Solicitation to Students for Summer Research Fellow Applications

MAE Distinguished Undergraduate Research Fellowship
(MAE Distinguished Research Fellow)

The Mechanical and Aerospace Engineering Distinguished Undergraduate Research Fellowship program supports excellent undergraduate students to pursue research with a faculty member over the summer. Students are encouraged to consult the attached project list, identify a project of interest, and submit the attached application form.

Due Date: February 12th, 2017

Research Fellow Support: $6,000

Fellowship Begin/End Dates: May 15 – Aug 15, 2017
An MAE Distinguished Research Fellow will also have the opportunity to continue their research project into the academic year with an additional $1000 support through the Missouri S&T OURE Program.

Anticipated Selection Announcement Date: March 1, 2017

Anticipated Number of Fellows: 5

Eligibility
- Mechanical or Aerospace undergraduate student with junior or senior standing (1-2yrs from completing BS)
- GPA >3.5

Application Process
1) Identify a research project you are interested in (see attached projects below).
2) Submit the application form (below, which includes a resume, unofficial transcript, and 1 pg. personal statement describing career goals, and how an undergraduate project fits within those goals) to the MAE Assoc. Chair Dr. Josh Rovey, roveyj@mst.edu, by Feb. 12th, 2017
3) Select candidates will be asked to interview with potential faculty mentors the weeks of Feb 13-24, 2017.

MAE Distinguished Undergraduate Research Fellowship
(MAE Distinguished Research Fellow)
Due February 12th, 2017

Student Application Form

Name: (First, Middle, Last)	
Email Address for contact:	
Telephone number: (Please provide area code)	
Current Mailing address: (Street, City, State, ZIP)	
Past Research Experience (if any, please describe projects and, if Missouri S&T, list faculty advisor)	
Current GPA (on a 4.0 scale): (Attach copies of unofficial transcripts)	
Current Class Standing: (Seniors are not eligible if degree will be completed on/before Summer 2017)	
Race (Missouri S & T is an affirmative action/equal opportunity employer)	
Gender:	
Are you a United States citizen or Permanent Resident?	
Title of Project you are interested in:	
Please attach a resume, and a max 1pg. personal statement describing your career goals and how undergraduate research fits within those plans	

Email Application Form to Both:

Josh Rovey, Ph.D.
MAE Associate Chair for Graduate Affairs
roveyj@mst.edu

Michele Warren
MAE Graduate Secretary
warrenmf@mst.edu

Undergraduate Research Project Titles

Additive Manufacturing of Glass for Optical Applications

Faculty: Dr. Edward Kinzel

http://mae.mst.edu/facultyandstaff/facultykinzel/

Project Description:

Additive Manufacturing (AM) permits layer-by-layer fabrication of freeform geometries with inhomogeneous materials. AM offers advantages in design versatility, rapid realization of low production volumes, and the ability to deposit materials that are difficult to process using subtractive methods. In addition, it raises the possibility of combining multiple materials in a single build. AM of optically transparent polymers using ink-jet printing as well as stereolithography show potential for bespoke freeform, as well as gradient index (GRIN), optics. While development of polymer based AM is well established and optical applications are in the initial states of commercialization, research on printing optically transparent glass is only beginning. Glass has significant benefits for optical applications over polymer based systems. This includes optical performance, power handling, temperature insensitivity, chemical inertness, and mechanical toughness. In addition, viable polymer systems do not exist for either UV or IR wavelengths. We have built a system for printing arbitrary parts out of transparent glass (one of four systems in the world). In our approach, a CO_2 laser locally melts a filament where it intersects the workpiece. We are in the process of improving the process, including implementing in-situ diagnostic tools for process control, improving the motion system and developing process parameters for different glasses. This includes studying different applications ranging from printing lenses to light-weight low thermal expansion structures to art.

Student's Research Activities:

There are several aspects of the project for undergraduate students to work on depending on interest. These include (a) machine design of fixturing and advanced filament feeders, (b) experiments studying the temperature of the glass and the effects on the transparency/strength (c) designing/printing/testing truss structures for light-weight mirrors, and (d) implementing pyrometric feedback control into the process.

This an opportunity to interact with a unique one-of-a-kind technology. The opportunity to controllably melt silica at 1500°C is fascinating. The student will join a dynamic group of graduate and undergraduate researchers on the project and will be involved in the NSF REU site. A goal of the project is that the student will have an opportunity to be an author/co-author on research publications.

