Jump Take-Off Retrofit for Auto Gyro

What is an Auto Gyro?

An Auto Gyro is a lightweight aircraft that uses an unpowered rotor in free autorotation to develop lift. Forward thrust is provided by an independent engine driven propeller. It requires a runway to spin the rotor to proper RPM for take-off. Pre-rotators are commonly used to spin the rotor to half of the flight RPM but the aircraft still requires a short runway.

Project Overview

The Popular Rotorcraft Association recruited Team Jumpman to develop a jump take-off system for Auto Gyros. The goal of this project was to develop a system that could power the rotor blades up to 150% of flight RPM to allow the aircraft to take-off vertically, eliminating the need for a runway. Many Gyro pilots operate in dense foliage, farmland, and sometimes isolated environments. This jump take-off system will allow pilots to take-off and land in remote areas, improving the overall functionality of the Auto Gyro. The Gyro used for this project was equipt with an 80 HP Yamaha snow mobile engine. Team Aztec Flight designed a reduction gearbox to modify the engine output for the propeller, and to include an output shaft for the jump take-off power transmition. Both of these designs will be available as instructional guides through the PRA for others to follow and build onto their Gyros.

Design Requirements

-Provide 150% lift to rotor blades before take-off.

-Minimum factor of safety of 2 for all components. All components must be designed for infinite fatigue life.

-Shall have clutch to disengage motor from rotor immediately before take-off.

-Center of gravity shall be within 1-3 inches of the center thrust line.

-Entire system weight shall be below 100 lbs.

-End user shall be able to complete a similar project for under $2,500 for all parts and tooling.

Power Requirements

$\rho = 0.0002378\ slug/ft^3 \quad W = 0.708\ ft$

$D = 25\ ft \quad RPM = 480 \quad C_D = 0.01$

$A_{Disk} = (\frac{D}{2})^2 * \pi = 490.87\ ft^2$

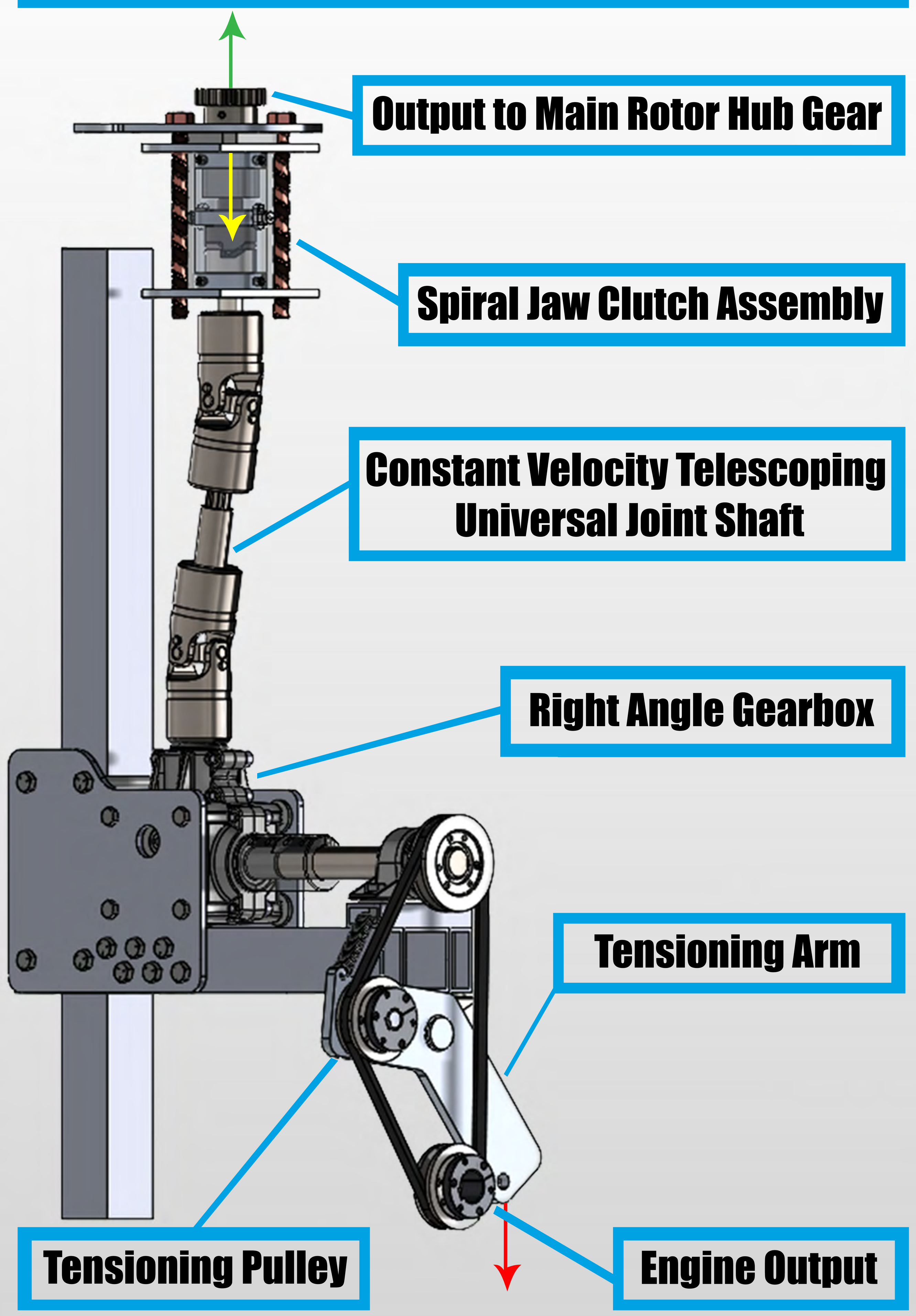
$V_{Tip} = 2 * \pi * \frac{RPM}{60} * \frac{D}{2} = 458.14\ ft/s$

