Introduction to Aircraft Design
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Lecture – 34
Propulsion System Layout

Let us look at the propulsion system layout. And here we have to look at the number of the engines to be used and also their location.

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So, when we look at the engine location, the first choice that we are encountered with is whether to use a pusher configuration or a tractor configuration. The pusher configuration is very, is considered today as uncommon and special. But interestingly, the first aircraft to fly successfully, the Wright flyer of 1903 was a pusher configuration and most of the aircraft which are used today that are meant for training of pilots or general aviation.

Typically, such aircraft have a nose mounted engine, and they belong to the family of tractor propulsion. Each category has its own advantages and disadvantages.

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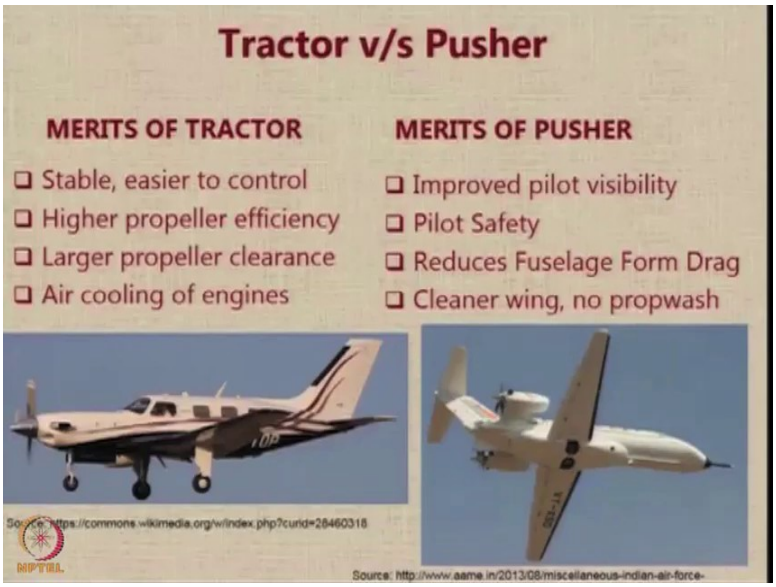

Let us have a look. Let us first look at the merits of the conventional configuration or the tractor configuration. The first and the most important factor is that a tractor configuration of engine gives you a configuration that is stable and relatively easier to control. Because the propeller is in undisturbed flow facing the wind as the aircraft flies forward, you get higher propeller efficiency.

And in most cases, you can also get much larger propeller clearance. This is especially true for tailwheel type of configurations, where the propeller in the nose gives you more clearance with the ground and the air which the propeller throws on the fuselage can be used to cool the engine. So, most tractor engine configurations have air cooling of the engines. On the other hand, we have a pusher configuration like the one shown here.

This is the Saras aircraft designed by National Aerospace laboratories, Bangalore, which has 2 engines mounted on the back and behind them, we have these propellers. So, this is a pusher configuration because the engines are behind. You notice here that since the engines are quite far away from the canopy, therefore, you have unrestricted improved visibility for the pilot, the prop does not come in the way and the second thing is pilot safety in case there is any problem with the engine.

And this was very common in the earlier days when engines used to catch fire and if you have engine right in front of the pilot, and if there is a damage or if it catches fire, then the whole problem will be immediately passed on to the passenger cabin. So, from pilot safety

point of view, it is better if the engines are far away and behind you. So that in case of any problem with the engine, the pilot is not directly injured or affected.

Another important point is that the pusher configuration which is on the normally has the ability to wash away the disturbed air, which is flowing over the rear fuselage behind the wing due to the wake of the wing, it can energize that air and with that it can reduce the form drag of the fuselage and lastly, a pusher configuration in which the propeller is mounted behind the wing of the aircraft.

You leave the wing in completely undisturbed flow of the air. In a tractor configuration, the propeller is throwing swirling air on the fuselage and it can create a large amount of drag it can lead to separated flow. Whereas, in the case of pusher, the engine is mounted behind Therefore, it is actually sucking air over the wing and hence the wing gets very clean undisturbed air with no propeller wash. So, depending on which configuration is of use to you, you have to choose an appropriate one.

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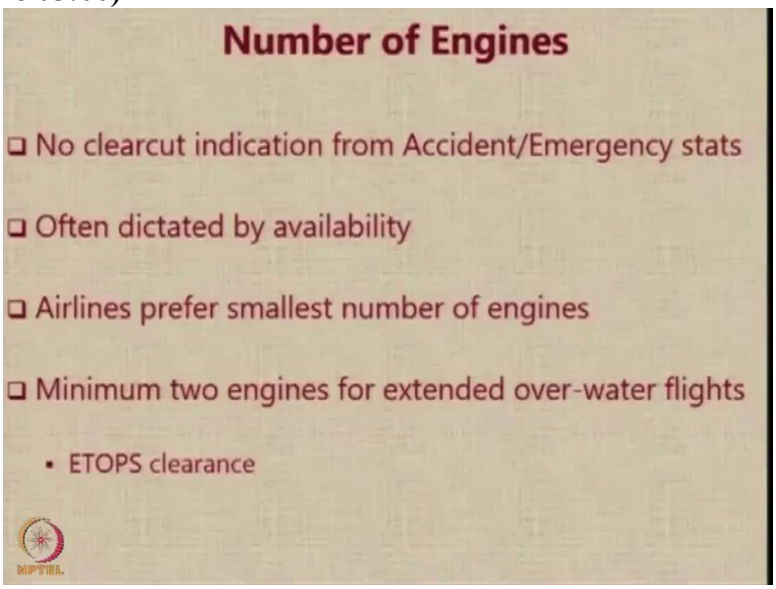

As far as number of engine is concerned, there is no clear cut indication from any accident or emergency statistics that have been equal number of accidents when their craft is with 2 engines or with 3 engines or with 4 engines. So, having more engines more than 1 see more than 1 is essential because you need to have redundancy and therefore, you need to have at least 2 engines especially when you carry a fair amount of passengers.

The regulations are very clear on this, the moment you carry 9 or more passengers who are fare paying passengers you are required by law to have more than 1 engine and most aircraft go for 2 engines, but just by giving 4 engines is not that you increase the reliability or you increase the safety. Often the number of engines that you provide on the aircraft is dictated by the availability of the engines of sufficient power.

That you have estimated and also sometimes you have certain engines available and you want to draw or you want to design the aircraft around those engines. In those cases, the number of engines is often dictated by the availability of the suitable engine. If you look at the airlines, they prefer to have the smallest number of engines. If you look at the airline point of view, they prefer to have the smallest number of engines with which the flight can safely operate.

Because, that reduces the constraint on the availability of the working number of engines. Now, regulatory requirements also ensure that when you fly a long distance over water over sea, then regulatory requirements also stipulate that when you fly for a large duration of time over water, you need to have minimum 2 engines the so called ETOPS clearance, extended range twin engine operations conditions. Thanks for your attention; we will now move to the next section.