Additive Manufacturing of Metal Matrix Nanocomposites

Faculty: Dr. Lianyi Chen

http://mae.mst.edu/facultyandstaff/facultychen/

Project Description:

Metal matrix nanocomposites are metal matrix composites reinforced by ceramic nanoparticles, which exhibit superior mechanical and thermal properties as compared with conventional metals. The objective of this project is to develop additive manufacturing (also called 3D printing) technologies to manufacture ultrahigh performance metal matrix nanocomposites parts for aerospace, biomedical, defense and automobile applications. A combination of experiment, theoretical analysis and simulation will be used to achieve this objective.

Student's Research Activities:

Prepare feedstock materials, make metal matrix nanocomposite parts by laser-based additive manufacturing equipment, analyze microstructure of additively manufactured parts, and test mechanical and thermal properties.

This research project is at the intersection of manufacturing, materials science and nanotechnology. Student will have hands on experience on multidisciplinary cutting-edge technologies (3D printing, nanotechnology, and materials design).

Arnold Defense Rocket Launcher Upgrade
Faculty: Dr. Dan Stutts
http://mae.mst.edu/facultyandstaff/facultystutts/

Project Description:

Arnold Defense, Inc. http://www.arnolddefense.com/

Arnold Defense, Inc., located in Arnold, MO, has been manufacturing rocket launching systems for US Department of Defense (DoD) for over 50 years. Modern rules of battle engagement have motivated the development of "smarter" munitions capable of intelligently tracking targets to minimize collateral damage; these new demands necessitate the redesign of the current, battle-tested and highly reliable systems. The proposed project will apply novel electromechanical technology in the development of new launcher systems to satisfy the constraints of the modern theater of battle.

Student's Research Activities:
The participating student will participate in the design, development, and evaluation of new electromechanical launcher systems. The student will learn how to apply finite element simulation and embedded system technology, and will collaborate with Arnold Defense engineers during the project with the goal of developing a prototype.

The student will collaborate with graduate students and other undergraduate research assistants in our S&T labs and with engineers at Arnold Defense – gaining a unique opportunity to learn how defense contractors interact with the DoD.

CFD Simulation of Tunnel Noise in Hypersonic Wind Tunnels

Faculty: Dr. Lian Duan

http://mae.mst.edu/facultyandstaff/facultyduan/

Project Description:

Hypersonic vehicles are important for space access, planetary (re)entry, and rapid global strike. Prediction of laminar-turbulent boundary-layer transition is a critical part of the design of hypersonic vehicles because of the large increase in skin-friction drag and surface heating associated with the onset of transition. Transition testing in hypersonic wind tunnels has been an important avenue to understanding the laminar-turbulent transition behavior of hypersonic vehicles. However, most of the existing transition test data using hypersonic wind tunnels are contaminated by facility noise that is radiated from the turbulent boundary layers on the nozzle walls. An understanding of tunnel noise effects is critical to enabling more effective use of the transition data from noisy wind tunnels and permitting more accurate extrapolation of the wind-tunnel results to flight.

Student's Research Activities:

The student will be able to will be able to participate in the ongoing DoD/NASA-funded research under the guidance of Dr. Lian Duan. He/she is expected to apply one of the existing CFD solvers for simulating the tunnel-wall turbulent boundary layer under realist operating conditions of hypersonic wind tunnels. He or she will compare simulation results with experiments.

The student will get experiences in CFD and hypersonics. He/she will have the chance to interact with experimentalists from multiple government agencies, including those from the Air Force Research Lab, Sandia National Laboratory, and NASA Langley Research Center.

Control of Additive Manufacturing
Faculty: Drs. Bristow and Landers

http://mae.mst.edu/facultyandstaff/facultybristow/
http://mae.mst.edu/facultyandstaff/facultylanders/

Project Description:

Dr. Bristow and Dr. Landers have several open undergraduate research positions in the area of Additive Manufacturing (AM) control. The student will be co-advised by Drs. Bristow and Landers and involve collaboration with a variety of other professors and industry researchers. The open positions are in the areas of:

1. Blown-powder metal AM (google Optomec LENS): Drs. Bristow and Landers have recently completed development of a fully instrumented LENS system with open-architecture Labview controller. Laser scanning systems are used in this unique setup for layer-to-layer control of part geometry addressing inherent process instabilities and increasing process throughput. Current collaborations exist with Optomec, the manufacturer of this process; funding is provided by NSF.
2. Wirefed glass fiber AM: Drs. Bristow and Landers are developing control algorithms for this one-of-a-kind process developed by Dr. Kinzel. The objectives are to enable precision control of the feeding and positioning system for accurate geometry fabrication and control of wire melt temperature for optical property. Control algorithms will be implemented on a Labview controller. This project is currently funded by NSF, AFRL, and Schott Glass.
3. Powderbed metal AM (google SLM): Drs. Bristow and Landers are developing new control methods using thermal imaging of the melt pool to regulate laser power and scan path for fabricating parts with precision microstructure control. Changing and uncontrolled microstructure are leading factors in loss of mechanical strength in powderbed AM. Real-time measurement and active control of the melt pool have potential to reject disturbances and transients that lead to performance loss. The project is currently funded by DOE National Security Campus.

Student's Research Activities:

Activities will depend on the AM system, student capabilities and interest, and may include process modeling, fabrication of artifacts, control/dynamic analysis, software development, and material analysis. The undergraduate student will their own defined project, but work closely with graduate students who will provide assistance and day-to-day mentoring. At the end of the summer students will create and present a poster at the Solid Freeform Fabrication conference in Austin, TX.

Students on this project will participate in the NSF REU site on Additive Manufacturing, held at Missouri S&T this summer. Students from around the country will spend the summer at S&T working on various aspects of AM research. The program will include organized social activities, trips to industrial facilities, and a trip to Austin, TX for the Solid Freeform Fabrication conference at the end of summer.

Development of Novel In-Situ Nonlinear Non-Destructive Inspection (NDI) Systems for Health Monitoring of Body and Vehicle Ballistic Armor

Faculty: Dr. Dan Stutts

http://mae.mst.edu/facultyandstaff/facultystutts/

Project Description:

Ceramic composites are widely used in both vehicle and body armor in the modern warfare. The effectiveness of ceramic composite armor is seriously degraded by accumulated damage in the form of micro-cracking due to impacts during combat as well as transport. Detecting the damage is currently a very time-consuming and expensive operation. The Department of Defense recently published a solicitation (DoD 2017.1 SBIR Topic A17-035) requesting proposals for portable (weigh less than 80 lbs) NDI solutions which may be employed in the field of combat within a fifteen-minute time limit. The goal of the proposed project is to develop a NDI system integrated within the armor which will add negligible weight, and facilitate nearly instantaneous in-situ damage detection – even during active combat operations.

Student's Research Activities:

The participating student will participate in the development and evaluation of Phase I, proof-of-concept prototypes utilizing highly-sensitive, nonlinear NDI spectral techniques. The student's specific responsibilities will include: design of experiments, numerical modeling, and experimental performance evaluation.

The student will collaborate with graduate students and other undergraduate research assistants in our S&T labs and with researchers at the Texas Instruments' Kilby Labs. The student will gain significant experience in the field non-destructive inspection, embedded systems sensing and control, and signal processing. The student will also meet world-class researchers from Texas Instruments as well as the DoD.

Development of Virtual Physical Objects for Human Balance Experiments
Faculty: Dr. Yun Seong Song
http://mae.mst.edu/facultyandstaff/facultysong/

Project Description:
The goal of this 3-month summer project is to develop and test virtual objects on a haptic device (Phantom Premium, 3D Systems, Inc.) for human balance experiments involving light-touch (LT). It is well known that LT can significantly improve human balance while standing even with very small force (~1 N). But the physical interaction mechanism leading to the improved balance from LT remains unclear. We will develop multiple novel virtual objects on the haptic device to separately test the effects of two human proprioception – position and force – to human balance during LT.

Student's Research Activities:
- Develop virtual physical objects and force fields on Phantom using OpenGL and C++
- Verify the physical characteristics of the virtual objects and force fields by analyzing the log files with Matlab
- (optional) Setup time-synchronized data collection scheme from multiple sensors
- (optional) Collect preliminary data on human balance using Phantom and a force plate

- Student will gain hands-on experience with virtual reality and virtual physical interaction
- Student be introduced to the procedures of human experiments in research
- Student may co-author on a future publication from this project
- If interested, the student may continue to contribute to this project during regular semesters

DMD Enabled Thermography
Faculty: Dr. Edward Kinzel

http://mae.mst.edu/facultyandstaff/facultykinzel/

Project Description:

Thermography (radiometric imaging to map surface temperature) is a widely used technique for non-destructive testing. Generally, an infrared (IR) imager is used to monitor the surface temperature of a target and identify discontinuities caused by uneven thermal conduction. These discontinuities can be produced by variances in the sub-surface structure including defects. Active thermography involves illuminating the target with a known heat flux to provide more accurate detection of defects. It has been widely studied and demonstrated for identifying features that impede the flow of heat away from the surface. A typical example is the detection of delamination defects in composites. Several temporal modulation schemes have been studied intensively; notably a single short pulse and a sinusoidal modulation. Both involve uniform spatial illumination of the target. While these are relatively simple to setup, neither technique produces thermal gradients tangential to the surface. This renders the inspection blind to features normal to the surface such as cracks or broken fibers. We project will involve developing a system to actively illuminate the target by modulating a laser beam using a Digital Micromirror Device (DMD). The DMD allows simultaneous control of both space and time dependence of the incident heat flux. This is a novel approach and offers significant advantages over other techniques. We will continue to refine and test the setup to produce results that will be combined with numerical models. The goal is to produce a framework for solving the inverse heat conduction problem and to characterize the subsurface structure of the target, including any damage.

Student's Research Activities:

The student will experiment with the existing system to measure the ability to detect subsurface features. This includes operating a NIR laser and illuminating different targets with frequency modulated radiation. The student will create different targets with a range of defects and collaborate with a PhD student who will model the experiment. The student will work on preparing a journal paper.

This an opportunity to interact with novel technology. There is one other group working on this process (Berlin). The student will experiment with a novel system which will gain heat transfer, optics, and processing experience. There is opportunity for generating patentable intellectual property. An explicit goal of the project is that the student will be an author/co-author on research publications.

Industrial Robot and Machine Tool Compensation
Faculty: Drs. Bristow and Landers
http://mae.mst.edu/facultyandstaff/facultybristow/
http://mae.mst.edu/facultyandstaff/facultylanders/

Project Description:
Dr. Bristow and Dr. Landers have several open undergraduate research positions in the area of volumetric error compensation (VEC) in industrial robots and machine tools. A new VEC method using laser trackers or high-accuracy laser interferometers on a 2-axis gimbal for tracking targets in 3D space, has been developed in Dr. Bristow's and Landers' research group and is currently being used at Boeing, GE, Toyota, Bell Helicopter, and NASA. Several projects are on-going to develop extensions to these tools through funding and collaborations with NSF, DMDII, Boeing, Caterpillar, API and NRK. These include developing adaptive compensation schemes for part variation, modeling and compensating machines under thermal deformation, developing algorithms for new measurement tools, and developing software for predicting machining errors.

Student's Research Activities:
Students will be trained in operating the laser tracker equipment and VEC toolsets, participate in and support on-site events at industry, conduct experiments, analyze results, and develop new software. The student will work closely with a graduate student who will provide assistance and day-to-day mentoring.

Students will participate in machine tool or robot calibration events at industrial sites including Caterpillar, Boeing, NASA, and others. The students will be a part of an active team of researchers including PhD students and industry collaborators. The student will also see a complete arc of activity from fundamental research development all the way through to industry implementation as they engage in various aspects of the on-going work.

Manufacturing Functional Infrared Metasurfaces over Large Areas to Control Radiative Properties

Faculty: Dr. Edward Kinzel

http://mae.mst.edu/facultyandstaff/facultykinzel/

Project Description:

Metamaterials are composite structures with properties that are "beyond" their constituent material properties. The metamaterial concept is most often used to engineer electromagnetic properties. Metasurfaces are 2D metamaterials and are used to engineer the reflectance, transmittance and absorptance with respect to wavelength, polarization, and angle of incidence so that the radiative properties are functions of the metasurface geometry. These surface properties determine heat transfer in radiation dominated environments. Other IR applications include defense, sensing, and thin-film lenses. The physics and the design of these devices were developed for radar applications in the 1960s and the principal challenge of realizing the benefits from IR metasurfaces is that they are cost prohibitive to manufacture due to requirements for fabricating nanoscale features. The manufacturing challenge is fundamentally different from producing/prototyping Integrated Circuits (IC). We have recently demonstrated the creation of functional metasurfaces using self-assembled arrays of microspheres, in-contact with photoresist, to pattern low-cost nanoscale features. This project will continue this work, extending the ability to manufacture metasurfaces to the point that it can be used to control the temperature of a satellite or affect energy harvesting and defense applications. Specifically, we will investigate large area microsphere self-assembly, hierarchical patterning (where the nanoscale structures change at the macroscale), and roll-to-roll fabrication. The ultimate goal is to transform the application of IR/visible metasurfaces by lowering fabrication costs from more than a million dollars per square meter to less than $\$10/m^2$

Student's Research Activities:

Student will learn the metasurface fabrication process including self-assembly of microspheres, exposure using UV collimated light source, electron-beam evaporation, characterization with Scanning Electron Microscopy (SEM) and IR measurement. Student will work to improve and scale-up process including developing LabVIEW control of illumination system and machine design of fixturing for hierarchical mask design and roll-to-roll patterning.

