2022/2023 APOP Statement of Work
Electrical Power Generation

The 2022-2023 Aerospace Propulsion Outreach Program (APOP) research activity requires undergraduate students, working as a team, to generate, harness and deliver electrical power derived from the performance of the JetCat P100-RX. In addition, the construction of a digital twin of the engine is recommended to properly assess base engine performance and to inspect changes and their consequences.

The goal with this project is to modify the stock JetCat P100 engine to deliver a minimum amount of DC electrical power while maximizing thrust-to-weight (T/W) ratio. The total system weight will consist of all stock components of the engine and any additions. Hardware used to sink and measure the generated electrical power will not be considered as extra weight. Students will model and test for achievable thrust, providing a baseline for how these modification may affect said parameter. A digital environment in which students may operate in is essential in achieving proper analysis of the engine. Therefore, a model of the engine's cycles, geometry and overall processes is highly encouraged. The digital twin mentioned acts as an activity for students, baselining data on contrasting solutions towards system modifications.

AFRL will gather data on the stock engine to include weight and thrust. The systems the teams develop must deliver at least 80 watts of power at idle and 500 watts of power at full throttle for at least 2 minutes. During this measurement period the thrust of the engines will be measured to determine an average value, which will be used to calculate the thrust-to-weight ratio.

The team's deliverables are:

- Design/build/implement modifications to a JetCat P-100 that maximize T/W while delivering the required electrical power generation.
    - Solution is not restricted to a certain component of the engine, but major modifications to the JetCat's rotating assembly and combustor are not allowed due to safety concerns. ○ Weight calculations will include all components on engine and not include supporting equipment such as battery or the fuel tank. Electronic loads, resistor banks or anything used to sink and store electrical power will not count towards total weight.
    - The fuel system to include fuel lines will not be modified for weight savings. Max fuel flow rate is limited to 20 kg/hr.
- P-100 "Digital Twin"
    - Digital performance and geometry models used during the engineering process. ○ Geometric modeling of engine components related to the competition design changes. ○ Thermodynamic modeling of hardware modifications predicting impacts to performance parameters such as thrust and thrust specific fuel consumption.
- Primary scoring criteria:
    - Total T/W >= 30%
    - Minimum Electrical Power Delivered >= 60%
    - "Digital Twin" Accuracy >= 10%
- Secondary scoring criteria
    - Electrical Power Generation Efficiency
    - Excess electrical power generation
    - Access to stored power
    - Cost cannot exceed funded amount, but the lower overall modification costs score higher.

    - Lower fuel flow rate
    - Lower weight
    - Higher max thrust
- Demonstrate a working modified JetCat P100-RX at Wright-Patterson Air Force Base or comparable laboratory facilities
- Submit a final report.
- Present to a panel of AFRL scientists and engineers at Wright-Patterson Air Force Base in a poster session.