

1. Research Title: Modeling and Simulation Study of Aircraft Thermal System Architectures for UAS Military Applications

2. Individual Sponsor:

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3. Academic Area/Field and Education Level:

Mechanical Engineering and Aerospace Engineering/Thermal Fluids, Heat Transfer, Computational Fluid Dynamics, Thermal Modeling and Simulation (BS, MS or PhD level)

4. Objectives: Model and evaluate advanced aircraft thermal management system architectures for military Unmanned Aircraft Systems (UAS) using an integrated aircraft level modeling and simulation approach. Compare alternative thermal management architectures and quantify their relative benefits, limitations, integration impacts, and system level tradeoffs.

Investigate the interactions between aircraft thermal management systems and other major aircraft subsystems, including electrical power systems, propulsion systems, and mission systems. Evaluate how variations in thermal loads, electrical power demand, heat rejection capability, operating conditions, and component or subsystem architectures influence overall aircraft performance.

Perform trade space architecture analyses using modeling and simulation tools to assess candidate thermal management concept against relevant system level metrics such as thermal performance, power consumption, weight, volume, efficiency, heat rejection capability, and mission capability. The research will support identification of promising thermal architectures and technology combinations for future military UAS applications.

5. Description: Future military UAS are expected to incorporate increasingly capable mission systems, sensors, communications, autonomy, and other electrically powered technologies. These capabilities can impose significant electrical power, and thermal management demands on the aircraft. As mission system capability increases, electrical power generation, propulsion, and thermal management become increasingly interconnected, requiring an integrated aircraft level approach to technology development and architecture selection.

Aircraft thermal management systems can be implemented using a variety of architectures and technologies, including air cycle, vapor cycle, liquid cooling, fuel based heat sinks, ram air heat rejection, and other advanced thermal management concepts. The selection and integration of these technologies can significantly affect aircraft power demand, weight, volume, propulsion performance, thermal capacity, and ultimately mission capability.

In this research, modeling and simulation will be used to investigate and compare alternative aircraft thermal system architectures for military UAS concepts. Candidate architectures will be evaluated across representative operating conditions and thermal loads to identify their relative advantages, limitations, and integration impacts.

Particular emphasis will be placed on understanding the interactions between the thermal management system, electrical power system, propulsion system, and aircraft mission systems. Modeling will be used to evaluate how changes in one subsystem propagate through the aircraft system and affect overall performance. Trade studies and Analysis of Alternatives will be conducted to identify architectures and technology combinations that provide the greatest system level benefit for future UAS applications.

The research may use system level and component level modeling tools such as MATLAB/Simulink, Simscape, computational fluid dynamics tools (e.g. Fluent), or other appropriate modeling and simulation environments. Results will provide insight into thermal system architecture selection, technology requirements, system integration, and future research priorities for military UAS systems.

6. **Research Classification/Restrictions:** Open to U.S. citizens only. Some aspects of this research may include ITAR restrictions.
7. **Eligible Research Institutions:** DAGSI (All DAGSI Universities).

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