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Wings & Things Guest Lecture Series

The Jet Race and the Second World War

Air University professor Dr. S. Mike Pavelec discusses the three competing programs -- German, British and American -- to develop jet aircraft technology during World War II.

Mike Pavelec: Special thanks to the Director, thank you for bringing me down and for having me here in Dayton it has been a long time and I did not remember the cold.

Thank you Dawn, wherever you're sitting for all your wonderful – standing - for all your wonderful help with the emails and coordinating this whole thing.

Thank you Jeff, for introducing me and for allowing me to look through your archives when I came down as a graduate student, and Squire Brown personal thank you to you sir, for helping me so much gather all my materials when I was here.

Jeff could have said controversial, I mean this is – it's good word too. I want to give you the overview of the book, "The Jet Race and the Second World War," that I wrote which was my dissertation at Ohio State, go Bucks, right up the street and I would come down here and hang out with the airplanes, including the Me 262, I can consider mine, sorry, I wrote the book.

And I went into the archives and this was one of the many archives that I went to, so there is a lot of really well, what I hope to think is good history in this. I did do a lot of research and I hope it is a little bit controversial because I do come to some conclusions that I can back up, that I'm going to offer here tonight and you can judge for yourself.

So I'm sure we'll have a lively conversation and then we'll have a good question and answer, and you can tell me what you think.

I do work for the Air Force. I'm speaking for myself as Jeff pointed out. If you want to get a hold of me, down there [Inaudible] at maxwell.af.mil, it was 80 degrees last Sunday in Montgomery. The summers are horrible; I got that going for me.

The genesis for this project, I've always been interested in airplanes. I'm a little bit too big to be a pilot. I tried, the Air Force didn't want me, now they do, I can't get it.

I would go to museums, like the one here, and the one in England at Duxford and they had an Me 262, and I kept hearing the story, and reading the story, about how Hitler ruined the German Jet Program. And I didn't believe it, because I don't like that single point of failure answer. So, let me give you the overview of what I wrote in "The Jet Race and The Second World War."

In the mid 30s, and these are all mid 30's airframes, there was a problem emerging with the technology.

Ed Constant, a historian, called this is a presumptive anomaly. There was going to be a problem with this configuration, to propel a new reciprocating engine, because you could only make the propeller move so quickly, and reciprocating engine can only produce so much power. This configuration - single engine fires - was only going to go about 440-450 miles an hour. The engineers, the people that work with numbers, figured this out.

A presumptive anomaly was coming. You can't get much more power out of these. Now of course these are the airplanes that become famous in the Second World War, all of them in this museum, I didn't - I think I might have even taken your pictures. All these are here, what they figured out is they had a couple of really intelligent people figured out as they had to figure out a different way to power an airplane to break this barrier, to go faster, to go higher and so what you get is the Jet Race and it's very dry here so excuse me while read.

Let's start with the Germans. In Germany you get this guy Dr. Hans Pabst Von Ohain. And I know you're trying to sign that but here is the spelling "Ohain." He's a PhD. He's just graduated; his dissertation was on jet engines? No. His dissertation was on how to add sound to movies. I was surprised, just about as surprise you are, but he is a really, really intelligent guy, but he has a very mechanical mind, and he figures out how to make a different kind of engine, and this is the birth of turbo jet engine.

His advisor goes to some of his industrial buddies, who you'll see in just another slide, and says "here is a smart guy; he thinks he has an answer to the airplane engine problem why don't you hire him." And so a very important German aircraft manufacturer says "Yeah, I'll take a shot. This guy is a doctor and he is smart, he looks great. He's got a pretty interesting idea, let's try it out."

Hans Von Ohain builds, with the help of his auto mechanic - I'm not making this up, this is how it happened. He goes to his auto mechanic he says "hey, can you do some welding for me?" I need to build something it looks like this". Builds this engine, which he eventually called the S -- the Heinkel S3 engine, and that's him sitting in front of a mock up, it's a centrifugal flow turbojet pushes the air out, burns it, and then it thrusts it out the back. The guy that hires them was named Ernst Heinkel has an aircraft company, make some pretty cool airplanes. Heinkel really, really wants the contracts for the brand Luftwaffe fighter airplanes, and as we all know, fighter planes are fast and sleek and blow things up in the sky.

And Heinkel builds this interesting looking airplane, it looks fairly fast right? The HE-178 as a test bed. The HE-178, powered by Ohain's engine, is going to fly it for the first time in August 1939 -- August 27th, a week before the Germans invade Poland.

