

# **Research Symposium II**

## **Ohio Aerospace Institute**

### **Wednesday, August 4, 2004**

#### **OAI Federal Room**

**9:00 A.M. Christopher Macisco, Ohio State University, Junior**

“The Office of Inspector General (OIG)”

0160/Donald Catanzarito, Office of the Inspector General

**9:15 Daniel Kascak, Ohio University, Senior**

“High Power Density Motors”

0300/Jerry Montague, Vehicle Technology Directorate

**9:30 Melissa Johnson, Howard University, Freshman**

“The Training Process of the Organization Development and Training Office”

0480/Nola Bland, Organization Development and Training Office

**9:45 David Miller, Shaw University, Masters**

“JDD, Inc. Database”

0620/Devan Anderson, Logistics and Technical Information Division

**10:00 Michael Simpson, Georgia Tech, Masters**

“Modeling and Analysis of a Regenerative Fuel Cell Propulsion System for a High Altitude Long Endurance UAV”

2400/Joshua Freed, Propulsion Systems Analysis Office

**10:15 Jeffrey Bender, Penn State University, Senior**

“Increasing the Thermal Stability of Aluminum Titanate for Solid Oxide Fuel Cell Anodes”

5130/Mrityunjay Singh, Ceramics Branch

**10:30 Amanda Ramsey, Lorain County Community College, Freshman**

“The Office of the Materials Division”

5100/Pamela Spinosi, Materials Division

**10:45 John Falsey, Cleveland State University, Senior**

“Microstructural Evaluation of Forging Parameters for Superalloy Disks”

5120/Tim Gabb, Advanced Metallics Branch

**11:00 LUNCH**

**1:00 Jonathan Fornuff and Matthew Cheplak, Georgia Tech, Masters**

“Property Variation and Life Prediction of Silicon-Carbide Ceramic Matrix Composites”

5130/Ajay Misra, Ceramics Branch and 5100/James DiCarlo, Materials Division

**1:30 Zachary Bogusz, Ithaca College, Junior**

“Syntheses and Chemosensory of Anthracene and Phenanthrene Bisimide Derivatives”

5150/Michael Meador, Polymers Branch

**1:45 George Cater, University of Michigan, Sophomore**

“Epoxy Adhesives for Stator Magnet Assembly in Stirling Radioisotope Generators (SRG)”

5150/Euy-Sik Shin, Polymers Branch

**2:00 Emily Berkeley, Johns Hopkins University, Junior**

**"Lithium Polymer Electrolytes and Solid State NMR"**

5160/Mary Ann Meador, Environmental Durability Branch

**2:15 Marissa Reigel, Colorado School of Mines, Senior**

**"Cyclic Oxidation of High-Temperature Alloy Wires in Air"**

5160/Elizabeth Opila, Environmental Durability Branch

**2:30 Daniel Hauser, Ohio University, Junior**

**"Thermal characteristics of Lithium-ion batteries"**

5420/Thomas Miller, Electrochemistry Branch

**2:45 Francisco Ortiz, Florida Agricultural and Mechanical University, Masters**

**"A Study of Penalty Function Methods for Constraint Handling with Genetic Algorithm"**

5920/Pappu Murthy, Life Prediction Branch

**3:00 Jonathan Lorig, University of Illinois, Masters**

**"Library Services Funding Assessment"**

0620/Susan Oberc, Logistics and Technical Information Division

**3:15 ADJOURN**

## The Office of Inspector General (OIG)

Christopher A. Macisco  
The Ohio State University  
World Economy and Business  
Junior  
Mentor: Donald L. Catanzarito

### ABSTRACT

The NASA Office of Inspector General is the Federal Law Enforcement Agency at NASA which conducts criminal and regulatory investigations in which NASA is a victim. The OIG prevents and detects crime, fraud, waste and abuse and assists NASA management in promoting economy, efficiency, and effectiveness in its programs and operations.

The IG organization is divided up into two separate disciplines, the Office of Investigations (OI) and the Office of Audits (OA). The investigations side deals with criminal Investigations, administrative investigations, and civil investigations. The Audits side deals with inspections and assessments as well as the Auditing of NASA Programs and Activities.

Our mission at the OIG is to conduct and supervise independent and objective audits and investigations relating to agency programs and operations; to promote economy, effectiveness and efficiency within the agency; to prevent and detect crime, fraud, waste and abuse in agency programs and operations; to review and make recommendations regarding existing and proposed legislation and regulations relating to agency programs and operations. We are also responsible for keeping the agency head and the Congress fully and currently informed of problems in agency programs and operations.

OI investigations primarily focus on violations of Federal laws. Some of these violations deal with False Claims, False Statements, Conspiracy, Theft, Computer Crime, Mail Fraud, the Procurement Integrity Act, the Anti-Kickback Act, as well as noncompliance with NASA Management Instructions, the Federal Acquisition Regulations (FAR), and the Code of Federal Regulations (CFR).

Most of the casework that is dealt with in our office is generated through "gum shoe work" or cases that we generate on our own. These cases can come from Law Enforcement Referrals, GIDEP Reports, EPIMS (NASA Quality System), Defense Contract Audit Agency, Newspaper Articles, and Confidential Information. In many cases, confidentiality is the biggest factor to informants coming forward. We are able to maintain confidentiality because the OI is independent of NASA Management and doesn't report to the Center Directors, therefore the informant's managers and supervisors are unaware of the informants actions. The only time when an informant's confidentiality may be compromised is when it is needed in a Court of Law and is released through a Judicial Court Order.

During my tenure here at the NASA OIG/OI at Glenn Research Center, I have been involved in many different tasks. They have ranged from updating Suspected Unapproved Parts case files to independently interviewing NASA employees to turn up general background information. The OI has the duty of informing NASA aeronautical safety managers of potential Nonconforming products. My mission is to compile a database of Nonconformance reports for distribution. The background information that I turn up from my interviews is then used to determine NASA's susceptibility to acceptance of unapproved parts.

## High Power Density Motors

Daniel J Kascak  
Ohio University  
Mechanical Engineering  
Senior

Mentor: Jerry Montague

### ABSTRACT

With the growing concerns of global warming, the need for pollution-free vehicles is ever increasing. Pollution-free flight is one of NASA's goals for the 21<sup>st</sup> Century. One method of approaching that goal is hydrogen-fueled aircraft that use fuel cells or turbo-generators to develop electric power that can drive electric motors that turn the aircraft's propulsive fans or propellers. Hydrogen fuel would likely be carried as a liquid, stored in tanks at its boiling point of 20.5 K (-422.5 F). Conventional electric motors, however, are far too heavy (for a given horsepower) to use on aircraft. Fortunately the liquid hydrogen fuel can provide essentially free refrigeration that can be used to cool the windings of motors before the hydrogen is used for fuel. Either High Temperature Superconductors (HTS) or high purity metals such as copper or aluminum may be used in the motor windings. Superconductors have essentially zero electrical resistance to steady current. The electrical resistance of high purity aluminum or copper near liquid hydrogen temperature can be 1/100<sup>th</sup> or less of the room temperature resistance. These conductors could provide higher motor efficiency than normal room-temperature motors achieve. But much more importantly, these conductors can carry ten to a hundred times more current than copper conductors do in normal motors operating at room temperature. This is a consequence of the low electrical resistance and of good heat transfer coefficients in boiling LH<sub>2</sub>. Thus the conductors can produce higher magnetic field strengths and consequently higher motor torque and power. Designs, analysis and actual cryogenic motor tests show that such cryogenic motors could produce three or more times as much power per unit weight as turbine engines can, whereas conventional motors produce only 1/5 as much power per weight as turbine engines.

This summer work has been done with Litz wire to maximize the current density. The current is limited by the amount of heat it generates. By increasing the heat transfer out of the wire, the wires can carry a larger current and therefore produce more force. This was done by increasing the surface area of the wire to allow more coolant to flow over it. Litz wire was used because it can carry high frequency current. It also can be deformed into configurations that would increase the surface area. The best configuration was determined by heat transfer and force plots that were generated using Maxwell 2D. Future work will be done by testing and measuring the thrust force produced by the wires in a magnetic field.

