The goal of this MQP is to design, test, and assess the feasibility of a flapping-wing micro air vehicle (MAV). After comprehensive research of similar MAVs, the group began material and component selection and modeled the vehicle. After completing the design process, the group manufactured the MAV to the best of its abilities and assessed the practicality of expanding upon its progress in the future. Although the MAV ultimately did not take flight, a number of recommendations were made to assist future MQPs in overcoming this shortcoming, which stemmed mainly from compatibility gaps between electronic components and the manufacturing of small and fragile parts. This report details the design and manufacturing processes involved with this MQP.
Design of Micropropulsion Plume Experiments

Carlie Crawford, Brandon Otte, Jonathan Rodgers
Advisor: Professor Nikolaos Gatsonis

This project involves design, analysis, and fabrication of a mounting assembly to be used within the Small Vacuum Facility-2 (SFV-2). The bell jar of SFV-2 includes a three degree-of-freedom positioning system for micropropulsion plume experiments. The fabricated mounting assembly allows the attachment of plasma diagnostics to the positioning system. Vibration data were collected with and without the SFV-2’s mechanical pump running using accelerometers placed on the positioning system. Analysis shows random vibrations with maximum amplitude of 8 micrometers. The position uncertainly of a Langmuir probe is obtained with SolidWorks vibration analysis using amplitude inputs from the experiments. Calibration of the mass-flow system for the SFV-2 ion plasma source is also presented.
The goal of this project was to design and construct a remote-controlled aircraft as an entry in the Micro Class of the 2013 SAE Aero Design West Competition. To succeed at the competition, the plane had to be as light as possible, carry a high payload fraction, and be stowed in a box with interior dimensions of 24"x18"x8". The final design is a flying wing that has an 88 centimeter wingspan, weighs 180 grams, and is capable of carrying a payload of 700 grams. The aircraft was assembled using a jig, which allowed for rapid construction and minimized construction flaws. By combining detailed analysis of aerodynamics, structures, and materials with flight testing, the team has refined the design of the aircraft and expects good performance at the competition, scheduled for mid-April, 2013.
Micro Aircraft Competition Design - Glider

Zaki Akhtar, Ryan Fredette, Phil O'Sullivan, Daniel Rosado
Advisor: Professor David Olinger; Co-Advisor: Professor Simon Evans

The goal of this project was to design an aircraft to compete in the micro-class of the 2013 SAE Aero Design West competition. To obtain the lightest possible aircraft, the team chose to construct a glider. The aircraft is completely dependent on potential energy to complete the course, thus a launching system was also developed. Ultimately, the aircraft did not cover the required distance, but significant improvements were made over previous designs. This report details the competition goals and constraints, design process, aircraft configuration, and recommendations for future development.

Design and Analysis for a CubeSat Mission

Dylan Billings, Ilea Graedel, Francis Hoey, Peter Lavallee, Nicolas Martinez, Justin Torres
Advisor: Professor Nicolaos Gatsonis

This project supports the design of a three-unit Cube Satellite (CubeSat) mission in a high-altitude, polar, sun-synchronous orbit. The goal is to perform solar and extraterrestrial X-ray spectroscopy using the Sphinx-NG instrument. The CubeSat design addresses the mission and the Poly-Picosatellite Orbital Deployer (P-POD) requirements. Mechanical design of the CubeSat is performed using SolidWorks. Vibration and stress analysis for expected launch conditions is performed using SolidWorks. Orbital decay analysis is performed using Systems Toolkit and NASA’s Debris Assessment Software. The magnetic fields induced by CubeSat’s three magnetic torquers are evaluated using COMSOL. Documents and procedures relevant to compliance with the P-POD are identified.
Thermal, Telecommunication and Power Systems for a CubeSat

Jennifer Hanley, Brian Joseph, Martha Miller, Samantha Monte, Joshua Trudeau, Racheal Weinrick
Advisor: Professor John Blandino

The objective of this project was to design the power, telecommunication, and thermal control subsystems for an earth-orbiting CubeSat. This mission payload is an X-ray detector designed to study solar radiation. Requirements on the spacecraft imposed by NASA and the standardized deployment system were reviewed and organized to provide a reference for future design teams. The power subsystem defined by previous WPI student projects was re-evaluated and the power budget finalized. In addition, wiring diagrams were created to show how the power subsystem hardware interfaces with other spacecraft systems. The telecommunication subsystem was designed in order to allow communication between the satellite and ground stations. A ground station plan was established, including a cost budget for hardware and identification of an existing network which could support the mission objectives. With this information, a telecommunications link budget was created and expected ground tracks calculated using Systems Tool Kit (STK) software. To better understand the thermal requirements for the mission, calculations of spacecraft-sun vectors as a function of time while in orbit were performed using STK. This data was then used to simulate such effects on the structure using COMSOL. The report concludes with recommendations for thermal-vacuum testing and future work with respect to these three subsystems.