Alongside of another airplane that Heinkel build which is a pure rocket one, but I don't do rockets I just do turbojets. We can do it in question and answer not now.

Hitler's there - our favorite bad guy to hate - is there, and he goes "It's interesting, fairly cool, admittedly fairly cool, flies without a propeller?" He goes "What good is it going to do me?" In his mind, I suppose. He says "How can I use this?" Hitler doesn't figure it out, frankly nobody can figure out, but Hitler doesn't. He says "now this war is going to be over pretty quick anyway, I don't need it." Heinkel go back to your fun little airplanes, keep building my bombers, HE-111s beautiful aircraft. This one -- they build two versions of the experimental plane where they are both powered by S3 engine, and it sort of does okay, but it doesn't do anything important. More importantly, Heinkel doesn't get any money for it or a contract or anything and it's really just an experimental test anyway.

Question from the Audience: [Inaudible]

Mike Pavelec: Absolutely.

Question from the Audience: [Inaudible]

Mike Pavelec: 410.

Question from the Audience: [Inaudible]

Mike Pavelec: Not bad, the first one only goes about 280 because they couldn't get the wheels to retract but that's - we're getting our topic now. Now we're getting really specific.

HE-178, so what does Heinkel do? Well Heinkel keeps building bombers and he builds some very interesting bombers, and very beautiful bombers, of course the biggest failure that he produces was the 177, which is - if you remember the story of that one it's two engines in each [Inaudible] and their back to back and the back one was always catching on fire. Not really a great design, but Ernst Heinkel takes all of his contract money that he was getting for all these airplanes and he says "I'm going to keep thinking about this problem, about this issue, about turbojet, about airplanes that go really, really fast."

And he goes and he takes his in-house engine designers, and he puts together the best engine of his whole career. There's one more after this, but the best engine of his career is the HE S8A, it is a mouth full - but that's what it looks like down there. Little bit axial and some centrifugal and then more axial, and it's the turbojet engine, the S8A, that powers his version of a twin engine fighter, the HE-280 from March 30th 1941.

Okay, let that sink in for a little bit, 1941. When the Germans are still doing well!

Heinkel comes up with an experimental platform with his twin tail design. I mean - he's just - it's a very aesthetically built plane, that's flying in 1941, experimental so we know it's going to take some time to develop it, and it's going to taking a lot of teething

problems and it's going to have some issues, but Heinkel's all over this, he says "Yeah, this is cool, this is going to make a difference."

What happens? Well, Heinkel is not one of Hitler's favorites. Heinkel builds bombers. Heinkel doesn't get a contract for a very viable aircraft, powered by his engines, his company's engines, he could have done the whole thing in-house, and he simply doesn't, he doesn't get a contract for it. For a couple of reasons; personality issues, the Fuehrer doesn't like this guy very much, he's not his favorite, he is okay, but he's not his favorite, we'll getting him next.

Secondly, the HE-280 was very lightly armed for the time, 20 millimeter cannons, as compared to the 30 millimeter cannons of the next page, so smaller guns. And it wasn't going to be as fast, very short range, very tempestuous engines; it's an experimental test bed. Well, one of my conclusions or suggestions would be that this could have been a viable project much earlier, but simply wasn't chosen. Heinkel goes back to building bombers and he has trouble with that.

Okay, about Willy Messerschmitt. This is one of Hitler's favorites and Messerschmitt as you can see is building all kinds of airplanes for the Germans at this point. Excuse me, the Me 108 which is a nice little trainer sort of liaison aircraft, the 109 of course in a multitude of variance, 35,000 of these built during the war by his company and a bunch of licensed companies. The 110, the heavy fighter, the 210 and /410 which is an even heavier fighter and sort of a disaster, and then the *Gigant*, in both the un-powered and the powered versions Willy Messerschmitt attempts to build a really, really big airplane.

Hitler says "stick the fighters you are good at that." Messerschmitt has the idea of "yeah, I can do this, this is interesting, this is exciting, I can do fighters, let me take a stab at this project, let me take a stab at this issue." And he comes up with in 1938, basically a drawing on the back of a cocktail napkin out having some couple of beers and some wienerschnitzels, "this might be interesting", he draws out this configuration that's going to have two engines under the wings, one under each, you seen what they look like.

And he says "I can build these," he doesn't have expressed permission, but he does have a lot of money from all of his contracts that are coming in, especially after 1935. He's got resources, he's got designers, he's got materials and he says "let me take a stab at this and build a couple of prototypes, see what happens." What you get is this little machine here Me 262 originally a tail-dragger and I've got a story, I know you like that".