## **The Training Process of the Organization Development and Training Office**

**Melissa S. Johnson**

Howard University

Business Management

Undergraduate, Freshman

**Mentor: Nola L. Bland**

The Organization Development and Training Office provides training and development opportunities to employees at NASA Glenn Research Center, as a division of the Office of Human Resources and Workforce Planning. Center-wide required trainings, new employee trainings, workshops and career development programs are organized by the OD&TO staff. They also arrange all academic, non-academic, headquarters, fellowship and learning center sponsored courses. They also service organizations wishing to work more effectively by facilitating teambuilding exercises.

My mentor, Nola Bland, is responsible for secretarial training, undergraduate programs, Equal Opportunity programs and upward mobility programs such as the STEP and GO programs for administrative staff. In working with my mentor I am very involved with Cuyahoga Community College classes, mandatory supervisory training and administrative staff workshops.

My largest tasks are in the secretarial training category. The Supporting Organizations And Relationships workshop for administrative personnel, commonly known as SOAR, began last year and continued this summer with follow-up workshops. Months before a workshop or class is brought to Glenn, a need has to be realized. In this case, administrative staff did not feel they had an opportunity to receive relevant training and develop skills through teambuilding, networking and communication. A Statement of work is then created as several companies are contacted about providing the training. After the company best suited to meet the target group's needs is selected, the course is announced with an outline of all pertinent information. A reservation for a facility is made and applications or nominations, depending on the announcement's guidelines, are received from interested employees. Confirmations are sent to participants and final preparations are made but there are still several concluding steps. A training office staff member also assists the facilitator with setting up the facility and introducing the class. After the class, participants' evaluations are read and summarized to determine the effectiveness of the class and instructor.

In addition to the SOAR workshops, I have several projects and daily tasks to complete. Coding training applications, which require me to be familiar with Glenn's budgetary allocations and policies on training, is an ongoing process. It also requires verifying information reported by an employee via her C-478 form, more commonly known as the training application. I am also the point of contact for the Cuyahoga Community College Advising Sessions held here at NASA Glenn which involves coordinating counselors' visits with employees' schedules. Two databases had to be created. The first database holds information on administrative staff, and the other tracks supervisors' training histories.

Through these assignments I gained experience in Microsoft Access 2002 and spreadsheet creation, communicating with co-workers, and successfully facilitating a training to serve specific purposes. With trainings and evaluations to assessment them, the Organization Development and Training Office can assure a quality product and continued customer satisfaction.

## **JDD, Inc. Database**

**David A. Miller Jr.**

Shaw University

Computer Science

Master Candidate

**Mentor: Devan Anderson**

### **ABSTRACT**

JDD Inc, is a maintenance and custodial contracting company whose mission is to provide their clients in the private and government sectors "quality construction, construction management and cleaning services in the most efficient and cost effective manners, (JDD, Inc. Mission Statement)." This company provides facilities support for Fort Riley in Fort Riley, Kansas and the NASA John H. Glenn Research Center at Lewis Field here in Cleveland, Ohio. JDD, Inc. is owned and operated by James Vaughn, who started as painter at NASA Glenn and has been working here for the past seventeen years.

This summer I worked under Devan Anderson, who is the safety manager for JDD Inc. in the Logistics and Technical Information Division at Glenn Research Center. The LTID provides all transportation, secretarial, security needs and contract management of these various services for the center. As a safety manager, my mentor provides Occupational Health and Safety Occupation (OSHA) compliance to all JDD, Inc. employees and handles all other issues (Environmental Protection Agency issues, workers compensation, safety and health training) involving to job safety.

My summer assignment was not as considered "groundbreaking research" like many other summer interns have done in the past, but it is just as important and beneficial to JDD, Inc. I initially created a database using a Microsoft Excel program to classify and categorize data pertaining to numerous safety training certification courses instructed by our safety manager during the course of the fiscal year. This early portion of the database consisted of only data (training field index, employees who were present at these training courses and who was absent) from the training certification courses. Once I completed this phase of the database, I decided to expand the database and add as many dimensions to it as possible. Throughout the last seven weeks, I have been compiling more data from day to day operations and been adding the information to the database. It now consists of seven different categories of data (carpet cleaning, forms, NASA Event Schedules, training certifications, wall and vent cleaning, work schedules, and miscellaneous) . I also did some field inspecting with the supervisors around the site and was present at all of the training certification courses that have been scheduled since June 2004. My future outlook for the JDD, Inc. database is to have all of company's information from future contract proposals, weekly inventory, to employee timesheets all in this same database.

# **MODELLING AND ANALYSIS OF A REGENERATIVE FUEL CELL PROPULSION SYSTEM FOR A HIGH ALTITUDE LONG ENDURANCE UAV**

**Mike B. Simpson**  
Georgia Institute of Technology  
Aerospace Engineering  
2<sup>nd</sup> Year Graduate Student  
**Mentor: Joshua Freeh**

## **ABSTRACT**

In the search to bridge current gaps in surveillance and communication technologies, a new type of aircraft is currently undergoing design. The idea of a High Altitude Long Endurance (HALE) aircraft is already a few decades old, but has only recently become realizable. A relay and collector of information at altitudes of 65,000 feet and higher could greatly improve standards of data exchange, homeland security, and research of the air, land and sea.

NASA, as a major force in propulsion research, is exploring methods of powering an autonomous aircraft for days, weeks, or even months without refueling. Such a task requires not only high energy density, but also the ability to make use of renewable energy sources to regenerate power.

Hydrogen is one of the most energy dense fuels available. Fuel cells make use of hydrogen by harnessing the energy released as it combines with oxygen to produce electricity and water. Fuel cells are envisioned to occupy future propulsion systems in cooperation with solar cells where the photovoltaic arrays harness sunlight into power which can electrolyze the water byproduct into reusable hydrogen and oxygen.

Modeling this type of system requires adequate assumptions of support hardware and daily transients in operation. The performance of a regenerative fuel cell propulsion system lies in the flight characteristics (altitude, density, temperature, latitude, etc.). Each subsystem is defined by many parameters which can be varied across wide ranges. Statistical and probabilistic analyses bring forward a wealth of information that can be utilized in the design process. This is necessary since the required technologies are relatively young and barely, if yet, capable.

Once the modeling is complete, a design space exploration of this highly constrained scenario can be utilized to find the optimal design. The model will become an interactive environment with which experiments and tests can be run. When linked to models of the airframe and drag polars, a complete vehicle will be available for simulation.

# INCREASING THE THERMAL STABILITY OF ALUMINUM TITANATE FOR SOLID OXIDE FUEL CELL ANODES

**Jeffrey B. Bender**

The Pennsylvania State University  
Materials Science and Engineering  
Senior

**Mentor: Stephen W. Sofie**

## ABSTRACT

Solid-oxide fuel cells (SOFCs) show great potential as a power source for future space exploration missions. Because SOFCs operate at temperatures significantly higher than other types of fuel cells, they can reach overall efficiencies of up to 60% and are able to utilize fossil fuels. The SOFC team at GRC is leading NASA's effort to develop a solid oxide fuel cell with a power density high enough to be used for aeronautics and space applications, which is approximately ten times higher than ground transport targets.

Every SOFC consists of a cathode and an anode separated by an electrolyte. These three layers must be able to operate as a single unit at temperatures upwards of 900°C for at least 40,000 hours with less than ten percent degradation. One key challenge to meeting this goal arises from the thermal expansion mismatch between different layers. The amount a material expands upon heating is expressed by its coefficient of thermal expansion (CTE). If the CTEs of adjacent layers are substantially different, thermal stresses will arise during the cell's fabrication and operation. These stresses, accompanied by thermal cycling, can fracture and destroy the cell. While this is not an issue at the electrolyte-cathode interface, it is a major concern at the electrolyte-anode interface, especially in high power anode-supported systems.

One way to avoid this problem is to design the cell such that the CTEs of the anode and electrolyte are nearly identical. Conventionally, this has been accomplished by varying the composition of the anode to match the CTE of the yttria-stabilized zirconia (YSZ) electrolyte ( $\sim 10.8 \times 10^{-6} / ^\circ\text{C}$ ). A Ni/YSZ composite is typically used as a base material for the anode due to its excellent electrochemical properties, but its CTE is about  $13.4 \times 10^{-6} / ^\circ\text{C}$ . One potential way to lower the CTE of this anode is to add a small percentage of polycrystalline  $\text{Al}_2\text{TiO}_5$ , with a CTE of  $0.68 \times 10^{-6} / ^\circ\text{C}$ , to the Ni/YSZ base. However,  $\text{Al}_2\text{TiO}_5$  is thermally unstable and loses its effectiveness as it decomposes to  $\text{Al}_2\text{O}_3$  and  $\text{TiO}_2$  between 750°C and 1280°C.

