite a different thing. An apprentice course is one wherein you have a boy practically indentured

for four years where you guarantee him a job for four years and he can't quit for four years and he has certain definite things in his contract that he will be taught and he must work in accordance with the scheme which means that you can turn out some very fine all around mechanics in four years and it's necessary that we do it because we haven't trained anybody in this country for the last fifteen years. Very few well trained craftsmen have been produced. We need a certain number of those for the early stages of production and we need them all for experimental work but we don't need very many of them for high production. In setting up a new job we had a crew of the craftsmen type that can do anything; they can take a sheet of metal and make it practically sing for you. They can even design the stuff as they go. That group of men build experimental airplanes. They also will start the production assemblies with people in that same crew As they work out all the little troubles and things become automatic, we feed more and more and more of these production type workers and pull these other types off by about two or three trips. The whole production set up is just production men and they aren't craftsmen at all. It is also possible that some consideration should be given to training women on some of these simple jobs. They are doing it in England. In Germany they are doing it to a tremendous degree. I saw one group of about 400 women, some of them with riveting, some of them were welding, some were just following a line with a pair of tin snips trimming stuff, some were splicing, soddering cable, etc. They were regular hausfraus brought to work on this stuff to learn a single skill. They were giving them that time of training in case of an emergency. A

large group of these women could go right in and take the jobs of the men who had to leave. It's noteworthy that even in this recent great emergency, so-called, that they had taken very few men out of the factories. They realized that they were going to need airplanes and plenty of them. This thing cracked open and they realized that it's just as easy to teach a farmer to carry a gun as it is an aircraft mechanic to carry a gun but that if you took a man out of the factory who had been trained and handed him a gun, that meant that you had to train a man from somewhere else and put him in his place and you could completely stall and disrupt any organization by such an operation as that. In fact, in England one of the reasons the shadow plant idea didn't make better progress was that when they set them up as an automotive group to build they wouldn't allow them to draft men from one of the airplane companies; they wanted that airplane company to go on and this to be in addition. So I think it's quite essential that in ourthinking and planning here we give up a lot of our thoughts of our boys around our plant who are lieutenants and captains in the Special Reserves, pulling them out, and leaving a pretty bad hole They will have to be trained all over again. Furthermore, I should think that great consideration will have to be given to exception from conscription or draft of the workmen in the plant. You just can't train them and lose them if you are going to get airplanes out.

Bricks and mortar are not hard to get or hard to get up and you can always have a building done by the time you can have the stuff together in the mortar. However, it is not a bad idea to

consider additional floor space in factory plans and possible build some in times like these because it's a very cheap insurance policy. The point on that sort of thing is that few of the companies can afford to go out today and buildon a million or two million orthree million dollars worth of buildings to sit there simply because they haven't got it in the first place and the public is tired of paying it in the second place and if they did have all this plant and equipment and we were to hit an economy wave and there isn't any business, you just can't afford to carry that sort of thing. Therefore, practically every company is operating with about fifty per cent machine capacity. In other words, they had only enough machinery in such as mill machines, drill presses, and lathes and all that kind of thing ordinarily machine shop equipment. Fifty per cent is enough to take care of their ordinary peak production which is a wise thing because they are able now very readilyto farm out the additional fifty per cent and then when work drops down you haven't got that idle machinery eating itself up. Again that is the prospect, the most expensive angle of the plant. However, just what is going to happen in time of emergency is another question. We have elaborate plans that pyramid one on top of the other for using that milling machine that old man Jones has over there. Douglas is going to use that too and so is the Navy. Then there is the idea that you have all worked out a nice plan that calls for 6 No. 4 Cincinnatis and a Van Norman No. 3 just like it. You take it up to the quartermaster and he gives you some leggings that don't fit and some shoes. But it isn't going to work that way. You're not going to get machine tools in a hurry. Right now in England