First flies on July 18th 1942, 1942 - still fairly early in the war. Okay, interesting story, the tail-dragger version suffered from control problems and the airflow doesn't go over the elevator services and it has trouble getting the tail up off the ground. So, the lead test pilot from Messerschmitt figures this out, he goes "yeah, let's try it this way," and he gets it going down the runway and he gets the jet going like this and he is going and at a 112 miles an hour, he stabs the brakes and it lifts the tail-off and then he takes off, just like that works perfect every time.

The first military test pilot to try it out, this airplane, this airframe, UC PC UC Version 3 does this and the test pilot says “okay, about 115 miles per hour you got to kind of stab the brakes,” the guy goes “you’re crazy.” Goes down the runway, goes down the runway, goes down the runway and he doesn’t take off and runs into the woods and almost ruins a plane, and he goes “well maybe I should stab the brakes.”

It’s tricky, it’s brand new technology, it’s very difficult and it’s got some problems, it’s experimental. And Hitler goes “but this might be useful,” 42 remember, this is when the British were starting to come over, not in huge numbers, but the British have these big bombers they bring, this might be useful.

So let’s think about it in the scheme of the whole Second World War. Okay, so in 1942 Messerschmitt has a viable prototype of this experimental jet plane that he’s going to have to fix, especially the tail-dragger part, but we’re getting closer to viable combat jet aircraft.

Question from the Audience: [Inaudible]

Mike Pavelec: No, no, no I’m getting to that problem in just a second. Not Heinkel’s engines, not even Messerschmitt’s engines, he has to farm them out. I’m getting there I promise. So let me give you a couple of the myths before I get back to the engine itself. It is an important component.

There is a myth, still perpetuated, saw it in a book today that was published last year, that Hitler came along and said “I want it to be a bomber, the 262.” Well let me rollback the pages a couple, about 30 pages, in what I hope you can buy and read and enjoy it. The book, based on a movie, on my life ... is this thing on, I’m kidding, I was very happy when I saw that you got a whole bunch of copies of “Jet Race” and that was very cool.

One of the first times I’ve seen it actually on the shelves since I finished writing and publishing it.

Yes, Hitler does say that he wants the Me 262 to be called a bomber, yes, there is that order I’ve seen it. But let’s go back to 1940, early, early in the war, Hitler goes and he says to Willy Messerschmitt and Ernst Heinkel and all the aircraft manufacturers “I don’t want you to work on any experimental aircraft that will not be in full production in six months, period. Cancel everything, if it’s not ready in six months, I don’t want you to even look at it, or think about it.”

Messerschmitt is national socialist, but he’s also capitalist, and he says “yes, but we will still be building planes for a long time, therefore I would just sort of ignore that one,” and he does, and he keeps working on the Me 262 airframe even after it was expressly forbidden by Hitler.

The next year, 41, Hitler reissues the order, anything not ready in six months cancel it, and Goering, head of the Luftwaffe, comes along and he says, “everything unless I give

permission for it,” so it cuts a loop hole, a big loop hole for Messerschmitt and Heinkel and everybody else - *Junkers*. So all along the way these orders came down and we’ve seem to think that yes they were followed to the “T” because Hitler he was all important and very powerful.

No, orders were expressly ignored on a regular basis. So when 1944 comes along and Hitler says “I don’t want it to be called anything but a bomber,” yes, I’ve seen the order, the order was ignored. Messerschmitt kept building the Me 262 as a fighter, and then when Hitler saw it fly and said, well can it carry bombs and Messerschmitt goes “of course it can!” Let’s go back to the shop and we’ll build this wooden bomb rack so it looks like it could carry bombs.

Messerschmitt throughout the entire time was ignoring the order for it to be bomber, and never even put a bomb sight in it. So the order – truly the order is there, but it is expressly ignored all throughout the production life as well as the design life of the Me 262. So in the end, Hitler, it really doesn’t matter that much because a lot of people ignored him, fortunately we win, Yay America, but he gets ignored on a regular basis, but I still hear this one on a regularly often, and not really. The other big one is aviation fuel at the end of the war was in very, very short supply, which is true.

But everybody seems to forget that the turbojets run on what’s equaled into diesel rather than high octane aviation fuel. So, it wasn’t lack of fuel because there were lots and lots of diesel lying around in Germany, in containers in various parts of Germany, not just lying around, but in containers around the country at the end of the war, tons of it. The USSBS, United States Strategic Bombing Survey sends economists in after the war and they go ahh, there’s, tons and tons of diesel, it’s just not in the right places. And we, P-47s, specifically, have destroyed lots of trains, so you couldn’t get it from one place to another place.