The objective of this summer research project was to evaluate several materials that could be used as additives to increase the thermal stability of  $\text{Al}_2\text{TiO}_5$  in SOFC operating conditions without adversely affecting the electrochemical properties of the SOFC anode. Three candidate materials were chosen through an extensive literature review:  $\text{MgO}$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{ZrTiO}_4$ . Although all three have been shown to prevent  $\text{Al}_2\text{TiO}_5$  decomposition under various conditions, their effectiveness in the temperature range and atmosphere of the SOFC has not yet been evaluated. Several batches of  $\text{Al}_2\text{TiO}_5$  with varying amounts of additives were prepared, exposed to reducing and oxidizing atmospheres at elevated temperatures, and the resulting decomposition of  $\text{Al}_2\text{TiO}_5$  was measured. The most promising additives were further evaluated with the goal of ultimately preparing low CTE anodes that are chemically compatible to current systems.

Adding minor constituents to stabilize  $\text{Al}_2\text{TiO}_5$  could ultimately preserve its low CTE for the life of the fuel cell and improve the cell's long-term performance without a drop in anode conductivity. Further, these low CTE filler additions could allow the use of new sulfur tolerant anode materials, improving the viability of SOFCs for future aeronautics and space applications.

## **The Office of the Materials Division**

**Amanda J. Ramsey**  
Lorain County Community College  
Communications/Physical Therapy  
Freshman

**Mentor: Raysa M. Rodriguez**  
**Denise S. Prestien**  
**Pamela Spinosi**

### **Abstract**

I was assigned to the Materials Division, which consists of the following branches; the Advanced Metallics Branch/5120-RMM, Ceramics Branch/5130-RMC, Polymers Branch/5150-RMP, and the Durability and Protective Coatings Branch/5160-RMD.

Mrs. Pamela Spinosi is my assigned mentor. She was assisted by Ms. Raysa Rodriguez/5100-RM and Mrs. Denise Prestien/5100-RM, who are both employed by InDyne, Inc.

My primary assignment this past summer was working directly with Ms. Rodriguez, assisting her with setting up the Integrated Financial Management Program (IFMP) 5130-RMC/Branch procedures and logs. These duties consisted of creating various spreadsheets for each individual branch member, which were updated daily. It was not hard to familiarize myself with these duties since this is my second summer working with Ms Rodriguez at NASA Glenn Research Center.

Another meticulous daily duty was working directly with Mr. Earl Hanes/5130-RMC ordering laboratory, supplies and equipment for the Basic Materials Laboratory (Building 106) using the IFMP/Purchase Card (P-card), a NASA-wide software program. I entered into the IFMP/Travel and Requisitions System, new Travel Authorizations for the 5130-RMC Civil Servant Branch Members. I also entered and completed Travel Vouchers for the 5130-RMC Ceramics Branch.

I assisted in the Division Office creating new Emergency Contact list for the Materials Division. I worked with Dr. Hugh Gray, the Division Chief, and Dr. Ajay Misra, the 5130-RMC Branch Chief, on priority action items, with a close deadline, for a large NASA Proposal.

Another project was working closely with Ms. Rodriguez in organizing and preparing for Dr. Ajay K. Misra's SESCO (two year detail). This consisted of organizing files, file folders, personal information, and recording all data material onto CD's and printing all presentations for display in binders. I attended numerous Branch meetings, and observed many changes in the Branch Management organization.

From this experience, I not only gained many organizational and computer skills, but I also learned the importance of teamwork, and how to work with a positive attitude towards accomplishing many facets of office tasks.

Through this internship, I worked with many diverse groups, on many different levels. From this positive experience, I have a better understanding of how an efficient workplace is accomplished.

I feel privileged to have worked at the NASA Glenn Research Center this summer and exposing myself to the many opportunities that the Center has to offer.

# Microstructural Evaluation of Forging Parameters for Superalloy Disks (tentative title)

John.R.Falsey  
Cleveland State University  
Mechanical Engineering  
Undergraduate, Senior  
**MENTOR:** Tim Gabb

## ABSTRACT

Forgings of nickel base superalloy were formed under several different strain rates and forging temperatures. Samples were taken from each forging condition to find the ASTM grain size, and the as large as grain (ALA). The specimens were mounted in bakelite, polished, etched and then optical microscopy was used to determine grain size. The specimens ASTM grain sizes from each forging condition were plotted against strain rate, forging temperature, and presoak time. Grain sizes increased with increasing forging temperature. Grain sizes also increased with decreasing strain rates and increasing forging presoak time. The ALA had been determined from each forging condition using the ASTM standard method. Each ALA was compared with the ASTM grain size of each forging condition to determine if the grain sizes were uniform or not. The forging condition of a strain rate of  $.03 \text{ sec}^{-1}$  and supersolvus heat treatment produced non uniform grains indicated by critical grain growth. Other anomalies are noted as well.

# Statistical Analysis of CMC Constituent and Processing Data

Jonathan Fornuff  
Georgia Institute of Technology  
Aerospace Engineering  
Graduate  
Mentor: DiCarlo, James

## Abstract

Ceramic Matrix Composites (CMCs) are the next "big thing" in high-temperature structural materials. In the case of jet engines, it is widely believed that the metallic superalloys currently being utilized for hot structures (combustors, shrouds, turbine vanes and blades) are nearing their potential limits of improvement. In order to allow for increased turbine temperatures to increase engine efficiency, material scientists have begun looking toward advanced CMCs and SiC/SiC composites in particular. Ceramic composites provide greater strength-to-weight ratios at higher temperatures than metallic alloys, but at the same time require greater challenges in micro-structural optimization that in turn increases the cost of the material as well as increases the risk of variability in the material's thermo-structural behavior.

The work I have taken part in this summer explores, in general, the key properties needed to model various potential CMC engine materials and examines the current variability in these properties due to variability in component processing conditions and constituent materials; then, to see how processing and constituent variations effect key strength, stiffness, and thermal properties of the finished components. Basically, this means trying to model variations in the component's behavior by knowing what went into creating it.

In this study SiC/SiC composites of varying architectures, utilizing a boron-nitride (BN) inter-phase and manufactured by chemical vapor infiltration (CVI) and melt infiltration (MI) were considered. Examinations of: (1) the percent constituents by volume, (2) the inter-phase thickness, (3) variations in the total porosity, and (4) variations in the chemical composition of the SiC fiber are carried out and modeled using various codes used here at NASA-Glenn (PCGina, NASALife, CEMCAN, etc...). The effects of these variations and the ranking of their respective influences on the various thermo-mechanical material properties are studied and compared to available test data. The properties of the materials as well as minor changes to geometry are then made to the computer model and the detrimental effects observed using statistical analysis software. The ultimate purpose of this study is to determine what variations in material processing can lead to the most critical changes in the materials property.

# CMC PROPERTY VARIABILITY AND LIFE PREDICTION METHODS FOR TURBINE ENGINE COMPONENT APPLICATION

Matthew L. Cheplak  
Georgia Institute of Technology  
Aerospace Engineering  
Masters Student  
Mentor: James DiCarlo

## ABSTRACT

The ever increasing need for lower density and higher temperature-capable materials for aircraft engines has led to the development of Ceramic Matrix Composites (CMCs). Today's aircraft engines operate with  $>3000^{\circ}\text{F}$  gas temperatures at the entrance to the turbine section, but unless heavily cooled, metallic components cannot operate above  $\sim 2000^{\circ}\text{F}$ . CMCs attempt to push component capability to nearly  $2700^{\circ}\text{F}$  with much less cooling, which can help improve engine efficiency and performance in terms of better fuel efficiency, higher thrust, and reduced emissions.

The NASA Glenn Research Center has been researching the benefits of the SiC/SiC CMC for engine applications. A CMC is made up of a matrix material, fibers, and an interphase, which is a protective coating over the fibers. There are several methods or architectures in which the orientation of the fibers can be manipulated to achieve a particular material property objective as well as a particular component geometric shape and size. The required shape manipulation can be a limiting factor in the design and performance of the component if there is a lack of bending capability of the fiber as making the fiber more flexible typically sacrifices strength and other fiber properties.