Design and Construction of a Supersonic Wind Tunnel with Diagnostics

William Bugden, Katherine Fitton, Geordie Folinas, Nathan Fournier, Gallagher Hogan, Markus Ito, Josh Lambert, Neel Patel, Dong-Uk Shin, Grant Wong, Earl Ziegler
Advisor: Professor John Blandino

The goal of this project was to design, construct, and conduct preliminary testing of a supersonic wind tunnel (SWT) in which flow properties could be measured and the flow qualitatively imaged. The current experimental facilities at Worcester Polytechnic Institute do not include a supersonic wind tunnel. The SWT built in this project represents a new facility that can be used for research and teaching in the future. In addition to observing supersonic flow characteristics, the behavior of test objects in these flows can also be investigated. The wind tunnel is an indraft type that uses the pressure ratio created between a vacuum chamber and the ambient air to generate a flow. The tunnel was designed and built to be modular, allowing future users to switch the current channel contours with alternative, test-specific designs. The tunnel uses a Pitot-static probe system to acquire pressure measurements which are then used to calculate Mach number. In addition to the pressure measurements, a schlieren optical system was built to allow imaging of flow structures. To ensure proper performance under a range of ambient conditions, a humidity control system was designed and built to prevent condensation in the channel.
Electrohydrodynamic Pumping Pressure Generation

Blair Capriotti, Derek Montalvan, Michal (Michelle) Talmor
Advisors: Professor Jamal Yagoobi, Professor Eduardo Torres-Jara, CS

Electrohydrodynamic (EHD) conduction pumping technology is based on the flow generating interactions between electric fields and electrolyte impurities within dielectric fluids. EHD conduction pumps have no moving parts, can be very small and offer superior performance for heat transport. Electrohydrodynamic conduction pumps have therefore been used previously to generate high mass flow rates for the purpose of heat transfer. However, high pressure generation is more difficult to achieve from these types of devices. For this Major Qualifying Project, a compact, macro-scale, multi-section EHD conduction pump capable of generating pressures up to 400 Pa per section was designed, built and tested. The pump utilizes porous 1.6mm wide high voltage electrodes with a pore size of 10 microns and 3.7mm long flush, ring ground electrodes. The high voltage and ground electrodes are 1.6mm apart. In total, the final pump contains 24 electrode pairs but can be extended to include more sections. Each electrode pair is spaced 8mm from each other, with 8 pairs per section. The working fluid for the pump is the Novec 7600 engineering fluid.

Attitude Determination and Control System for a CubeSat

Alan Snapp, Assaad Farhat, Jighjigh Tersoo-Ivase, Ye Lu
Advisor: Professor Michael Demetriou

This project continued the work on the development and testing of an Attitude Determination and Control Subsystem (ADCS) for a three-unit Cube Satellite mission led by WPI, the NASA Goddard Space Flight Center, and the Space Research Centre in Poland. This project focused on hardware selection in three areas: sensors, actuators, and processors. The attitude maintenance and control scheme was validated using numerical code written in MATLAB. A secondary goal of the project was to outline a design for a test-bed where the control policies could be verified experimentally. This project developed a complete test-bed stand, leaving the construction portion for future ADCS teams, as well as recommendations for the parts to be used in the experimental section.
Design and Construction of a Velocity Probe Calibration Rig

Paul Ciolek, Ethan Deragon, Daniel Frodell, Stephen Kressaty
Advisor: Professor Simon Evans

This report involved the design and construction of a velocity probe calibration rig to be used in future fluids research at Worcester Polytechnic Institute. The aim of the project was to build a high accuracy, automated calibration system, capable of calibrating pneumatic probes and hotwire anemometers over a wide range of both flow speed and direction. The primary components of this calibration rig were an air flow channel, a probe manipulator, and a drive system for an axial flow fan. To achieve the desired measurement accuracy with the probe manipulator, rotary tables with 1/10 degree accuracy were used to control the system.

Re-Design of Kite-Powered Pump and Wind Turbine Systems

Valerie Butler, Jeffrey Corado, Kimberly Joback, Bryan Karsky, Matthew Melia, Robert Monteith, Brandy Warner
Advisor: Professor David Olinger

The Kite Power MQP was split in two parts, water pump and wind turbine, both designed to be implemented in developing nations. The goal of the water pump project is to build a low-cost water pump system generated by kite power. Design modifications and additions, notably a latch and ground string, were made to the Kite Power 2012 MQP system. These additions generated a periodic motion of the rocking arm, and testing demonstrated that the system independently pumped water. The goal of the airborne wind turbine project is to design a lightweight airborne wind turbine with an output capacity of 300 watts that can be supported beneath a high altitude kite. Scaled turbine system tests demonstrated proof of concept, however, due to cost constraints the full-scale system was only theoretically designed.