There was loss of fuel for the airplanes, the jets especially; they just couldn’t get it a round. So, a couple of myths I wanted to dispel - you can come after me in the question and answer - Here is the real problem, getting back to your question, here is the real problem, and I checked today and there is one right out in front of the Me 262 out in the Second World War wing and its cutaway like this, so you can look at it.

The eloquent designs of *Junkers Jumo*, the Junkers Aircraft Engine Manufacturing Company who built 99% of the engines for the Me 262. There were a couple of test beds with the Heinkel Engines in a bunch of different really weird configurations, but this is the engine that they used.

In the first versions of the experimental 004, they were unrestricted as far as what materials they can use. And so the first models used a lot of things like chromium and molybdenum. When you get to 1943 and 1944 and the Germans are running out these very, very scarce raw materials. Molybdenum comes from, I want to say, Brazil, maybe South Africa at that time, it came from somewhere with the Germans weren’t, let’s just leave it at that.

So when they freeze production of the 004 in 1943, and they say, this is the model we are going to build, don't change it, do it like this. There is no chromium; there is no raw material, the really high-end stuff that's going to protect it. And what the Germans find is it therefore becomes a very, very fragile engine. After about 10 hours of running it you have to completely dismantle it and put it back together, 10 hours.

Rolls-Royce builds the engines today for all of the big Jet Airliners, just had one of their newest engines just about to come out pass a hundred thousand hour test, that gives you a bit of a comparison, sure we're in the 21st century and get it.

10 hours of flight time and there is two of them on each airplane. But they can make them, they can make a of lot them, Germans make about 3000-3400 of these during the war, it's not going to change everything, but it's the step forward in jet development, but this is the big problem, it's the engines rather than Hitler's orders, or fuel, or pilots. I will come back to the pilot later, that's another great story.

Okay. So I want you to think about this one as the focal point of what holds the German Jet Programs' pull back and that's the engines because of the scarce raw materials the German simply do not have.

However, I told you I had a lot of good pictures. By 1945, by the end of the war, the Germans have produced a couple of jet airplane, aircraft types, that are interesting even if they are not completely game changing, the Me 262 at the top, first flight July 1942 -- excuse me, the Heinkel-178 1939, the HE-280 1941, the HE-162 right at the end of the war. Fascinating little aircraft, single engine on top of the spine, designed, preproduction, production testing and operational status, nine weeks. It's mostly made out of the plywood, except for the engine obviously.

Great interesting stories about that, it barely reaches operational status by the end of the war, I have seen one report of a P-51 pilot that saw one fly, it is the closest the Germans ever got to putting that into operation.

And the *Arado*, which is BMW engines, yes, that same company, BMW. The bomber version of the Ar 234 that flew for the first time in June 1943, and the *Arado*, although not produced in a whole in a huge number of aircraft, lets Hitler finally in December 1944 say, "okay, the Me 262 can be called a fighter because we now have the *Arado* bomber" and Messerschmitt goes "yeah, I wasn't really sweating that much to begin with" and so, we've gotten the Bomber Jet and a Fighter Jet in the German inventory right at the end of the war which is obviously going to be too late. Americans are already on the continent, the French are free once again and the Russians are coming in from the Eastern Front.

Okay. Let's switch gears for a bit. So what's happening in the other two places that I promised I would talk about. Right on time, yeah, this is good.

If the Germans have both important, interesting and intelligent people at the bottom pushing this idea up the Ohain's, Messerschmitt, Heinkel, and they have also got official top cover, somebody paying in for it, I used the words in the book, "incentive and initiative." Initiative from the bottom, incentive from the top, people both pulling Hitler and money for the Luftwaffe and pushing it from the bottom Ohain and Messerschmitt and Heinkel.

In Britain you've only got the push, the initiative, and that comes in one man, Frank Whittle, later Sir Frank Whittle, later came to our country because we paid him more.

Frank Whittle comes up with the idea about the same time as a Ohain and it looks pretty similar to what Ohain came up with as well, and there doesn't seem to be any sharing of secrets, both of them kept to their lands, neither one of them really knew what they were doing on either side of the English channel and there were couple of other jet programs that had a potential of cropping up in other places.

So it's just technology that was just ready to be born, and as a technological determinist I would say, "the technology sort of found the people that needed to invent it," we can talk about that later too if you want, I get a lot of concerns about that in conferences.

Frank Whittle comes up with the idea for this engine, the first one he builds his own company and he calls it the W1X. Whittle is an important and interesting person for another reason too.