Various analysis codes are available (pcGINA, CEMCAN) that can predict the effective Young's Moduli, thermal conductivities, coefficients of thermal expansion (CTE), and various other properties of a CMC. There are also various analysis codes (NASAlife) that can be used to predict the life of CMCs under expected engine service conditions. The objective of this summer study is to utilize and optimize these codes for examining the tradeoffs between CMC properties and the complex fiber architectures that will be needed for several different component designs. For example, for the pcGINA code, there are six variations of architecture available. Depending on which architecture is analyzed, the user is able to specify the fiber tow size, tow spacing, weave parameter, and angle of orientation of fibers. By holding the volume fraction of the fibers constant, variations in tow spacing can be explored for different architectures. The CMC material properties are usually calculated assuming the component is manufactured perfectly. However, this is typically not the case so that a quantification of the material property variability is needed to account for processing and/or manufacturing imperfections. The overall inputs and outputs are presented using a regression software to rapidly investigate the tradeoffs associated with fiber architecture, material properties, and ultimately cost. This information is then propagated through lifing models and Larson-Miller data to assess time/temperature-dependent CMC strength. In addition, a first order cost estimation will be quantified from a current qualitative perspective. This cost estimation includes the manufacturing challenges, such as tooling, as well as the component cost for a particular application. Ultimately, a cost to performance ratio should be established that compares the effectiveness of CMCs to their current rival, nickel superalloys.

# Syntheses and Chemosensory of Anthracene and Phenanthrene Bisimide Derivatives

Zachary A. Bogusz  
Ithaca College  
Chemical Engineering  
Junior, Undergraduate  
**Mentor: Dr. Michael A. Meador**

## Abstract

As the present technology of biochemical weapons advances, it is essential for science to attempt to prepare our nation for such an occurrence. Various areas of current research are devoted to precautionary measures and potential antidotes for national security. A practical application of these precautions would be the development of a chemical capable of detecting harmful gas. The benefits of being capable to synthesis a chemical compound that would warn and identify potentially deadly gases would ensure a higher level of safety.

The chemicals in question can be generalized as bisimide anthracene derivatives. The idea behind these compounds is that in the presence of certain nerve gases, the compound will actually fluoresce, giving an indication that there is a strong likelihood of the presence of a nerve gas and ensure the proper precautionary measures are taken. The fluorescence is due to the quenching of an electric proton transfer within the structure of the molecule. The system proves to be very unique on account of the fact that the fluorescence can be "turned off" by reducing the system. By utilizing the synthesis designed by Dr. Faysal Ilhan, four distinct compounds can be synthesized through photochemical reactions involving para- and ortho- diketones. The photochemistry involved is very modern and much research is being devoted to fully understanding the possibilities and alternative applications of such materials.

The objective of my project is to synthesis several derivatives of this compound, a para- and meta- nitro anthracene bisimide (ABI-NO<sub>2</sub>), the amine of each (ABI-NH<sub>2</sub>), a para- and meta- nitro phenanthrene bisimide (PBI-NO<sub>2</sub>), and the amine of each (PBI-NH<sub>2</sub>). Upon synthesizing these distinct compounds, I must then purify and analyze them in order to obtain any relevant trends, behaviors, and characteristics. The chemical composition analyses that will be conducted are the procedures taken by Dr. Daniel Tyson on previous experiments. The results generated from the data will point further research in the correct direction and hopefully provide enough information to possibly create a stepping-stone for a brand new area in an unexplored frontier of chemistry.

# **EPOXY ADHESIVES FOR STATOR MAGNET ASSEMBLY IN STIRLING RADIOISOTOPE GENERATORS (SRG)**

**George M. Cater**  
University of Michigan  
Chemical Engineering  
Sophomore

**Mentor: E. Eugene Shin & James K. Sutter**

## **ABSTRACT**

As NASA seeks to fulfill its goals of exploration and understanding through missions planned to visit the moons of Saturn and beyond, a number of challenges arise from the idea of deep space flight. One of the first problems associated with deep space travel is electrical power production for systems on the spacecraft. Conventional methods such as solar power are not practical because efficiency decreases substantially as the craft moves away from the Sun. The criterion for power generation during deep space missions are very specific, the main points requiring high reliability, low mass, minimal vibration and a long lifespan. A Stirling generator, although fairly old in concept, is considered to be a potential solution for electrical power generation for deep space flight.

A Stirling generator works on the same electromagnetic principles of a standard generator, using the linear motion of the alternator through the stationary stator which produces electric induction. The motion of the alternator, however, is produced by the heating and cooling dynamics of pressurized gasses. Essentially heating one end and cooling another of a contained gas will cause a periodic expansion and compression of the gas from one side to the other, which a displacer translates into linear mechanical motion. NASA needs to confirm that the materials used in the generator will be able to withstand the rigors of space and the life expectancy of the mission. I am working on the verification of the epoxy adhesives used to bond magnets to the steel lamination stack to complete the stator; in terms of in-service performance and durability under various space environments. Understanding the proper curing conditions, high temperature properties, and degassing problems as well as production difficulties are crucial to the long term success of the generator.

My work involves specimen fabrications, testing, and data analyses of the epoxy adhesive system and steel substrate used in the stator. To optimize the curing conditions of the epoxies, modulated differential scanning calorimetry analysis was done as a function of cure time and temperatures. Adhesion bond strength was tested at various temperatures with lap shear samples using Hiperco 50 substrate to ensure that the proper adhesive is being used. To try and solve the problem of bondline thickness, micro glass beads of 0.0017" in diameter were investigated to see if any other physical properties of the epoxy were affected. Efforts will be made to develop a standard, optimized, fabrication process/procedure of sub-scale magnet-stator assemblies for various adhesive performance evaluation studies under simulated generator conditions. Also, accelerated aging testing will be done in a pressurized canister with stator assembly samples for three years to verify if any degassing or thermal degradation of the epoxy occurs. The necessity of verifying the correct epoxy adhesive system for the stator magnet in the SRG is crucial because failure of the stator assembly would jeopardize the electrical system, and thereby the entire mission itself.

# LITHIUM POLYMER ELECTROLYTES and SOLID STATE NMR

**Emily R. Berkeley**  
Johns Hopkins University  
Chemistry  
Junior  
**Mentor: Mary Ann B. Meador**

## ABSTRACT

Research is being done at the Glenn Research Center (GRC) developing new kinds of batteries that do not depend on a solution. Currently, batteries use liquid electrolytes containing lithium. Problems with the liquid electrolyte are (1) solvents used can leak out of the battery, so larger, more restrictive, packages have to be made, inhibiting the diversity of application and decreasing the power density; (2) the liquid is incompatible with the lithium metal anode, so alternative, less efficient, anodes are required. The Materials Department at GRC has been working to synthesize polymer electrolytes that can replace the liquid electrolytes. The advantages are that polymer electrolytes do not have the potential to leak so they can be used for a variety of tasks, small or large, including in the space rover or in space suits.

The polymers generated by Dr. Mary Ann Meador's group are in the form of rod-coil structures. The rod aspect gives the polymer structural integrity, while the coil makes it flexible. Lithium ions are used in these polymers because of their high mobility. The coils have repeating units of oxygen which stabilize the positive lithium by donating electron density. This aids in the movement of the lithium within the polymer, which contributes to higher conductivity. In addition to conductivity testing, these polymers are characterized using DSC, TGA, FTIR, and solid state NMR.

Solid state NMR is used in classifying materials that are not soluble in solvents, such as polymers. The NMR spins the sample at a magic angle ( $54.7^\circ$ ) allowing the significant peaks to emerge. Although solid state NMR is a helpful technique in determining bonding, the process of preparing the sample and tuning it properly are intricate jobs that require patience; especially since each run takes about six hours. The NMR allows for the advancement of polymer synthesis by showing if the expected results were achieved. Using the NMR, in addition to looking at polymers, allows for participation on a variety of other projects, including aero-gels and carbon graphite materials.

The goals of the polymer electrolyte research are to improve the physical properties of the polymers. This includes improving conductivity, durability, and expanding the temperature range over which it is effective. Currently, good conductivity is only present at high temperatures. My goals are to experiment with different arrangements of rods and coils to achieve these desirable properties. Some of my experiments include changing the number of repeat units in the polymer, the size of the diamines, and the types of coil. Analysis of these new polymers indicates improvement in some properties, such as lower glass transition temperature; however, they are not as flexible as desired. With further research we hope to produce polymers that encompass all of these properties to a high degree.