The student will have an opportunity to gain experience in nanotechnology and transformative nanomanufacturing. This will include experience with fabrication and characterization tools as well as interaction with talented graduate and other undergraduate students. A goal of the project is that the student will have an opportunity to be an author/co-author on research publications.

Optimal Design of Surface Acoustic Wave Actuators for Lens Cleaning

Faculty: Dr. Dan Stutts

http://mae.mst.edu/facultyandstaff/facultystutts/

Project Description:
The proliferation of automotive cameras and Lidar arrays, especially in autonomous vehicles, has produced an increased demand for novel liquid and particulate contaminate rejection solutions. Among the various mechanisms currently under study is the application of piezoelectric actuators to produce high-surface accelerations in the ultrasonic to mega-sonic frequency range. Proposed here is a proof-of-concept study to apply surface acoustic wave (SAW) devices to produce ultra-high-frequency Rayleigh waves for the same purpose. The potential advantages of using SAW technology for lens decontamination are: (1) production of very traveling waves with very high transverse accelerations as opposed to standing waves, (2) higher efficiency due to the potential for regenerative energy circulation, and (3) the potential for lower bulk stresses in the lens material relative to lower-frequency, ultrasonic standing wave approaches.

Student's Research: The participating student will learn to develop numerical predictive models using ANSYS while at the same time gaining hands-on experience conducting experiments to measure the performance of early prototypes.

The student will collaborate with graduate students and other undergraduate research assistants in our S&T labs and with researchers at the Texas Instruments' Kilby Labs. The student will gain significant experience in the field of piezoelectric vibrations – especially in the physics of acoustic wave propagation in elastic solids – through both hands-on experimental practice as well as the application of theory. The student will also meet world-class researchers at TI's Kilby Labs, leading to the potential of additional research funding and future career opportunities.

Parallel Algorithm Development for Computational Aerosciences
Faculty: Dr. Lian Duan

http://mae.mst.edu/facultyandstaff/facultyduan/

Project Description:

Novel scalable scientific algorithms are needed to enable key aerospace applications to exploit the computational power of massively parallel systems. This is especially true for the current tier of leading petascale machines and the road to exascale computing as HPC systems continue to scale up. These systems require unique scientific algorithms to hide network and memory latency, achieve very high computation-to-communication ratios, and minimize synchronization. As HPC continues to play an ever-larger role in today's science and engineering disciplines, more extensive usage of HPC systems is envisioned for large-scale CFD development and testing, as outlined in a recent NASA report on CFD Vision 2030 (http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140003093.pdf).

Student's Research Activities:

The prospective student will be able to participate in ongoing DoD and NASA funded research on high-speed turbulent flows under the guidance of Dr. Lian Duan. He will leverage existing HPC assets in Dr. Lian Duan's group and help analyze large-scale CFD database. The simulations results will be documented in project reports and, wherever appropriate, in manuscripts for archival publication.

The student will get access to leading petascale HPC systems in the nation and be exposed to the excitement of cyberphysics discovery. He/she will get experience in CFD and programming.

Quantitative Characterization of Aluminum Polish on Aerospace Skins

Faculty: Dr. Edward Kinzel

http://mae.mst.edu/facultyandstaff/facultykinzel/

Project Description:

Aerospace manufactures use polished aluminum surfaces for key portions of aircraft skins such as the leading edge. These are currently polished using a labor intensive and operator specific process. In addition, the evaluation process for the polished skins is inspector dependent. This consists of binary qualitative specifications such as the ability of the inspector to read the reflection of a driver's license. This lack of quantitative measurements for evaluating polish quality limits process improvements. A need exists for rapidly quantitatively evaluating the quality of the polish. This needs to accommodate the significant curvature of aircraft skins. It should to be rapid (evaluation times on the order of m^2/s) and non-intrusive. The technique should be able to quantifiably discriminate between different standards, ultimately be traceable to average roughness values (Ra or RMS roughness).