At the time he was in the RAF, he was Flight Officer Frank Whittle, and he was a test pilot that was sent to engineering school because he had this idea and he was just finishing engineering school and he did really well by the way, and they said right, now you've got your masters, the equivalent, you are going back to be a test pilot because you are such a good test pilot, he goes "let me work on this for a little while," and the RAF said "why, its nothing we need, you need to be a test pilot."

He goes, "no, come on, let me work on this for a little while, I am almost got it running," a guy comes down and said - by the name of Henry Tizard - who we might recognize from this thing called Radar and he writes a letter to the General and he says, now you should let this guy work on this, it might become important. Tizard was such an important guy that the General said, "yeah, okay." The RAF puts Frank Whittle on what's called a special assignment and lets him be an officer in while he's building the first jet engines for Britain. So he is off the hook from doing Air Force stuff and he designs Britain's first jet engine, the W1X, later with W1.

The government, who plays a big role in just a second, goes to Gloster, an aircraft manufacturer who is not doing anything important at that time, biplanes mostly for Coastal Command. And says, "Gloster, why don't you build the mockup of an experimental aircraft that we can use for this crazy new idea that this Frank Whittle dude has," and they come up with a, and the British really love long designations for the airplane, E-28/39 Pioneer.

Frank and his team call it the *Squirt*, because the air squirts out the back. I like the *Squirt* better, just me. *Squirt* flies for the first time on 15 May 1941, a little bit after the Germans, which is still prior to any sort of operational production of Combat Jet Aircraft.

So the British are in the game, but face problems, here's why. Britain says, the Crown, the Treasury says, okay, now it works. We, the Crown, are going to take this idea and build it in a bunch of different places, Frank Whittle goes, "how about my pay check" and they said, no, no, you work for the RAF you don't get a pay check, you get an Air Force pay check. The government comes in takes the engine design basically and gives it out to three different companies who change it and modify it slightly and makes it very different because the Crown owns the patents.

And you get Rover, the now car company that I don't even know who owns anymore, maybe Ford. Rolls-Royce, who's still in the Jet Engine Development World and Power Jets which was Frank Whittle's Company, and the three different versions of the very same engine that are being built in Britain during the war.

You would think it would work out great, wouldn't you? It doesn't because there are changes, then there are problems and then Frank Whittle refuses to work with those two companies because he says, they are ruining my designs, and so only Power Jets has a really good working one but they are also the one with a smaller shop and they only do one about every month.

And if we look at the Gloster *Meteor*, the follow-on to this *Squirt*, it means two, right? So there is a problem with production. You get a very, very strong initiative from the bottom Frank Whittle and this very, very small company Power Jet, they just don't have a capacity to do it and Frank Whittle simply doesn't want to give up his patent rights. It goes a little bit deeper than that, but the British don't have any real need for this aircraft at that time either, by this point the Germans are no longer coming across the English Channel, what do you need to high-speed intercept for?

Gloster builds one anyway, the F9/40 *Meteor*, the first allied jet in operation. Cool story time. Yes, it saw combat, no, not against Me 262s. The Gloster *Meteor* was the only airplane in the inventory – British Inventory fast enough to catch up with FI-103 which are known more fluently as the V-2 Buzz Bomb, V-1 Buzz Bomb, sorry, V-1. Not the rocket, the little airplane. Fischer 103, one of those out on the floor too, the pulse jet by the Germans with the warhead packed with dynamite.

The Gloster could sneak up behind it and shoot it down. There is a great pilot report in Britain of one of the pilots, he's flying up trying to catch this V-1, and his guns jammed. He has no guns. "What will I do," that was more Scottish than English wasn't it? Anyway, so what he does is he flies a little bit faster, little bit faster, catches up to it, flies next to it, puts his wing tip underneath the wings tip of the little one and does one of those, and it spins off and explodes.

Now he puts his wing tip under the wing tip of a flying bomb, tips it over and explodes. Not on London, so I guess that's the happy ending. Then he says "destroyed [Indiscernible] nothing else to report," great story. Okay, history's full of them.

So it flies in Home Defense, and then it flies for the rest of the Commonwealth countries until like ten years ago, in different versions.

By the end of the war, catching us up to 1945 to talk about the three programs separately, Gloster produced the *Meteor*, which first flies in March 1943. De Havilland another aircraft company using the same engines comes up with *Vampire* by September 1943.

The British have a fairly decent jet program going, but they really don't have the need. They don't see the driving force behind having these airframes, especially during the war. What they really need is some heavy bombers and to be able to find cities at night, that is another issue, so what they do is they don't put a lot of effort into the jet program, until after the war, whole other story, not even going to touch it.