they are waiting a year for a lathe that has first priority. A man wanted a hydraulic press and they said they thought they could get it in two years. That is bad. Right now you can go out and buy machinery and get it rather quickly but a year ago last spring you couldn't. A year ago last spring everybody wanted machinery. They said, "We'll let you have a lathe about next March. Eight or nine month delivery." and that condition was nothing compared with what a national emergency would produce so somewhere there ought to be a nice lot of standard machine tools. You don't have to have a great number of special tools. The special and made-to-order tools can wait. The standard tools ought to be in storage somewhere because you're going to need them. The training planes will last for ten years. You don't see any great change coming in observation in the future. That sort of thing can be frozen. We say it's all right the way it is. We're not going to try to improve it. We should start to build tools;by tools I mean dies for forges, dies for fittings, a simple fixture, parts that require a great deal of machining and fitting. Interchangeability gauges which build a huge structural iron thing to represent a wing which is very accurate and they move that around from plant to plant to fit their various jigs in the various plants to the same gauge because they came, much to their astonishment, to the point that you can't make a tool from a drawing and make it work. You match one with the other and the little variation in the drawing and the workmen just couldn't make them fit. They have to be matched one with another. We should have that tooling done right now and if we are thinking about producing thousands we should have production studies and innumerable

places where you'd use a forging if you are going to build a thousand. But you're only getting a dribble of fifty at a time and you never can afford that at $802,000. In cases where you're depending on an intricate forging it isn't enough to have one die; you'd better have a reserve die. I know of one ship that was rather close to me that was held up for four months because we lacked a die and it took that long to build a new one. We weren't buying two of those dies because they cost $3600 apiece. If you're going to build, the Government could buy an extra one and have it on the shelf. The third item is really the most important, I think, of all those three things. The personnel plant equipment and terms. You can have the finest machinery and the best personnel in the machine/and if you don't have some aluminum and everything else. For ten years I have been arguing with a lot of you people out here and a lot of other ones that we are going into an unholy stall just about the time you're yelling for the most airplanes. The only way to avoid doing that and it's a simple way, is to take some more of Uncle Sam's money and buy twenty or thirty thousand dollars of material. You may have to throw them away and you have had an insurance policy in the meantime. On sheet you never lost; that steel tube you're not going to lose - it will always be used. Things like that electric cable that will depreciate in time - when they give you a new order give you four miles of cable before its thrown out or obsolete. Well, look, suppose we had done this with it. You went right ahead and raised it to 24 and all that 17 would have been lost. Actually you can use 24 and 17 interchangeably and about 75 per cent of an ordinary structure without any effect whatever on weight. The

only reason we don't is that they look so much alike we sometimes get them mixed up. But if you had that 17 ST cents material in stock and you were changing to 24 better material, the outer part of the contract as well as your material could be farmed out and then fill in with the new material; such a thing as that, if properly handled, would gain. You could get to work like that You wouldn't be waiting for anything; if you changed the type of pipe fitting you'd use the ones you had. Even if you had an improved one you'd never hold up an airplane for a pipe fitting. So the thing would not be expensive. It would mean that you would get to work and when with waiting ten months a year and a half ago for deliveries of aluminum parts and we'll wait longer than that if a war because this was just a little commercial war. But in a real scrap you're going to have everybody pulling and all of the industry that uses aluminum is going to come to a complete stall and if you haven't got the material you can't make it.

Thank you.

DISCUSSION

following lecture by Mr. J. H. Kindelberger

November 16, 1938

The Army Industrial College
Washington, D. C.

I think, in view of the possibility that most of our most intelligent questions will come from the airminded of our audience, we will give them first opportunity. Personally, I want to express the hope that some of the good hard common sense that Mr. Kindelberger has given here this morning may be accepted by those who have the responsibility for meeting the situation which he, apparently, believes is more or less inevitable.

Q. I think it would be very interesting if Mr. Kindelberger would unburden himself to the extent of making an estimate of Germany's present production capacity.