# **CYCLIC OXIDATION OF HIGH-TEMPERATURE ALLOY WIRES IN AIR**

**Marissa M. Reigel**  
Colorado School of Mines  
Metallurgy and Materials Engineering  
Senior  
**Mentor: Elizabeth J. Opila**

## **ABSTRACT**

High-temperature alloy wires are proposed for use in seal applications for future re-useable space vehicles. These alloys offer the potential for improved wear resistance of the seals. The wires must withstand the high temperature environments the seals are subjected to as well as maintain their oxidation resistance during the heating and cooling cycles of vehicle re-entry. To model this, the wires were subjected to cyclic oxidation in stagnant air.

All metals react with oxygen in the atmosphere to form an oxide layer. The rate of this layer formation is dependent on temperature. Slow growing oxides such as chromia and alumina are desirable. Once the oxide is formed it can prevent the metal from further reacting with its environment. Cyclic oxidation models the changes in temperature these wires will undergo in application. Cycling the temperature introduces thermal stresses which can cause the oxide layer to break off. Re-growth of the oxide layer consumes more metal and therefore reduces the properties and durability of the material.

Based on earlier isothermal testing in oxygen, three different wire compositions were used for cyclic oxidation testing. The baseline material, Haynes 188, has a Co base and is a chromia former while the other two alloys, Kanthal A1 and PM2000, both have a Fe base and are alumina formers. Haynes 188 and Kanthal A1 wires are 250  $\mu\text{m}$  in diameter and PM2000 wires are 150  $\mu\text{m}$  in diameter. The coiled wire has a total surface area of 3 to 5  $\text{cm}^2$ . The wires were oxidized for 11 cycles at 1204°C, each cycle containing a 1 hour heating time and a minimum 20 minute cooling time. Weights were taken between cycles. After 11 cycles, one wire of each composition was removed for analysis. The other wire continued testing for 70 cycles. Post-test analysis includes X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) for phase identification and morphology.

In previous isothermal testing, the Kanthal A1 and PM2000 wires performed better than the Haynes 188 wires. The cyclic oxidation results showed the same trend. This is to be expected since alumina forming alloys typically outperform chromia-forming alloys at this temperature.

Based on the results thus far, a few questions have been raised. Why is the weight gain higher in isothermal testing than cyclic testing? Are the wires affected by the way they are suspended in the furnace, either in a bucket or by themselves? What role does dry oxygen vs. stagnant air play in the oxidation rate of the wire? Continued efforts for this project include post-test analysis of the wires still undergoing cyclic oxidation testing. Further analysis should help answer these questions.

## **Thermal characteristics of Lithium-ion batteries**

**Dan Hauser**

Ohio University

Chemical Engineering

Undergraduate, Junior

Mentor: Thomas Miller, Concha Reid

### **ABSTRACT**

Lithium-ion batteries have a very promising future for space applications. Currently they are being used on a few GEO satellites, and were used on the two recent Mars rovers' Spirit and Opportunity. There are still problems that exist that need to be addressed before these batteries can fully take flight. One of the problems is that the cycle life of these batteries needs to be increased.

One way of increasing the cycle life is to increase the stability of the materials inside the battery. Research is being focused on the chemistry of the materials inside the battery. This includes the anode, cathode, and the cell electrolyte solution. These components can undergo unwanted chemical reactions inside the cell that deteriorate the materials of the battery. During discharge/ charge cycles there is heat dissipated in the cell, and the battery heats up and its temperature increases. An increase in temperature can speed up any unwanted reactions in the cell. Exothermic reactions cause the temperature to increase; therefore increasing the reaction rate will cause the increase of the temperature inside the cell to occur at a faster rate. If the temperature gets too high thermal runaway will occur, and the cell can explode.

The material that separates the electrode from the electrolyte is a non-conducting polymer. At high temperatures the separator will melt and the battery will be destroyed. The separator also contains small pores that allow lithium ions to diffuse through during charge and discharge. High temperatures can cause these pores to close up, permanently damaging the cell.

My job at NASA Glenn research center this summer will be to perform thermal characterization tests on an 18650 type lithium-ion battery. High temperatures cause the chemicals inside lithium ion batteries to spontaneously react with each other. My task is to conduct experiments to determine the temperature that the reaction takes place at, what components in the cell are reacting and the mechanism of the reaction. The experiments will be conducted using an accelerating rate calorimeter (ARC), which uses a heat-wait-search mode until an exothermic reaction is detected. After an exotherm is found the calorimeter maintains an adiabatic environment around a bomb which holds the test sample. The ARC will help identify important reactions and what temperature these exothermic reactions take place at.

In order fully understand the battery, we are first going to take apart the battery and test the individual components of the battery using the ARC. I will first conduct a test on the electrolyte solution by itself. We will then test the electrolyte solution with the anode. We would like to see how the electrolyte solution reacts with the anode and its binder material. The next would be the same test using the cathode instead of the anode.

By comparing the results of the electrolyte, electrolyte with anode, and the electrolyte with the cathode we can determine the reactions that are taking place due to each component. Using the heat capacity of the each individual sample and the temperature by which the sample increases, kinetic and thermo-dynamical information can then be found. A Gas chromatograph could be used to help with the task of identifying the by-products at the end of each test.

# **A STUDY OF PENALTY FUNCTION METHODS FOR CONSTRAINT HANDLING WITH GENETIC ALGORITHM**

**Francisco Ortiz**

Florida A&M University

Industrial Engineering

PhD Candidate

**Mentor: Surya N Patnaik**

## **ABSTRACT**

COMETBOARDS (Comparative Evaluation Testbed of Optimization and Analysis Routines for Design of Structures) is a design optimization test bed that can evaluate the performance of several different optimization algorithms. A few of these optimization algorithms are the sequence of unconstrained minimization techniques (SUMT), sequential linear programming (SLP) and the sequential quadratic programming techniques (SQP).

A genetic algorithm (GA) is a search technique that is based on the principles of natural selection or "survival of the fittest". Instead of using gradient information, the GA uses the objective function directly in the search. The GA searches the solution space by maintaining a population of potential solutions. Then, using evolving operations such as recombination, mutation and selection, the GA creates successive generations of solutions that will evolve and take on the positive characteristics of their parents and thus gradually approach optimal or near-optimal solutions. By using the objective function directly in the search, genetic algorithms can be effectively applied in non-convex, highly nonlinear, complex problems. The genetic algorithm is not guaranteed to find the global optimum, but it is less likely to get trapped at a local optimum than traditional gradient-based search methods when the objective function is not smooth and generally well behaved.

The purpose of this research is to assist in the integration of genetic algorithm (GA) into COMETBOARDS. COMETBOARDS cast the design of structures as a constrained nonlinear optimization problem. One method used to solve constrained optimization problem with a GA to convert the constrained optimization problem into an unconstrained optimization problem by developing a penalty function that penalizes infeasible solutions. There have been several suggested penalty function in the literature each with their own strengths and weaknesses. A statistical analysis of some suggested penalty functions is performed in this study. Also, a response surface approach to robust design is used to develop a new penalty function approach. This new penalty function approach is then compared with the other existing penalty functions.

## Library Services Funding Assessment

Jonathan A. Lorig  
University of Illinois at Urbana-Champaign  
Graduate School of Library and Information Science  
Level: Master's  
Mentor: Susan F. Oberc

### ABSTRACT

The Glenn Technical Library is a science and engineering library that primarily supports research activities at the Glenn Research Center, and provides selected services to researchers at all of the NASA research centers. Resources available in the library include books, journals, CD-ROMs, and access to various online sources, as well as live reference and inter-library loan services. The collection contains over 77,000 books, 800,000 research reports, and print or online access to over 1,400 journals. Currently the library operates within the Logistics and Technical Information Division, and is funded as an open-access resource within the GRC.