What about America? Come on, this is where it gets really cool, no I promise if you loved it up to now just wait. The United States, you have incentive from the top, from the very, very highest levels of government and industry. You don't have the guys inventing it, you don't have initiative from the bottom, but you do have a government that says "yeah, now, like right now, we need this yesterday."

Henry Harley "Hap" Arnold goes to – it is a mouth full, Henry Harley "Hap" Arnold goes to Britain, 1941, and he sees Frank Whittle. This is Frank – this is British picture again, and this is the early version of the Whittle engine and he's poking it out the window here because that's where exhaust goes and he sees it running and he goes, "you know what I am in charge of the Air Forces" before they separate. "He says, this looks interesting, let's put some money on this and let's put some industry on this, I think we can make a difference."

Do we need it? No. Has it ever stop America? No. We're going to build jets. And he goes to a very close friend of his, again, personal contacts matter, Larry Bell, who owns Bell Aircraft Company in Buffalo, New York. And you think it's cold here.

Larry Bell builds weird airplanes, not just strange, not just odd, but weird.

In the mid 30s he built what was called XF-1, they actually build a couple of these abomination, which was designed as a heavy fighter and these – the engines point backwards and you can see the propellers back here and you can see the guns here and you can have a dude who sat in this and shot the gun and if anything happen the engine you can turnaround and work on the engine.

I don't have to make this stuff up, it is awesome.

They were going to build something that look like this and it was designated XP-59 and he will reuse that designation on this first jet, because it's much more secret, the XP-59 was suppose to look like that.

His greatest contribution up to 1939 to aeronautical history is a P-39 and is a great interesting aircraft. A door for the pilot, mid-engine configuration, the long shaft so you can shoot a really big bullet right through propeller hub and a nose wheel. First airplane with a nose wheel. That's -- that was his legacy up to this point well that and he knew Hap Arnold and Hap Arnold goes, "you build weird airplanes, how about this idea?"

Larry Bell was sitting on six aircraft designers, who he called his "secret six" and not a lot of interpretation there, he just called them the "secret six." Hap Arnold said "you build weird airplanes, you are not busy right now," we didn't like these, the Soviets loved them, we didn't like them at all, "how about you build the first jet airplane for the United States of America." Larry Bell said, "yeah, I can do that, why not? How much is it worth." Well he didn't say that, at first he agreed to do it and then asked how much it would be worth for him.

Larry Bell puts his six best designers on this airframe, the XP-59A, they just add a little "A" to make it more secret.

The XP-59A, also called the *Airacomet*, he liked putting "A's" in the middle of words. *Airacomet* is a very, very conservative design, very low wing loading, it's not built for really fast speeds, it's built just to test out the theory of jet aircraft. Yeah, they are going to put some guns on it at one point. We eventually build 66 of these, couple for the Navy, 66 inclusive. But it's not built to be a production jet fighter necessarily. It can do the job it needs to, but hopefully not. The point is other planes, in the American inventory, are just as good or better than this as designed – it's designed more as an experimental platform.

We get a couple of engines from the Brits, we don't even build them ourselves initially to test out this airframe. And it first flies with British engines, 1 October 1942. General Electric will be approached to build what becomes America's first jet engine and this is the I-16 -- yeah, the I-16 that general Electric will build. General Electric was specifically chosen because they didn't build engines.

Okay, we didn't want Wright to do it because they built very cool engines and they might find conflict of interest, "well, why would I build the jet engine, if I am building really good reciprocating engines." Brad Whitney struck from the list. All these other places were struck from the list, and then Henry Harley Hap Arnold said "General Electric, you build the Turbo Superchargers for B-17 engines and the Turbo Supercharger impeller and compressor all it needs in the middle of the burning part and you got a jet engine," and the General Electric guys go "well, yeah, wonder why we need, we never thought of that."

Well, here's the plan from the Britains. Go build them, and they said "how soon do you need 1000," next week, "okay." General Electric cranks up production very, very quickly and starts building license-built British designs of the Whittle engines, and they look very similar don't they?

Eventually, we get fairly decent production in the United States to where we can build our own and our Whittle Engines, turned out to be better than Whittle's Whittle engines because of the standardization and tolerances and materials and production et cetera, et cetera. So we have the jet program going by 1942, again all incentive from the top.