A. Well, they are building about a thousand airplanes a month right now. I've figured that a half dozen ways and I have had some cross bearings about it, and they are building about a thousand airplanes a month at the present time. They are building principally several types of light, twin-engine bombers with performance of about three hundred miles an hour. The highest one is a new one. It is a little better than that. Its about 315 miles an hour at seventeen thousand feet. That is the newest and best. They are building a new Messerschmitt and that ship's a honey. There are five plants building it and with it a 750 horsepower rated motor, but they were rated more than they could do. They would run about 350 miles an hour and they did about the world's record--about 379 miles an hour. But it was

not a military airplane. It was gorgeous, but you couldn't build them like that and you couldn't pull as much out of them very long. Then they are building a few new Type Four engine jobs up at Junkers. It is different. They are building some high-wing monoplanes that look like the O-46 very much just at a glance. For ground cooperation they are building some twin-engine pursuit planes, Messerschmitt type, and some training planes, a fairly small and light type, principally wood. We estimated the aggregate of all of that right now as at least eight hundred and I don't think a thousand a month is saying too much. Nor is that all they could produce. Most of their factories are on one shift.

Q. We have got the airplane frame building and they have the engine. Now, how about the instruments? Is the production of instruments going to come through to meet aircraft production?

A. I think that can be done because, as I say, it isn't too much to expect. Take Delco Appliance. I know Delco Appliance. I have been in there. I have seen how they operate and what they can do. Actually, these little motors they make are practically as accurate. They have to be Its cheaper to make them that way. I have particular reference to flight instruments. They can make flight instruments. They have got the machinery and equipment to do that job, although I think that there is a point where some of this educational order business might not be bad. I happen to know Delco Appliance, that is why I say, let them make altimeters and tool up for them--see what they can do, because you can't fly an airplane without them. I do know that our present facilities for instrument construction aren't big enough. However, in engine production, propellor production, and instrument and equipment production, we have gone

a little beyond the actual airframe production. They are stuck for airframes when they are doing very well on their engine stuff. However, the engine stuff has been kept pretty well as an expansion of the old engine companies.

Q. How much gas has Germany got and how long will it last?

A. They don't use gas. They run on benzol and they are making something like a phenomenal number of tons per month--I think eight hundred thousand tons a month of benzol and they are getting a fuel in Germany now from low grade coal from the stripper mines, surface mines and the like. I have fallen over a couple of them--tremendous ones--and there are several I don't know anything about, vegetable oil, alcohols, principally benzol They have got it stabilized now, and by this fuel injection which they are doing entirely, they are able to operate with this fuel which won't work well in a carburetor, and, apparently, they are having no problems. Because of the fact that they have got this so-called synthetic fuel for the ignition type of engine, which is very much lighter, they have stopped making as many Diesels. In fact, they were taking Diesels out of DO-17's and putting in the ignition type of fuel injection engine. The reason for Diesels was that they couldn't get gasoline but they could make Diesel fuel. Now that they can make a fuel that works perfectly, they are slowing up on Diesels and going more and more into the ignition type engines, and they have got the finest engines in the world

Q. How about their supply of raw materials for continued operations?

A. It is pretty scanty. In walking through a plant you will find

that instead of seeing stock rooms like we have out here, for instance, a thousand feet long, with tremendous supplies of raw materials ahead, they are using the sheet practically two days after it comes from the mill. They are taking it out of the cars and fitting it into the production department. Admittedly, one of their biggest problems is supply. However, Germans have imagination and they have developed a magnesium casting which is a work of art. Its beautiful. They are making magnesium castings over there that make my mouth water. They're gorgeous. In fact, they've made bigger castings than I ever have. They are using a lot of that sort of thing. They are using magnesium sheet for everything. Of course, they have to import from Sweden and Switzerland and a lot of other places a lot of aluminum alloys.

Q. How many plants are involved in that production of a thousand a month that you mentioned, and do any of those--how many of those plants are involved in the production of a thousand airplanes a month in Germany and are any of them making the same type or are more than one making the same type?