Scatterometery describe the radiometric measurement of the Bidirectional Reflectance Distribution Function (BRDF). BRDF describes the how much light scattered in a given direction relative to the irradiance. A perfect surface will only reflect light specularly (reflected angle exactly equal to the incident angle – both measured relative to surface normal). Defects on the surface (even sub-wavelength defects) scatter light away from the specular direction. The distribution of this scatter can be mathematically related to roughness or defect size. Such techniques are widely used to qualify mirrors and substrates for semiconductor manufacturing.

Student's Research Activities:

The student will work on a basic optical scatterometery system consisting of a HeNe laser (λ=632.8 nm) and digital camera/lens. The camera will collect scattered light from the surface. The pixel locations will be mapped to angular coordinates and allow the angular spectrum of the scattered radiation and the surface curvature to be determined. The laser beam will be modulated (chopped) and the camera digitally-locked to this signal to allow it improve the sensitivity in an ambient environment. Algorithms will be developed to account for the curvature of the surface which will cause both the specular and diffuse reflected lights angular spectra to spread. These algorithms will be combined with standard scatterometric techniques to estimate surface roughness and correlated with standard test articles.

This an opportunity to interact to apply advanced optics to a practical aerospace manufacturing problem. The student will learn important skills and interact with an industrial sponsor. He/she will be able to compare experimental results to theory. If successful the results will be implemented in production.

Separation of Deformable Micro-Particles with Magnetic Fields

Faculty: Dr. Cheng Wang

http://mae.mst.edu/facultyandstaff/facultywang/

Project Description:

The objective of this project is to investigate a novel method for separating deformable micro-particles (e.g. droplets and vesicles) using external magnetic fields. Deformability is one of the important physical properties (or biomarkers) of biological particles, such as cells. Oftentimes, deformability is an indicator of the health status of bio-particles. For example, Malaria infected red blood cells become rigid compared to normal healthy red blood cells. Therefore, separation of cells according to their deferability is essential for both clinical and diagnosis purposes. In the proposed technique, deformable micro-droplets and vesicles will be used model cells and suspended in a ferrofluid. When subject to magnetic fields, the droplets/vesicles are deformed differently depends on the physical properties of the droplets, and lateral migrations are induced due to the shape change of the droplet.

Student's Research Activities:

In this project, the following specific research tasks will be conducted. First, microfluidic devices will be designed for producing micro-droplets, which are used as model deformable cells. Second, giant uni-lamellar vesicles will be produced use an electro-formation method. Third, systematic experiments will be conducted to investigate the characteristics of deformation, transport and separation of the deformable objects in microfluidic channels when subjected to magnetic fields of different directions and strengths.

By working together with the faculty advisor and graduate student, the undergraduate researcher will be exposed to the latest technology advancement in the field of microfluidics. The undergraduate researcher will be able to gain a valuable experience on conducting independent scientific research. The student may contribute as a co-author on conference/journal publication related to the work.

Small Satellite Design, Fabrication, and Test
Faculty: Dr. Pernicka
http://mae.mst.edu/facultyandstaff/facultypernicka/

Project Description:
Student will work with the Missouri S&T Satellite Research team (M-SAT) on three current small satellite missions (MR/MRS SAT, APEX, and M^3) missions. Most work will be done in the Space Systems Engineering lab in Toomey 315. Possible areas of focus include:

- Spacecraft design;
- Fabrication and test of prototype components (hardware, software, embedded systems);
- Mission analysis (mission planning, concept of operations, simulations, FEA, thermal analysis);
- Development of mission requirements (mission objectives, mass/volume/power/data budgets, communication link margins);
- Documenting designs/tests, including creating presentations and other materials for design reviews;
- Assembly of flight hardware (depending on team progress over the spring semester).

Student's Research Activities:
The student will be assigned individual and/or group projects based on their interests, coursework completed, and past experience. Both basic and applied research topics will be available. Projects may involve theoretical work, hands-on work in the lab, or computational analysis/design.

Student will work on a research team dedicated to developing new technologies for small satellites, while working on hardware that will actually be launched into Earth orbit (funded by both AFRL and NASA). Attendance at the SmallSat conference in Logan Utah in August will be encouraged, where many networking opportunities with industry/government personnel will be available. (Student may also participate in an M-SAT design review for AFRL at the conference.) Mentoring support will be strong from graduate students and other undergraduate students. The student will also assist with the balloonsat summer camp for high school students that culminates in launching/recovering payloads from campus to 100,000 feet on a high altitude balloon.