By the end of the war, okay I am fast forwarding a bit here, but once again the United States, we really don't need them. We've got the P-51, we've got the P-38, we've got the P-47 and we're bombing the heck out of Germany, so it's all about the bombers in the combined bomber offensive. We can't really; we don't really have a desperate need for the jet, like the Germans do for example.

That said, by the end of the war, you have Bell aircraft, XP-59A, the Lockheed P-80, and five other companies in the United States building jet airframes. You also have engines from General Electric by that point, the I-16, what's the other one – sorry I am getting my numbers confused, it's in the book. I-16 and four other companies building jet engines, so we pretty much say "that's a good idea, we're going to go with it we're just going to kick it down the road," and everybody is going to get some money doing war time, we get everybody interested in this and they all go, "yeah, this is good idea, this will supersede existing aircraft."

By the end of the war P-80 is flying, at least over the United States. By one account two of them to go to Italy to do a demonstration flight right after the end of the war. So we go in full hog and the companies are given the contracts and the money to build these, even if we didn't have the incentive, the people to think about the ideas initially, we relied on the British designs at the beginning of the war. So the end of the war, let me go back to some stories, successes? That's what that's for.

Jets at war. The Germans are the ones to produce and put into operational use, combat, jet aircraft. The British do a little bit with home defense, the Americans do not. Here are some raw numbers. By the end of the war, the Germans have to produce 1,294 Me 262s. And this is actually from the Air Force website. Thank you very much the Air Force Museum website. That's one that was flown here at Dayton after the war.

1,294, of that number, there are no more than 400 that actually become operational. Why is that? Brand new technology, you are going to have some problems. You're going to have some accidents. Their issues with pilots understanding jet technology, especially they've grown up in propellers.

Lots and lots of accidents about 400 of those 262s lost at accidents. About another 400 are going to be lost to air raids - at the factory, on the tarmac, somewhere in transportation, getting to operational squadrons. So you really only have about 400 that

reach operational units. Still, not too bad, right? Not really. I'm coming to that. Another handful of *Arado* Bombers and maybe half dozen of the Heinkel 162s. So we are talking about 1,300 airplanes.

Here is another story for you. Adolf Galland, one of the most highly decorated Luftwaffe pilots of the war, falls out of favor with Goering in December, 1944 and that's really putting it nicely. Goering just starts to hate him. Hitler still thinks he is pretty cool.

So, Adolf Galland goes to Hitler and he goes, "dude, Goering doesn't like me anymore" - I'm paraphrasing, of course he was saying it in German. "Dude, Goering doesn't like me anymore, let me form my own squadron." And Hitler says, "dude, you are pretty cool. You can form your own squadron, gives him a letter. Go, form your own squadron." That's squadron is known as JV 44 [Indiscernible] in German, sorry. [Indiscernible] JV 44 and his letter says, "from Hitler, give this guy whatever he wants," in German. And he goes around and he goes to Messerschmitt and he goes, "I want those airplanes, here is my letter." Messerschmitt goes, "alright take them." Then he goes around other squadrons, he goes to all of his buddies, "Hey, join me in my new squadron, it's going to be awesome" and his buddies do.

He's not - not lacking for pilots. They are like "Jets? Cool". And he gathers a squadron, squadron of [Indiscernible], squadron of experts. All of the highest ranking air aces in the whole Luftwaffe, except for one, Erich Hartmann, who is doing really well on the Eastern Front; he says "nah, you guys go ahead."

He gathers all of his friends together, all the really cool Luftwaffe pilots and goes "let's go fly jets." In his, Galland's diary, he says "we already know the war is over, so we just want to have some fun; shooting on Americans." He doesn't say the last part, but that's what the "fun" means.

And he forms the squadron and they go fly jets in the very, very closing days of the Second World War for the Germans.

10 April 1945, it's an interesting date in this whole story and here's why. 10 April 1945 is the most active day for Jet combat in the Second World War. Went through the records, saved you the time and it's written in the book. Did I say that too often, I really want you to buy [laughter]. 10 April 1945, Galland and his buddies and all the Jet squadrons in Germany, just three of them, decide they are going to launch a raid against an incoming American bomber stream.

On that day, the Luftwaffe is able to put up 55 Me 262s; that's the most active day. 55 Me 262s, not bad right? Against a bomber stream of 800 B-17s and 1,200 P-51s.

Okay, that is industrial production on a massive scale. On our side, yay America, 800 bombers and 1,200 fighters against the best of the Luftwaffe, 55 Me 262s. It's no wonder they lost, which is a good thing, but that's the most active day of Jet combat.

So, if you look at the 1,294 you might be a little impressed, but if you get to the actual reality of combat operations, it's a drop in the bucket.

