SUPERIOR AIR PARTS, INC

Tech Notes

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Subject: Engine Balancing Part V

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In the last in a five-part series of my articles on methods of minimizing Engine Vibrations, I discuss vibrations due to torque imbalance. Vibrations in a reciprocating engine are primarily caused by imbalance of 5 types:

Rotating, Reciprocating, Inertial, Combustion, and **Torque**

Torque vibration forces are the result of the transmission of combustion forces to the crankshaft and in the end the prop, as well as any feedback from the prop to the engine. Many of the inertial and combustion imbalances discussed in my prior articles show up in the end as torque vibrations, so I won't go into those again. Suffice it to say that most torque fluctuations are the result of many types of inertia and combustion imbalances.

Other types of torque imbalances, primarily flight related, can also cause significant engine and airframe vibrations. These factors include propeller blade-pass, changes in airspeed, and turbulence. These are usually transmitted through the engine mounts and engine cowl to the airframe, but can be transmitted through the air itself and has been known to cause resonant vibrations.

Prop blade-pass vibrations are the result the propeller blade coming close enough to the cowl or airframe for the air to compress and result in flexure of the blade as a reaction to the change in the air density/pressure created. The number of blades on the propeller also affects the frequency and severity of this vibration. This buffeting creates variations in the torque absorbed by the propeller and therefore loading of the engine changes.

Similarly, changes in airspeed and angle of attack can also change the torque loading of the engine by changing the "bite" the prop takes out of the air. Although these are of a much lower frequency than blade-pass vibrations they may be more noticeable to passengers. Turbulence is a combination of the above effects and can result in many combinations of engine loading and unloading as well as vibrations.

There isn't much engine designers or manufacturers can do to reduce these vibrations, but airframe designers must take many of these things into consideration. This is primarily because the engine/prop/airframe must already be designed before they can be identified – although things like wind tunnels and, recently, computer simulations can aid the designer. Many sleepless nights have been spent by aircraft test engineers tracking down these aircraft Gremlins. Things like prop extensions and cowl design, as well as prop and airframe design itself must all work in combination with the engine to result in a smooth ride for the passengers.

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