Some of the research units at the GRC have recently requested that the library convert to a "pay-for-services" model, in which individual research units could fund only those journal subscriptions for which they have a specific need. Under this model, the library would always maintain a certain minimum level of pooled-expense services, including the ready reference and book collections, and inter-library loan services. Theoretically the "pay-for-services" model would encourage efficient financial allocation, and minimize the extent to which paid journal subscriptions go unused. However, this model also could potentially negate the benefits of group purchases for journal subscriptions and access. All of the major journal publishers offer package subscriptions that compare favorably in cost with the sum of individual subscription costs for a similar selection of titles. Furthermore, some of these subscription packages are "consortium" purchases that are funded collectively by the libraries at multiple NASA research centers; such consortial memberships would be difficult for the library to pay, if enough GRC research units were to withdraw their pooled contributions.

The head librarian wishes to establish a cost analysis dataset that compares the cost of collectively-funded journal access with the cost of individual subscriptions. My primary task this summer is to create the cost dataset framework, and collect as much of the relevant data as possible. Hopefully this dataset will permit the research units at the GRC, and library administration as well, to make informed decisions about future library funding. Prior to the creation of the actual dataset, I established a comprehensive list of the library's print and online journal subscriptions. This list will be useful outside the context of the cost analysis project, as an addition to the library website. The cost analysis dataset's primary fields are: journal name, vendor, publisher, ISSN (International Standard Serial Number, to uniquely identify the titles), stand-alone price, and indication as to the presence of the journal in current GRC Technical Library consortium membership subscriptions. The dataset will hopefully facilitate comparisons between the stand-alone journal prices and the cost of shared journal subscriptions for groups of titles.

# **Research Symposium II**

## **Ohio Aerospace Institute**

### **Wednesday, August 4, 2004**

#### **OAI Industry Room**

**9:00 A.M. Elizabeth Fehrmann, Rochester Institute of Technology, Junior**

“Resolving the Issues with Flywheel Position Sensors”

5450/Barbara Kenny, Electrical Systems Development Branch

**9:15 Robert Reid II, University of Detroit-Mercy, Freshman**

“Nickel-Hydrogen and Lithium Ion Space Batteries”

5420/Marla Perez-David, Electrochemistry Branch

**9:30 Matthew Bielozer, Ohio State University, Senior**

“Thermal Energy Conversion Branch”

5490/Jeff Schreiber, Thermo-Mechanical Systems Branch

**9:45 Timothy Collins, University of Central Oklahoma, Senior**

“Optical Tweezer Assembly and Calibration”

5520/Susan Wrbanek, Optical Instrumentation Technology Branch

**10:00 Wei Zhang, Georgia Tech, Masters**

“Parametric Studies of Flow Separation using Air Injection”

5530/Dennis Culley, Controls and Dynamics Technology Branch

**10:15 Ranjan Radhamohan, University of Michigan, Junior**

“The Direct Digital Modulation of Traveling Wave Tubes”

5620/Dale Force, Electron Device Technology Branch

**10:30 Vanessa Varaljay, Cleveland State University, Junior**

“A Novel Biomedical Device Utilizing Light Emitting Nano-Structures”

5620/Maximillian Scardelletti, Electron Device Technology Branch

**10:45 Jason Reinert, Youngstown State University, Senior**

“Modeling of a Variable Focal Length Flat Lens Using Left Handed Metamaterials”

5620/Jeffrey Wilson, Electron Device Technology Branch

**11:00 LUNCH**

**1:00 Joseph Downey, University of Toledo, Freshman**

“Traveling Wave Tube (TWT) RF Power Combining Demonstration for Use in the Jupiter Icy Moons Orbiter (JIMO)”

5620/Edwin Wintucky, Electron Device Technology Branch

**1:15 Oluwatosin Ogunwuyi, City College of New York, Masters**

“Statistical and Prediction modeling of the Ka Band Using Experimental Results from ACTS Propagation Terminals at 20.185 and 27.505 GHz”

5640/Roberto Acosta, Applied RF Technology Branch

**1:30 Eric Miller, University of Cincinnati, Sophomore**

“Analysis of Droplet Size During the Ice Accumulation Phase of Flight Testing”

5840/Sam Lee, Icing Branch

**1:45 Nilika Chaudhary, MIT, Sophomore**

**"Graphical User Interface Development for Representing Air Flow Patterns"**

5820/David Ashpis, Turbine Branch

**2:00 Joseph Kardamis, Rochester Institute of Technology, Junior**

**"Glenn Heat Transfer Simulation and Solver Graphical User Interface:  
Development and Testing"**

5820/Barbara Lucci, Turbine Branch

**2:15 Stephen Huang, California Polytechnical State University, Senior**

**"Air Separation Using Hollow Fiber Membranes"**

5830/Clarence Chang, Combustion Branch

**2:30 Heidi Robinson, University of Akron, Masters**

**" 'We Burn to Learn' About Fuel-Air Mixing Within Aircraft Powerplants"**

5830/Yolanda Hicks, Combustion Branch

**2:45 Jacqueline Corrigan, University of Dayton, Sophomore**

**"Bubble Combustion"**

5830/Viet Nguyen, Combustion Branch

**3:00 Gregory Newstadt, Miami University, Junior**

**"Battery Resistance Analysis of ISS Power System"**

6920/Ann Delleur, Analysis and Management Branch

**3:15 ADJOURN**

## RESOLVING THE ISSUES WITH FLYWHEEL POSITION SENSORS

**Elizabeth A. Fehrmann**  
Rochester Institute of Technology  
Computer Engineering  
Undergraduate, Junior  
Mentor: Barbara Kenny

### ABSTRACT

For the past few years, the Advanced Electrical Systems Branch here at NASA Glenn has been pursuing research in the area of flywheels. The purpose of these pursuits has been to explore the potential for flywheels to replace current battery-powered systems in space. So far it has been learned that flywheels offer large momentum storage capacity, comparatively small volume, high durability, and near-complete discharge capabilities, all of which are advancements over the existing nickel hydrogen and nickel cadmium batteries. Another significant advantage of flywheels is the potential they offer for combining the function of attitude control with energy storage. During the summer of 2004, I worked with Dr. Barbara Kenny in the Advanced Electrical Systems Branch, supporting the work she is doing by analyzing and testing some new components for the new Generation-2 flywheel.

To monitor the speed and angular position of the flywheel rotor, a once-around (OAR) signal along with a sensorless algorithm is used. The OAR signal is used for the magnetic bearings that keep the flywheel suspended for frictionless operation. The sensorless algorithm is used for the flywheel motor/generator control. The OAR is generated from position sensors that monitor a circular plate. The plate has a cut down the middle such that one half of the circle is on a slightly lower level than the other. Every half-turn, or 180°, the sensors detect the "cut" on the plate, and trigger the OAR, telling the computer that the rotor has made half a revolution. This, however, doesn't provide needed detailed information about the angular position of the rotor, since it only provides a signal alert every half-revolution. This is enough information for the magnetic bearing control but is insufficient for the motor/generator control. A new resolver was designed such that it would give continuous angle information rather than the 180 degree information of the OAR. The new resolver has two separate observable pieces: a flat middle section to monitor vertical motion, and an angled section around the circumference, which, when observed from above, produces a sine-wave displacement through the entire 360° revolution. My first job when I arrived this summer was to calibrate the sensors that would be mounted on the inside of the flywheel casing to monitor the position (angular and vertical) of the shaft. After calibration, I used the sensors to evaluate voltage outputs created by position differences between two pairs of sensors on the angled portion of the resolver for eight different angular positions, moving the resolver vertically and laterally through its entire potential range of motion. The results of these tests will be used to determine the rotor angular (and axial) position from the sensor readings once the new flywheel unit is assembled.

The sensorless algorithm mentioned above consists of two operations: the signal injection method and the back electro-motive force (EMF). The signal injection is meant to work at low speeds, while the back EMF algorithm is meant to work at higher speeds. Both work together to determine the correct estimate of rotor position and speed based on the measured motor/generator current. It was determined that we wanted to know exactly how accurate our estimation methods were, and so a resolver (a commercially available mechanical sensor mounted to the motor/generator shaft to measure rotor position and speed) and a "Resolver to Digital" (R2D) circuit board was purchased to make the comparison to the existing estimation. My work related to the R2D board has included the following: creating two connector cables (one to power the circuit and one to get readable output off the board), writing Simulink code to process the board's output, and building a dSpace panel to control and monitor the circuit. The next step in the process will be to perform tests to compare the estimated rotor position and speed from the sensorless algorithm to the actual rotor and speed from the resolver signal.