$\sigma = (2 * W) \div \pi = 0.45$

$$Power\ (HP) = \frac{\rho * A_{Disk} * (V_{Tip})^3}{550} * \sigma * \frac{C_D}{8} \approx \boxed{29.567\ HP}$$

$$Torque\ Required = \boxed{309\ ft * lbs}$$

Final Design

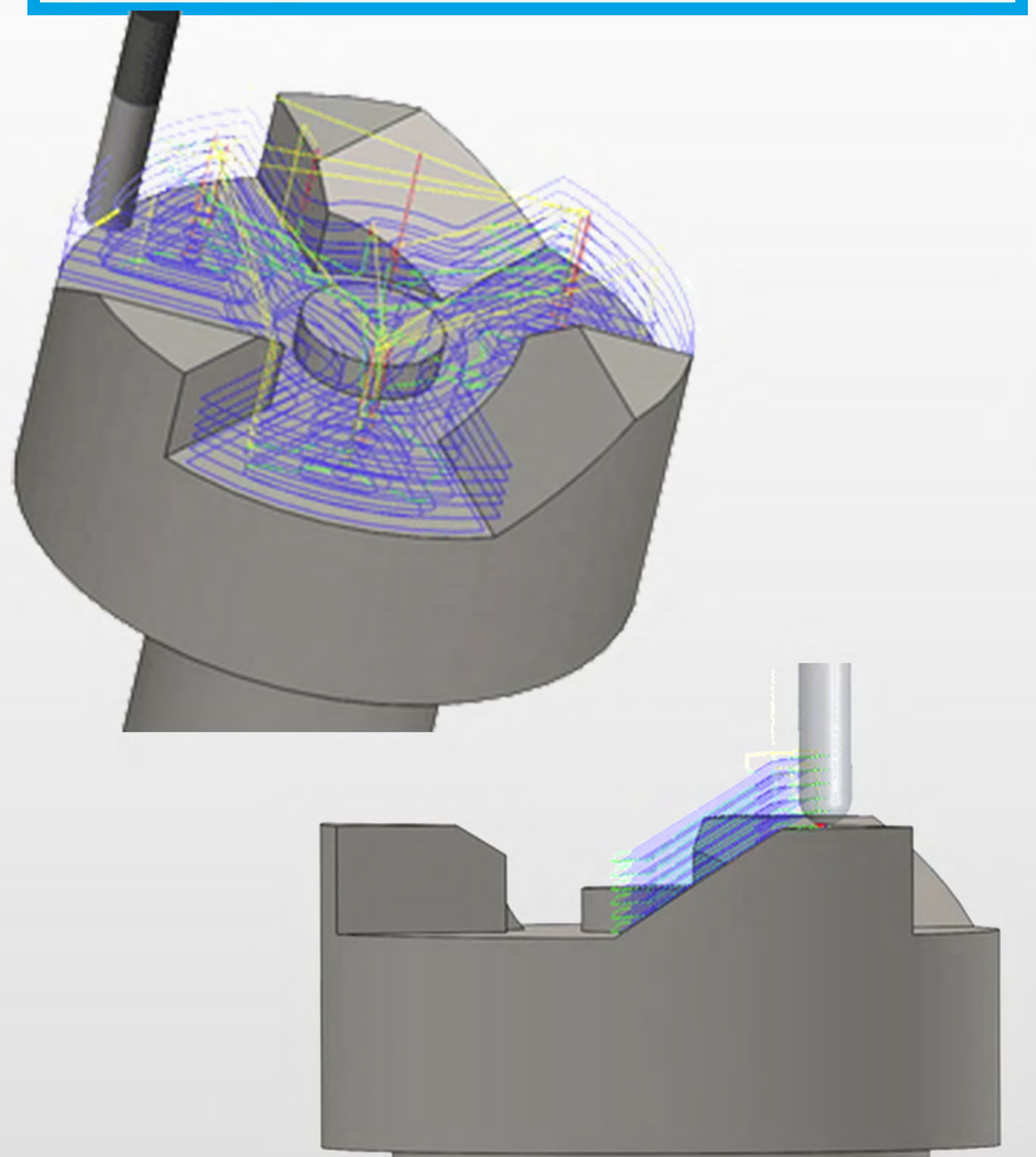


System Weight : 42 Pounds

System Operation

A pulley is fixed to the engine output shaft and transmits power to the top pulley connected to the gearbox when the tensioning pulley is engaged. This is done by pulling down on the tensioning arm through cabling as shown in the graphic above with the red arrow. To complete the power transfer to the main rotor, the spiral jaw clutch mechanism must also be engaged through cabling as shown by the yellow arrow. The user would engage both systems and allow the rotor blades to reach the desired RPM. Releasing the tension arm reduces the belt tension, and will allow the belt to slip on the top pulley and will not transmit power to the gearbox. In order to allow the rotor to enter autorotation, the output to the main rotor gear must also disconnect simultaneously through the spiral jaw clutch assembly. Once the cabling is released, the compression spring between to the two jaws seperates them. The output gear located above the clutch assembly moves up and disconnects from the main rotor hub gear as shown with the green arrow.