A. Five plants are making Messerschmitt Fighters. There are about twenty-five or thirty separate plants. There are a couple of plants making (Heinkels.) There are three plants making DO-17's

Q. In their single seat pursuit, what type of engine installation is being made?

A. Well, they have got an engine over there that is a high speed inverted V engine, the Dammelbenz and the Junkers. If you drew it on the front of one of our radial engines it looks like the carburetor. It is light from our standards and it is apparently quite efficient. It seems to take the beating because some of these tests they have made--they

have pulled phenomenal hours out of those engines. They are not using any turbo stuff except experimentally and they don't like it and I don't either. They have got and are apparently getting very good supercharging effect blower stuff and they seem to do it without inner cooling. I don't know how, but they are getting it without much inner cooling Maybe its their 120 octane fuel that has a lot to do with it. But those engines are sweet. They are set up so they can fire a cannon through the propellor and they have such a small frontal area you see. For instance, their Messerschmitt was an extremely tight fit on me and I was complaining to Udet about the lack of comfort and he said: "What the hell, Dutch, a big guy like you gets a pick and shovel." He said: "You weigh 210 pounds. We have got a lot of boys who make much better pilots. Take a boy who weighs 125 pounds. What we save on parachute and clothes and everything else is one hundred pounds--one machine gun and all the ammunition." I said: "How come no navigation instruments? How come no generation starter battery?" "Well", he said, "I never saw anybody get shot with a starter. These little ships only go for a couple of hours or an hour and a half. If a guy's going to get lost in that time, then he is too dumb anyhow." Its a rather practical viewpoint, I think.

Q. Did you get any information on Italy while you were over there? What are they doing?

A. I did not. I didn't go down there, but they are trailing. Italy is trailing. Everybody is trailing Germany.

Q. On expansion, you were talking about expanding our plants up there in place of a shadow mill. Won't that make them much more vulnerable to attack?

A. Well, I don't know. You might do what they are doing over there. Of course, over in England they make one big tremendous plant and then they camouflage it. Of course it is there. You can't camouflage it But in Germany their most beautiful plant, the Heinkel plant, is broken down into small units, I would guess quickly that they have got about six hundred thousand square feet of factory space broken down into probably seven or eight buildings and each of these buildings is separated by a hundred yards or more from the others. It is built in a second growth timber up there and this was, two years ago, just a forest. They have just cut a hole in the trees and there is that branch of the factory and here another. They assemble their airplanes on a small truck. It is a very simple little welded up truck and, of course, the detail of manufacturing that is simple. In the machine shop they do the work and haul it over on a cart, but when they start assembling it they put it on a truck and the truck carries it from factory to factory. When it goes so far they will hook two or three of them together to a little tractor and take it down to the next spot to the next operation and so on. We could do the same sort of thing if we wanted to in this country. It is much harder to work that way, but that is about all you could do. Of course, it has always been the idea that Wichita is a grand place to build airplanes but I'm not going to build them there.

Q. Did you get any information as to how they are getting along in training personnel and also in the maintenance of personnel?

A. I asked that question of one of their Generals over there and he said: "Well, of course we are figuring on maybe losing eighty per cent

of our first line airplanes in the first month. When you lose an airplane you lose the personnel. They don't come running home. So, of course, it is useless for us to think of a reserve of two or three hundred per cent without having a similar reserve of personnel." You know, way back ten or twelve years ago we were hearing about these flying clubs and the light type planes they were building and the Government's financing groups a long time ago, and they are training all of those people. The present system for training is a rather elaborate one and has been in operation for some time. Their scientific association, the Lilienthal Society, is a very fine institution and it is quite an honor to belong to it over in Germany. They have a Junior Lilienthal. In all the public schools like our grade schools, in the last couple of years they pick out the boys--and all the boys try to get picked, you see--it is quite a nice thing--and they give them a little insignia and they belong to this Junior Lilienthal Society. They have to give some of their time to lectures and study on airplane work. They build model airplanes, etc. By the time they get to high school they have had a pretty thorough training along engineering lines and simple appreciation of what an airplane is. In high school they pick out the next group out of that group and during the Summer and at other times they send them down to gliding schools and with no particular expense they are given very thorough training in gliding, first, in ordinary gliding, and going on to soaring stuff, so that by the time they have gone through that they have a very keen feel of the air and what it is. All this time they are going through military training with it. From there they take the best of that group and they have all over Germany these low powered training planes which they give them their training on. It is a weeding process, of

