**Introduction to Aircraft Design**
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**Lecture - 26**
**Three Surface Aircraft**

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Now, one more option that you have and you see sometimes is a 3 surface layout or a 3 surface aircraft. Now, the question that somebody will ask is that if you can make a design with only 2 surfaces, then why use 3 surfaces, because it adds cost, it adds weight and it gives you a larger wetted area. So in a 3 surface layout as can be seen in this picture, you have 1 surface in the front which is a canard, the second one which is the wing and the third one, which is the tail, this is why we call it as a 3 surface layout.

So obviously, there must be some benefit and the principal benefit is that because there are 3 surfaces, you are able to trim the aircraft with near minimum drag over a much wider centre of gravity range. Because you can load or unload each of the 2 extreme surfaces to allow creation of the moments required to balance about the centre of gravity. And secondly, if you do it very carefully, and if you design it very carefully, efficient component integration can actually save weight.

If you notice in this picture, for example, the wing of this aircraft Piaggio P 180 Avanti seems to be a much slender and smaller compared to a typical wing that would be needed for an aircraft of this particular type.

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So this particular aircraft GP 180 has earned the epitaph of the Ferrari of the skies. This is a image of the aircraft taken from the bottom and many people would think that this aircraft is flying from right to left because they see the engines mounted in that fashion. But actually it is flying from left to the right So I think it is very important for us to get familiar with this very interesting aircraft is one of my favorites, so I thought it is better we watch a short promotional film about this aircraft.

**(Video Starts: 02:23)**

The original Piaggio Avanti P 180 twin turboprop pusher first flew in 1986 was certified in 1990 yet it is 2001 model still looks as futuristic as it did more than a quarter century ago perhaps not surprisingly this aircraft is still economically in a class of its own. The small forward lifting wing means that the rear horizontal stabilizer is also lifting surface resulting in a 34% decrease in main wing area deepening the fuselage itself is shaped as the aircraft total lift.

The narrow chord wing ensures that the laminar flow is maintained around 50% of wing chord compared to around 20 to 25% for conventional tractor turboprops where the propeller wash disturbs the air flow over the wing and underlying reason for its ability to maintain laminar flow is the quality of the surface finish. Over the Avanti's 90% element in alloy, the fuselage and wing look like they are molded from composites because they are constructed with airframe panels held in place in the check during assembly by large vacuum pass.

Some frames and ribs can be riveted from the inside. This makes for an exceptionally smooth finish and reduces drag. The result is that the Avanti's of the superb performance for turboprop, a cruise 41,000 feet with a cabin altitude of only 6600 feet, cruising around 353, 360 knots in the high 30s with a fuel burn less than 300 pounds per side and a range of close to 1450 nautical miles, which means you can fly 1000 nautical miles and a little over 3 hours burning just 1600 pounds of fuel.

The aircraft is certified to catch up to instrument landings, steep approaches and flight into known icing and the Avanti has the ability to operate on short runway lengths around 1070 meters at maximum weight. This airframe has also been recertified to increase maximum takeoff weight to 12,100 pounds, allowing an, extra 2 passengers at the maximum fuel load. The cabin provides a stand up height of 1.75 meters and the weight of 1.85 meters, dimensions only bettered by super midsize jets.

The cabin can seat up to 9 in a corporate shuttle out but typically seats 6 in this VIP role with a half toilet. The Avanti is certified for single pilot operation the Avanti is a DC electrical aircraft with no aptitude but you can use an external power cart to load the FMS price start or engine start and run switches are centrally located in 1 panel before the end of the centre console just to handle the throttles.

A rotary test switch on the base of the console is used to check all ancillary systems such as hydraulics, electrics and de ice, and the aircraft can be ready to taxi in 3 to 4 minutes after engine start. Avionics include weather, radar, traffic avoidance and tours, in addition to 8.33 megahertz VHF radius precision on F and V now, this P 180 also has the optional HF radio. Avanti was introduced this avionics upgrade of the P 180 Avanti 2 turboprop pusher.

The Avanti 1 remains; that have to proposition with its load appreciation and combining with its perfect cabin and low operating costs. The Avanti has no natural turboprop competitors this closest jet rivals being the rating premier 1 and Cessna citation CJ 1 and 2. If pure top speed is not the overriding criteria, the Avanti is combination of fuel efficiency, cruise speed, range, sealing and cabin size are hard to beat. The aircraft deserves its Ferrari in disguise and can hold its own against a similar size jet.

