YAMAHA ENGINE ADAPTATION TO GYROPLANE

Project Statement
Currently, a majority of gyroplanes use an expensive, specialized, 65 hp, 2-stroke engine that lacks the reliability of a 4-stroke engine. Team Aztec Flight was tasked with locating and adapting a more reliable, less expensive, 4-stroke engine onto a kit-based gyroplane. To ensure proper engine adaption, a reduction drive gearbox is necessary, capable of reducing the output operating RPM of the engine to a usable propeller operating RPM. Switching to a mass produced, 4-stroke engine would reduce costs while improving reliability and usability.

Requirements and Constraints
• Factor of Safety of all major components to be AT LEAST 1.5.
• Gearing ratios shall be common, widely used ratios.
• System shall be water-proof.
• System shall be able to operate in up to 3G and SFC-15,000ft environment.
• System shall operate off a 12V battery.

Team Members (from left to right are: Jose Thompson, Daniel Templeman, Duong Nguyen, Kyle Ryan, Dillon Devore

Project Description
Team Aztec Flight designed a kit that allows the end user to adapt a Yamaha Phazer snowmobile engine onto various gyroplanes. Through the use of 4 possible gearing ratios designed to allow various propeller sizes to be used, this kit is capable of reducing the output RPM of the engine from 7700 to an RPM that is suitable for aircraft usage. This kit was reverse engineered to attach directly to the engine, via the crank interface while not requiring any modifications to the engine. Standalone engine functionality also required Team Aztec Flight to design a custom air filter assembly (reverse engineered from the stock throttle body), a custom oil tank mount and utilize a modified-OEM wiring harness. The overall cost of this kit was to be less expensive than commercially available units.

Reduction Gearbox

Exploded View of Reduction Gearbox

Analysis
To verify the system met minimum requirement of a Factor of Safety of 1.5, extensive Finite Element Analysis (FEA) was conducted on all core components of our final design utilizing SolidWorks. It was found that the Output Shaft had the minimum FOS at 1.55, where the Retaining Ring had the maximum at 33.28

Fabrication
A fabrication plan was developed for this kit that was to utilize equipment found in the SDSU Machine Shop, to include: HAAS VF-2, Prototrac Mill, Lathe, Waterjet and other common shop tools. Heat treatment and Wire EDM processes were to be outsourced locally. Due to the COVID-19 pandemic, which caused access to SDSU Machine Shop to be terminated, fabrication was halted mid-process. All fabrication work has been transferred to the Project Sponsor as “traveled work.”

System Level Diagram

Reduction Gear Set Design Process

Engine Cradle