

**Project:** UAV Electric Propulsion, Control, and Power Electronics Research

**Brief Description:**

Electrical propulsion systems will power an increasing number of military Unmanned Aerial Vehicles (UAVs). The proposed research would develop electronics and control technologies and testing capabilities needed to integrate electric propulsion with multiple energy technologies including fuel cells, super-capacitors, photo-voltaics, and batteries.

**Executive Summary:**

Unmanned Aerial Vehicles (UAVs) are being deployed on an increasing number and range of military and civilian missions. The appeal of traditional UAVs is that they can fulfill roles that are either too dangerous or too long in duration for human flight crews. A new generation of smaller, more flexible UAVs are enabling a range of military missions that have no parallel in traditional manned flight. These UAVs are primarily based on electrical propulsion systems.

There are many benefits of electric propulsion. An electric UAV has no exhaust noise and can temporarily minimize prop noise to tactical advantage. The control bandwidth available to the motor can conceivably be used improve roll axis stability for sensing and targeting. And, while there are very few options for improving the performance of internal combustion Predator, electric UAVs can overcome the endurance gap through "hybrid" systems using multiple energy sources: high-efficiency fuel cells, solar energy (especially at high-altitude), high-performance electrical energy storage, and energy conserving power electronics. The specific benefit of the proposed university research lies in the development of controls and scalable, hybrid power electronic configurations integrated with the latest energy conversion and storage technologies. This is the key technology required for the next generation of high-endurance, low profile military UAV's. MSU Bozeman is ideally positioned to have a transformative impact in this area.

**Electric Propulsion Research at MSU**

MSU Bozeman has a fledgling of a program in electric UAV propulsion. In collaboration with PNNL, AFRL, MSE in Butte, Boeing Phantomworks and UTC/UTRC, MSU-Bozeman is developing controls, electronics, and system integration models for a high-power density, solid-oxide fuel cell powered UAV. We have proposed a novel hybrid power electronics topology to the Air Force research lab, and demonstrated prototype hybrid systems in our facilities. We have gained a better understanding of implementation barriers and the process of developing and transferring technologies to the military from our collaborations. In particular, we appreciate the need for an integrated scientific understanding of the processes and constraints of fuel cells, batteries and other developmental technologies incorporated in an electric UAV propulsion system. MSU has a very strong record of multi-disciplinary research in energy and materials critical to the successful development of UAV propulsion research.

Funding through this request would support the development of a number of research areas critical to a broad range of electric propulsion, military UAV applications. In particular, MSU would target the following areas with the requested allocation :

- multi-source controls development
- development of UAV military-grade power electronics
- development of new, light-weight and rugged fuel cell structures
- scalable power electronics and controls to facilitate electric UAV development beyond existing size constraints
- fixed testbed for UAV propulsion system characterization

Specific first-year deliverables include:

- hybrid multi-source power electronics and control prototype
- UAV propulsion system testbed
- demonstration of scalability in UAV propulsion electronics and controls

**Congressional Action Needed:** Funding of \$2.5 million dollars in FY10 is requested.

**Benefit to the State of Montana**

While not directly part of the proposed program, we imagine that research in UAV technology at MSU Bozeman may ultimately lead to an enhanced role for the state in testing and development of next generation military UAVs. This seems a particularly natural fit as we transition from the ballistic missile program era. Although most closely identified as a military technology, UAVs are finding civilian applications that are of special interest to Montanans. Examples include fire surveillance, crop and weed monitoring, wildlife monitoring, remote sensing, search and rescue, and border security. Montana will be better positioned to take advantage of developments in these areas with in-state expertise in UAVs.

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## **TALKING POINTS**

- New UAV propulsion technologies are focused on electric drives powered by multiple sources.
- Multiple sources (photo-voltaic, fuel cell, battery) can be combined to form *hybrid* UAV propulsion systems with dramatically improved dynamic, endurance, and weight characteristics.
- Controls and electronics for hybrid UAV propulsion systems are not yet available and would be developed by the proposed research.
- The controls and electronics would be scalable and potentially applicable to a broad range of UAV electric propulsion systems.
- High-bandwidth control of UAV propulsion can conceivably be used for roll-axis stabilization of small UAVs, enabling precision targeting and sensing applications previously requiring larger aircraft.