course. Then they take them from there and put them right through the military schools, which they can do very much more quickly because they don't have to waste any time on a ground school set up. They don't have to go through primary or basic training because they've got it by the time they give them the military angle. They are able to go through rather fast and I was told, and I have nothing but one man's statement, that they have trained fifty-five thousand pilots through what we would call a basic stage.

Colonel Lewis: Mr. Kindelberger, how about the will to produce of British production personnel and German production personnel?

A. Well, the English personnel, I don't know, they don't seem to have any pep. You go into the average English factory and it makes you want to go around with an axe. You see too many people standing around and talking. They are allowed to smoke, you see, in the factory, and I looked into one fuselage and there were four men supposed to be working, all of them sitting there smoking and talking. They don't seem to have any ambition or push or drive or any personal pride in what they are doing. On the other hand, the German group was working with a great deal of vim. After you have been around the factories for thirty odd years, you can smell when they are working right and when they are not, and you get a tempo of progress in this German group. They seem to like it, too. I don't mean they are driven, of course. When I asked one of these men if they have any labor troubles, he said: "No, we have very fine concentration camps." Yet that doesn't seem to be the driving force. What that does is remove from the plant the man, who, like a worm in an apple, and makes it rot. They get rid of those people very easily. We don't. In

the Heinkel plant, for instance, they were working there and one fellow starts to sing or whistle and the whole big factory takes it up, and while they are working they are singing or whistling and enjoying it thoroughly. I would say that in Germany they are working at top efficiency, man by man, and liking it. In England they are still muddling.

Q. We have had some dope now that the German production system is better than the British system, but evidently the British must have had some reason for adopting their type of plants.

A. Well, I don't know. I'd guess that somebody sold it to them. They figure that, well, after all, our war planes have a great deal in common with the automotive industry. Just like some of our automobile manufacturers. They look at an airplane at a glance and say: "Well, look. That's not much more than a Plymouth or a Chevrolet. We could make five thousand of those a month without any trouble." But they never have and they never will. I think that's just what happened in England. For instance, Lord Nuffield, the Chairman of this Morriss Car Company, has been filling the papers with what he is going to do, you see. He is building a huge factory and he is going to produce one thousand Spitfires a year and I'll lay anybody odds he doesn't produce a hundred in two years, because I have talked with some of his personnel. They aren't the kind that are going to make a thousand airplanes in a year. As a matter of fact the Spitfire is now three years old and when the crisis occurred there were six of them dunked. 1, 2, 3, 4, 5, 6. They have a genius for making three parts do the work of one and making each of those parts as hard as possible to make.

Q. Mr. Kindelberger, did you see anything in the way of guns, machine guns, 37 millimeter or 27 millimeter cannons?

A. Yes, Germany is using quite a lot of 20 millimeter stuff. England is using a few but I didn't get to France. I didn't have much time and I didn't think it was worth going from stories I had heard from other people. Then they are not too sure how good they are. As a matter of fact, they are putting them on because other people are putting them on. The trouble with the cannon is that it is too slow firing and that there is no sight that is good enough to fire accurately. One fellow I saw said: "You know we go so fast now that the time that we are on a target is a split second and if a gun is going to go kapumpf, kapumpf, kapumpf, by the first kapumpf the plane is way over and beyond the target. Furthermore, it isn't a matter of accuracy. It isn't like getting a score by aiming at a mark or like lying on your stomach with a nice rifle with a sling to steady it and pressing a hair trigger. It isn't like that at all. Its more like trying to shoot ducks off a galloping horse. You want a scatter gun effect and plenty of firing power.