# **Nickel-Hydrogen and Lithium Ion Space Batteries**

**Robert O. Reid, II**

University of Detroit Mercy

Mechanical Engineering

Undergraduate, Rising Freshman

**Mentors: Thomas B. Miller**

**Concha L. Reid-Callwood**

## **Abstract**

The tasks of the Electrochemistry Branch of NASA Glenn Research Center are to improve and develop high energy density and rechargeable, life-long batteries. It is with these batteries that people across the globe are able to power their cell phones, laptop computers, and cameras. Here, at NASA Glenn Research Center, the engineers and scientists of the Electrochemistry branch are leading the way in the development of more powerful, long life batteries that can be used to power space shuttles and satellites.

As of now, the cutting edge research and development is being done on nickel-hydrogen batteries and lithium ion batteries. Presently, nickel-hydrogen batteries are common types of batteries that are used to power satellites, space stations, and space shuttles, while lithium batteries are mainly used to power smaller appliances such as portable computers and phones. However, the Electrochemistry Branch at NASA Glenn Research Center is focusing more on the development of lithium ion batteries for deep space use. Because of the limitless possibilities, lithium ion batteries can revolutionize the space industry for the better.

When compared to nickel-hydrogen batteries, lithium ion batteries possess more advantages than its counterpart. Lithium ion batteries are much smaller than nickel-hydrogen batteries and also put out more power. They are more energy efficient and operate with much more power at a reduced weight than its counterpart. Lithium ion cells are also cheaper to make, possess flexibility that allow for different design modifications. With those statistics in hand, the Electrochemistry Branch of NASA Glenn has decided to shut down its Nickel-Hydrogen testing for lithium ion battery development. Also, the blackout in the summer of 2003 eliminated vital test data, which played a part in shutting down the program.

Therefore, during my tenure, it is my responsibility to take down final test data from the nickel-hydrogen batteries and compare it to past data. My other responsibilities include superheating the electrolyte that is used in the nickel-hydrogen cell in a calorimeter to test its performance under various conditions. I used a program called Arbin to study my data. The Arbin allows me to look at different parameters such as pressure and time and how they affect the changing temperature of the electrolyte that is being tested. In addition, I had the responsibility of taking apart and modifying battery coolers that would be used. My mentors told me that the batteries kept shutting down, so it was my responsibility to remove excess fan grilles, rotate the fans, and then switch the aluminum standoffs with nylon ones so that the coolers could operate without problems. My last task is to collect all the battery test data and organize them into charts using Microsoft Excel, before the Branch is able to conduct its research on lithium ion batteries.

# **Thermal Energy Conversion Branch**

**Matthew C. Bielozer**  
The Ohio State University  
Mechanical Engineering  
Senior

**Mentor: Jeffrey G. Schreiber  
& Scott D. Wilson**

## **ABSTRACT**

The Thermal Energy Conversion Branch (5490) leads the way in designing, conducting, and implementing research for the newest thermal systems used in space applications at the NASA Glenn Research Center. Specifically some of the most advanced technologies developed in this branch can be broken down into four main areas: Dynamic Power Systems, Primary Solar Concentrators, Secondary Solar Concentrators, and Thermal Management. Work was performed in the Dynamic Power Systems area, specifically the Stirling Engine subdivision. Today, the main focus of the 5490 branch is free-piston Stirling cycle converters, Brayton cycle nuclear reactors, and heat rejection systems for long duration mission spacecraft.

All space exploring devices need electricity to operate. In most space applications, heat energy from radioisotopes is converted to electrical power. The Radioisotope Thermoelectric Generator (RTG) already supplies electricity for missions such as the Cassini Spacecraft. The focus of today's Stirling research at GRC is aimed at creating an engine that can replace the RTG. The primary appeal of the Stirling engine is its high system efficiency. Because it is so efficient, the Stirling engine will significantly reduce the plutonium fuel mission requirements compared to the RTG. Stirling is also be considered for missions such as the lunar/Mars bases and rovers

This project has focused largely on Stirling Engines of all types, particularly the fluidyne liquid piston engine. The fluidyne was developed by Colin D. West. This engine uses the same concepts found in any type of Stirling engine, with the exception of missing mechanical components. All the working components are fluid. One goal was to develop and demonstrate a working Stirling Fluidyne Engine at the 2<sup>nd</sup> Annual International Energy Conversion Engineering Conference in Providence, Rhode Island.

# **OPTICAL TWEEZER ASSEMBLY AND CALIBRATION**

**Timothy M. Collins**  
University of Central Oklahoma  
Engineering Physics  
Senior

**Mentor: Susan Y. Wrbanek**

## **ABSTRACT**

An Optical Tweezer, as the name implies, is a useful tool for precision manipulation of micro and nano scale objects. Using the principle of electromagnetic radiation pressure, an optical tweezer employs a tightly focused laser beam to trap and position objects of various shapes and sizes. These devices can trap micrometer and nanometer sized objects. An exciting possibility for optical tweezers is its future potential to manipulate and assemble micro and nano sized sensors. A typical optical tweezer makes use of the following components: laser, mirrors, lenses, a high quality microscope, stage, Charge Coupled Device (CCD) camera, TV monitor and Position Sensitive Detectors (PSD's). The laser wavelength employed is typically in the visible or infrared spectrum. The laser beam is directed via mirrors and lenses into the microscope. It is then tightly focused by a high magnification, high numerical aperture microscope objective into the sample slide, which is mounted on a translating stage. The sample slide contains a sealed, small volume of fluid that the objects are suspended in. The most common objects trapped by optical tweezers are dielectric spheres. When trapped, a sphere will literally "snap" into and center itself in the laser beam. The PSD's are mounted in such a way to receive the backscatter after the beam has passed through the trap. PSD's used with the Differential Interference Contrast (DIC) technique provide highly precise data.

Most optical tweezers employ lasers with power levels ranging from 10 to 100 miliwatts. Typical forces exerted on trapped objects are in the pico-newton range. When PSD's are employed, object movement can be resolved on a nanometer scale in a time range of milliseconds. Such accuracy, however, can only be utilized by calibrating the optical tweezer. Fortunately, an optical tweezer can be modeled accurately as a simple spring. This allows Hook's Law to be used.

My goal this summer at NASA Glenn Research Center is the assembly and calibration of an optical tweezer setup in the Instrumentation and Controls Division (5520). I am utilizing a custom LabVIEW Virtual Instrument program for data collection and microscope stage control. Helping me in my assignment are the following people: Mentor Susan Wrbanek (5520), Dr. Baha Jassemnejad (UCO) and Technicians Ken Weiland (7650) and James Williams (7650). Without their help, my task would not be possible.

# **Parametric Studies of Flow Separation using Air Injection**

**Wei Zhang**

Georgia Institute of Technology  
Aerospace Engineering  
Graduate: Master Degree Candidate

**Mentor: Dennis E. Culley**

## **Abstract**

Boundary Layer separation causes the airfoil to stall and therefore imposes dramatic performance degradation on the airfoil. In recent years, flow separation control has been one of the active research areas in the field of aerodynamics due to its promising performance improvements on the lifting device. These active flow separation control techniques include steady and unsteady air injection as well as suction on the airfoil surface etc. This paper will be focusing on the steady and unsteady air injection on the airfoil. Although wind tunnel experiments revealed that the performance improvements on the airfoil using injection techniques, the details of how the key variables such as air injection slot geometry and air injection angle etc impact the effectiveness of flow separation control via air injection has not been studied.

A parametric study of both steady and unsteady air injection active flow control will be the main objective for this summer. For steady injection, the key variables include the slot geometry, orientation, spacing, air injection velocity as well as the injection angle. For unsteady injection, the injection frequency will also be investigated. Key metrics such as lift coefficient, drag coefficient, total pressure loss and total injection mass will be used to measure the effectiveness of the control technique. A design of experiments using the Box-Behnken Design is set up in order to determine how each of the variables affects each of the key metrics. Design of experiment is used so that the number of experimental runs will be at minimum and still be able to predict which variables are the key contributors to the responses. The experiments will then be conducted in the 1 ft by 1 ft wind tunnel according to the design of experiment settings. The data obtained from the experiments will be imported into JMP, statistical software, to generate sets of response surface equations which represent the statistical empirical model for each of the metrics as a function of the key variables. Next, the variables such as the slot geometry can be optimized using the build-in optimizer within JMP. Finally, a wind tunnel testing will be conducted using the optimized slot geometry and other key variables to verify the empirical statistical model.