Manufacturing

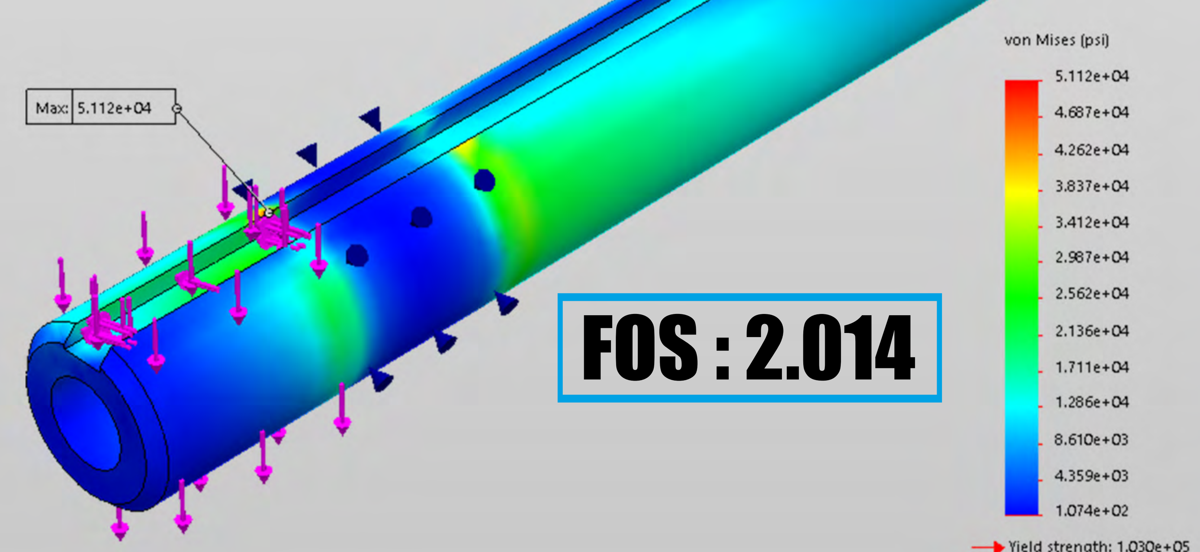


Analysis and Results

Material: AISI 4340 Steel

Forces: 50 lbs : Tension in Belt
950 in*lbs : Pulley Torque

Fixture: Fixed to Gearbox

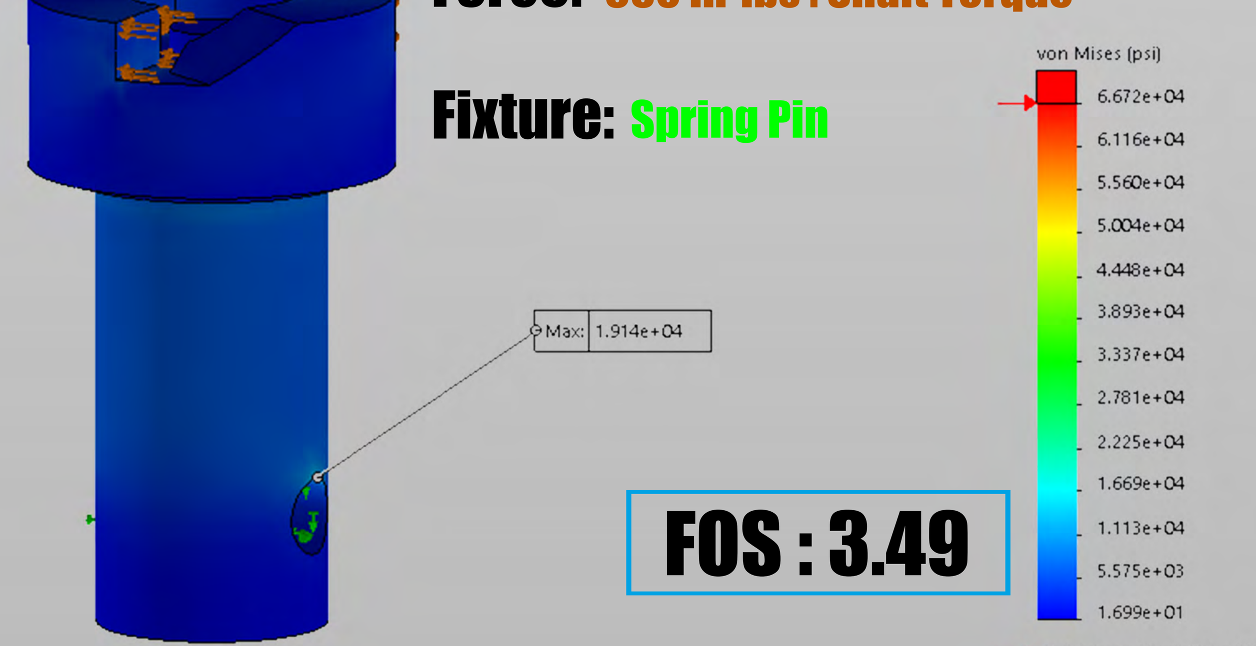


FOS : 2.014

Material: AISI 4130 Steel

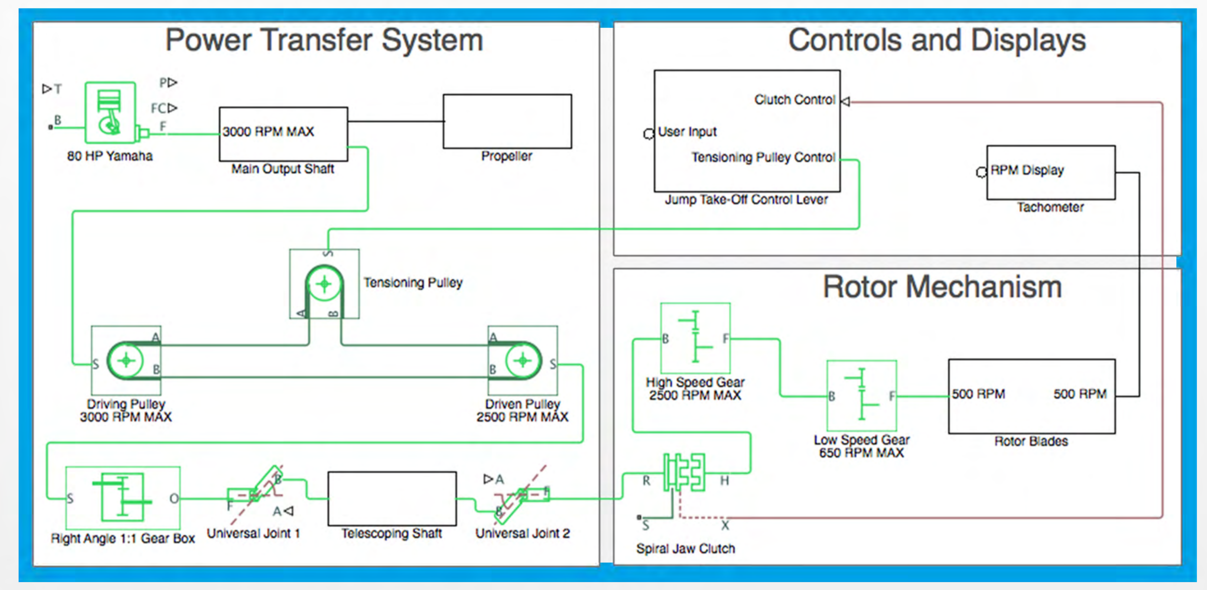
Force: 950 in*lbs : Shaft Torque

Fixture: Spring Pin



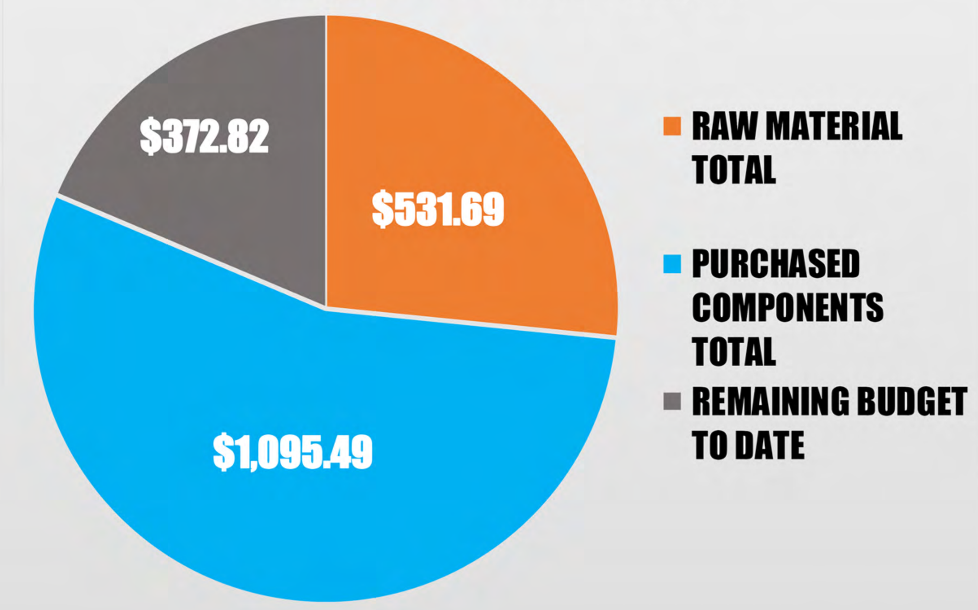
FOS : 3.49

System Level Diagram



Project Cost

Jumpman Final Budget



Meet the Team

Team Member	Position
John Rountree	Project Sponsor
Scott Shaffar	Project Instructor
Dustin Drummer	Clutch Design Lead
Austin Gurule	Safety / Test Lead
Kenneth Murillo	Analysis Lead
Nikola Modrusan	Project/Manufacturing Lead
Charles Winkowski	Design Engineer

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