They shoot down a couple, we shoot down a – couple of them and I will get to that in the just a second, but that's the best the Germans could do. We had good enough aircraft to destroy the Luftwaffe and Germany. Their best, couldn't compete with our – not too bad and the P-51s not too bad. I mean, it's a pretty good airplane.

Here's where the real success has come. Success! The real successes come in the post-war production, in the United States, specifically in the Soviet Union.

In United States, we go in right towards the end of the war and right after the war and we mount what's called Operation LUSTY. I love the old operational names, right, they're fantastic. LUSTY stood for Luftwaffe Secret Technology and a bunch of aircraft designers and engineers and pilots and people went in to Germany and they said, "we are going to gather up all the cool stuff the Germans have and we are going to bring it back to United States." There were a couple of programs going on at the same time. One is for the atomic scientists, one was for the rocket scientists, LUSTY was for the aircraft.

And we grab up all the cool German airplanes that you see on the floor of the Air Force Museum, because that's where they end up, after we test them extensively. And those designs and what the Germans were hoping to work on, have they survived, become part of the American industrial process. And we build a lot on what the Germans had been to working on at the end of the war. Some of it directly copied, some of it sort of derivative, because we also bring a bunch of the scientists and designers and say "hey, why don't you come build airplanes for us?"

And of course, the very famous story – infamous famous – you make the judgement call. Wernher von Braun goes to Alabama and builds rockets. But what you get is the technology transfer from Germany, defeated Germany, in 1945 to the United States. It also goes over the bad guys, and this story is played by the Soviets.

They take German Jet technologies specifically and directly and they build their first series of Jet fighters. There's look a little bit more cumbersome, ours look absolutely beautiful; oh there is a British one at the top too. But the Soviets do the same thing because they are way behind, even us. There is no Soviet Jet program during the war. They are focusing on other things.

And so the Soviets are going to benefit mightily from the German efforts during the war and they are going to build their Jet program, almost directly based on German technologies, okay. Alrighty. So, Meteor, this one is Bell's follow on called the – it escapes me right now. It's the bigger version of the XP-59 – P-63 isn't right? Somebody help me out. 83, thank you very much. Someone in the audience helped me. Okay. And then the P-80 at the bottom.

The first Jet to Jet combat is of course not to be realized until 1950. So as I'm teaching my Majors and Lieutenants Colonels, out in the Big Blue Air Force. I break it down into military effectiveness, the levels of war.

Now, just to let you know, I convey this to you, see if like or not. Tactically, as individuals, I argue that Jets were technological revolution; you don't see really many propeller planes anymore, do you? They changed the nature of aviation, of air combat, of pretty much everything we think about when we think about airplanes, especially for the younger generation, we had a great conversation about the younger generation at dinner and the things that they forgot or never knew because we're old, at least I am.

At the individual level, these were awesome airplanes. The Me 262 was about a 100 miles an hour faster than the P-51, could catch the *Mosquito* from behind. Very, very fast; very, very heavily armored and put in the right hands of these experts right at the end of the war, really, really deadly airplanes. Okay.

Operationally, you have in the German Jet program at least, a potential game changer, and I put potential in there because there was a lot of potential. I don't want to take anything away from the German aircraft designers – excuse me, and the engine designers, but it was simply not realized.

A little bit of too little too late, little bit of meddling from the higher command. Problems with the engines themselves, problems with the airframes, but if you look at the lifecycle of any technology, it takes a while to develop, it takes a while to produce, it takes a while to understand how to use a revolutionary technology. And besides that the United States, we wouldn't have sat back, we probably would have built something to compete with it because we can and we were in war.

At the strategic level, insignificant to the outcome of the Second World War, the German Jets simply did not make a difference.

They are a very cool story and they have a cool myth factor. That's why I wrote about it, but they don't change the Second World War and honestly, I don't see how they could have ever changed the Second World War.

You play it out your mind, you get them a year earlier - even if that was feasible, simply doesn't change the outcome of World War II. But they do become significant in the early Cold War arms race as the Americans and Soviets are competing and eventually competing in the skies over Korea, Vietnam and et cetera. Tactical operational strategy.

So that's me. That's my presentation, hope I stirred up a little bit of controversy. I will leave you with one more. This isn't our airplane; I warned Jeff about this earlier, this is White 35, which was recently rebuilt at the National Museum of Naval Aviation in Pensacola, Florida, I was there a couple of weeks ago and got my picture taken in front of the White 35, it's a two-seater that was lent to them for rebuilding ... [trails off and ends]