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So that was about the Ferrari of the skies. What are the design features of this aircraft which make it very distinctive?

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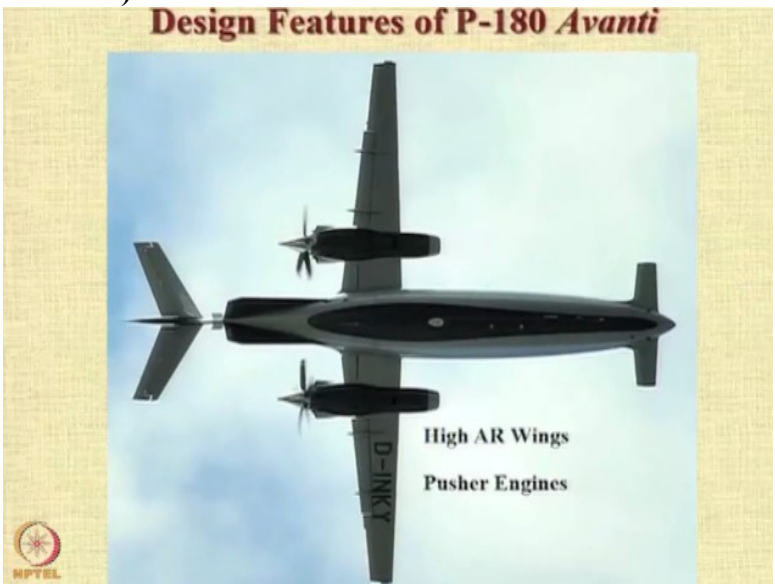


First of all, it has high aspect ratio wings. As you can see in this picture, very slender wings and the engines are mounted behind the pusher engines which result in a very quiet cabin.

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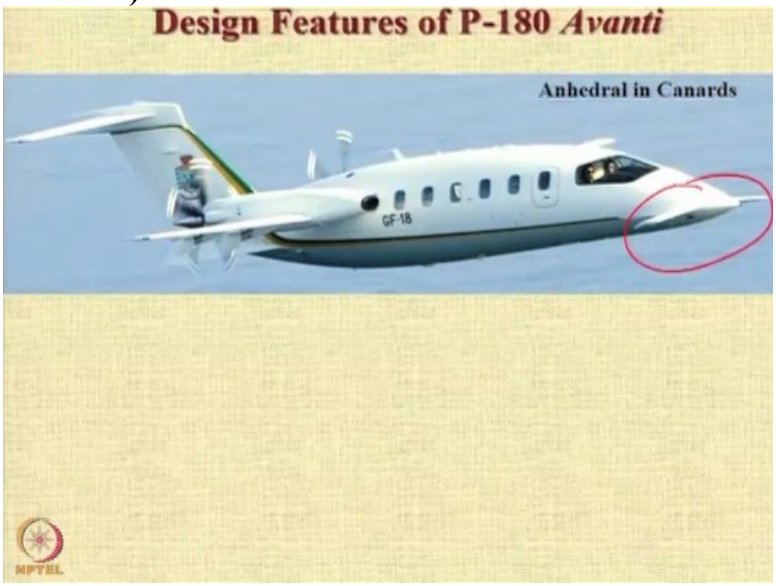


It has got anhedral in the canards you can notice here, one can notice here that the canards are mounted at a slight 2 or 3 degree downwards angle.

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We also see that the canards, has flaps. It is very clear in this particular figure that these canards have flaps you can see here.

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You have delta fins on the aerofoil shaped fuselage. So, the fuselage itself, you know, is very beautifully shaped, as you can see, it is shaped like an aerofoil and you have these delta fins. These fins enhance its lateral stability characteristics.

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And interestingly, the passenger cabin is mounted ahead of the wings, the wings are mounted behind the passenger cabin and the engines are mounted behind the wings. So, you have unrestricted view for the passengers, you know, the view that is available to the passengers is completely unrestricted on both sides plus the location of the engines behind results in very low noise levels. Thanks for your attention we will now move to the next section.