One of England's newest conceptions of an airplane is around a 2500 horsepower engine. It isn't going to give them a great deal more speed than the 11 or 12 hundred horsepower engines, because most of the weights on that ship are almost directly proportional to the power plant. They are, you see, outside of your pilot and the little ammunition and guns. Everything else in that airplane is directly proportional to your power plant, with a given endurance range and everything else being constant. Furthermore, there being the square cube law, the ship is even a little heavier in

proportion, so that that means they have just got about twice as much airplane with twice as much power going a very little bit faster, but they are getting twelve and fourteen machine guns. The Germans seem to be going on their machine guns to a higher velocity, smaller caliber type--more rapid firing. Another thing that they have been working on is a method of making a gun start quicker, if you know what I mean, making it jump from zero to fifteen hundred rounds a minute like that, because that's all the time you have.

Q. Going back to the instrument board again, are they stripping the instruments down to bare necessities even on their small engine jobs and their multiple engine jobs? What about the automatic steerer?

A. They are using very few. They are using an automatic steerer on some of their stuff. I didn't see any complete automatic pilot. They don't use it on their fighter class at all, only on their bigger longer range stuff. This radio set that they have on the fighter is just a little bit of a thing, a self-contained unit, a battery setup. They also don't use any shielding. They seem to get by even with their radio ships. You know, we have to put every wire in a beautiful tube that's hermetically sealed, practically, and we use about four hundred miles of what looks like spaghetti that got damp--bent aluminum tube to seal up our wires. The only thing they are sealing at all in Germany is high tension stuff. The rest of it lays right out in the open and is very easy to put in and take out. We've even gone so far as to carefully put the wire inside a tube and put the tube inside a wing. It can't get out of the wing. One of our most expensive things today is the electrical system. But they have cut everything down to the simplest terms. The formula that Udet gave me for an

airplane was: "Leave everything off that won't shoot. Get a little bit of an engine, put it in a little bit of a plane, load it up, push it way up high with lots of power and it'll go fast." He says that's all there is to it.

Q. In view of the remarks regarding the engine situation in Germany, Mr. Kindelberger, and in view of the comments that have been made very frequently as to the relative technical progress in Germany and Italy as compared to this country, do you feel that their remarkably high speed, for example, their all around performance in general, is due to their engines, their superior engines, or would you say it is also their construction? How do we stack up?

A. I think a large part of it is engine without a doubt. If you take the DO-17, with a radial engine its performance is just good reasonable performance. You take a Messerschmitt with its engine and compare it with a P-37 or with a Spitfire and I'd say that you'd get a coefficient that was pretty close or the same, indicating that the engineering is close, but it is the difference in conception and size of the ship and in the power plant. I don't think that they are so much better. In fact, in looking over their jobs, the roughness on the construction is about that you'd find in a good plant anywhere, just about the usual manufacturing roughness. They have gone into flush riveting to a great degree, but when I was talking to Messerschmitt's men down there, they had taken split lentils and started at the tail and glued them on the sides, but they found that they couldn't measure them even at high speed, and they were seriously considering cutting out the more expensive operations. But they were going to the greatest extremes to get a perfect smoothness and rigidity on their leading edges in the forward end of things where you get your high pressure

and thin boundary line, and are going far beyond ordinary conditions. We tend to compare rivet heads with perfection. We will take a beautifully polished, nondistorting wing and measure that and then put rivet heads on and measure that and say that the difference is the difference between the perfect wing and the rivet head--we lose that much. Actually, we are somewhere in between that because you can't drive any rivet without its being slightly rough.

Colonel Burns: I want to express my appreciation for the most interesting lecture we have heard.

Colonel Miles: You seem to have answered all the questions successfully, Mr. Kindelberger. I know that everybody here today greatly appreciated Mr. Kindelberger's appearance and especially do we appreciate it when we realize that he has done it under the handicap of this cold and I hope his coming here has not added very greatly to the effect of the cold. Thank you very much.