The long term goal for this effort is to assess the impacts of active flow control using air injection at system level as one of the task plan included in the NASA's URETI program with Georgia Institute of Technology.

# THE DIRECT DIGITAL MODULATION OF TRAVELING WAVE TUBES

**Ranjan S. Radhamohan**

University of Michigan

Electrical Engineering

Undergraduate, Junior

**Mentor: Dale A. Force**

## ABSTRACT

Traveling wave tube (TWT) technology, first described by Rudolf Kompfner in the early 1940s, has been a key component of space missions from the earliest communication satellites in the 1960s to the Cassini probe today. TWTs are essentially signal amplifiers that have the special capability of operating at microwave frequencies. The microwave frequency range, which spans from approximately 500 MHz to 300 GHz, is shared by many technologies including cellular phones, satellite television, space communication, and radar. TWT devices are superior in reliability, weight, and efficiency to solid-state amplifiers at the high power and frequency levels required for most space missions.

TWTs have three main components –an electron gun, slow wave structure, and collector. The electron gun generates an electron beam that moves along the length of the tube axis, inside of the slow wave circuit. At the same time, the inputted signal is slowed by its travel through the coils of the helical slow wave circuit. The interaction of the electron beam and this slowed signal produces a transfer of kinetic energy to the signal, and in turn, amplification. At the end of its travel, the spent electron beam moves into the collector where its remaining energy is dissipated as heat or harnessed for reuse. TWTs can easily produce gains in the tens of decibels, numbers that are suitable for space missions.

To date, however, TWTs have typically operated at fixed levels of gain. This gain is determined by various, unchanging, physical factors of the tube. Traditionally, to achieve varying gain, an input signal's amplitude has had to first be modulated by a separate device before being fed into the TWT. This is not always desirable, as significant distortion can occur in certain situations. My mentor, Mr. Dale Force, has proposed an innovative solution to this problem called 'direct digital modulation'. The testing and implementation of this solution is the focus of my summer internship.

The direct digital modulation of a TWT removes the need for a separate amplitude modulation device. Instead, different levels of gain are achieved by varying the electron beam current. The lower the current, the less kinetic energy is available to be transferred to the signal. To vary the current, a grid is placed in-between the electron gun and the slow wave circuit. By changing the voltage across the grid, the electron beam current can be controlled. Grid technology has mostly been used in pulse applications such as radar, where only two voltage states are necessary. For direct digital modulation, however, a continuous range of voltages is required.

Our current task is to enhance an existing TWT so that it produces varying electron beam current, and also to add certain features that reverse the small side-effects of this operation.

Vanessa A. Varaljay  
Cleveland State University  
Biology  
Undergraduate, Junior

Mentor: Maximilian C. Scardelletti

## A Novel Biomedical Device Utilizing Light Emitting Nano-Structures

### ABSTRACT

This paper will discuss the development of a novel biomedical detection device that will be used to detect microorganisms with the use of infrared fluorochrome polymers attached to antibodies in fluids such as water. The fluorochrome polymers emit light in the near infrared region (NIR), approximately 805 nm, when excited by an NIR laser at 778 nm.

The device could remarkably change the way laboratory testing is done today. The testing process is usually performed on a time scale of days while our device will be able to detect microorganisms in minutes. This type of time efficient analysis is ideal for use aboard the International Space Station and the Space Shuttle (ISS/SS) and has many useful commercial applications, for instance at a water treatment plant and food processing plants. With more research and experimentation the testing might also one day be used to detect bacteria and viruses in complex fluids such as blood, which would revolutionize blood analysis as it is performed today.

My contribution to the project has been to develop a process which will allow an antibody/fluorescent dye pair to be conjugated to a specific bacteria or virus and then to be separated from a sample body of water for detection. The antibody being used in this experiment is anti beta galactosidase and its complement enzyme is beta galactosidase, a non harmful derivative of E. Coli. The anti beta galactosidase has been conjugated to the fluorochrome polymer, IRDye800, which emits at approximately 806 nm. The dye when excited by the NIR laser emits a signal which is detected by a spectrometer and then is read by state of the art computer software.

The state-of-the-art process includes incubating the anti beta galactosidase and beta galactosidase in a phosphate buffer solution in a test tube, allowing the antibody to bind to specific sites on the enzyme. After the antibody is bound to the enzyme, it is centrifuged in specific filters that will allow free antibody to wash away and leave the antibody-enzyme complexes on top in solution for testing and analysis. This solution is pipetted into a cuvette, a special plastic test tube, which will then be excited by the laser. The signal read will tell us that an antibody is present and since it is bound to the enzyme, that the bacteria is also present.

# Modeling of a Variable Focal Length Flat Lens Using Left Handed Metamaterials

**Jason Reinert**

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Senior

**Mentor: Jeffrey D. Wilson**

## ABSTRACT

Left Handed Metamaterials (LHM) were originally purposed by Victor Veselago in 1968. These substances would allow a flat structure to focus electromagnetic (EM) waves because they have a negative index of refraction. A similar structure made from conventional materials, those with a positive index of refraction, would disperse the waves. But until recently, these structures have been purely theoretical because substances with both a negative permittivity and negative permeability, material properties necessary for a negative index of refraction, do not naturally exist. Recent developments have produced a structure composed of an array of thin wires and split ring resonators that shows a negative index of refraction.

Traditional lenses made from conventional materials cannot focus an EM wave onto an area smaller than a square wavelength. How small the area is can be determined by how perfectly the lens is polished and how pure the substance is that composes the lens. These lenses must also be curved for focusing to occur. The focal length is determined by the curvature of the lens and the material. On the other hand, a flat structure made from LHM would focus light because of the effect of a negative index of refraction in Snell's law. The focal length could also be varied by simply adjusting the distance of the lens from the source of radiation. This could create many devices that are adjustable to different situations in fields such as biomedical imaging and communication.

My goal was to model LHMs and create a flat lens from them. This was to be done using the software package XFDTD which solves Maxwell's equations in the frequency domain as well as the time domain. The program used Drude models of materials to simulate the effect of negative permittivity and negative permeability. Because of this, a LHM can be simulated as a solid block of material instead of an array of wires and split ring resonators. After a flat lens is formed, I am to examine the focusing effect of the lens and determine if a higher resolution flat lens can be developed.

# **TRAVELING WAVE TUBE (TWT) RF POWER COMBINING DEMONSTRATION FOR USE IN THE JUPITER ICY MOONS ORBITER (JIMO)**

**Joseph A. Downey**  
The University of Toledo  
Electrical Engineering  
Undergraduate, Freshman  
**Edwin G. Wintucky**

## **ABSTRACT**

The Jupiter Icy Moons Orbiter (JIMO) is set to launch between the years 2012 and 2015. It will possibly utilize a nuclear reactor power source and ion engines as it travels to the moons of Jupiter. The nuclear reactor will produce hundreds of kilowatts of power for propulsion, communication and various scientific instruments. Hence, the RF amplification devices aboard will be able to operate at a higher power level and data rate. The initial plan for the communications system is for an output of 1000 watts of RF power, a data rate of at least 10 megabits a second, and a frequency of 32 GHz. A higher data rate would be ideal to fully utilize the instruments aboard JIMO.

At NASA Glenn, one of our roles in the JIMO project is to demonstrate RF power combining using multiple traveling wave tubes (TWT). In order for the power of separate TWT's to be combined, the RF output waves from each must be in-phase and have the same amplitude. Since different tubes act differently, we had to characterize each tube using a Network Analyzer. We took frequency sweeps and power sweeps to characterize each tube to ensure that they will behave similarly under the same conditions. The 200 watt Dornier tubes had been optimized to run at a lower power level (120 watts) for their extensive use in the ACTS program, so we also had to experiment with adjusting the voltage settings on several internal components (helix, anode, collector) of the tubes to reach the full 200 watt potential.

The process began with two 100 watt tubes, a Varian and a Logimetrics, salvaged from the ACTS program. Phase shifters and power attenuators were placed in the waveguide circuit at the inputs to the tubes so that adjustments could be made individually to match them exactly. A magic tee was used to route and combine the amplified electromagnetic RF waves on the tube output side. The demonstration of 200 watts of combined power was successful with efficiencies greater than 90% over a 500 MHz bandwidth. The next step will be to demonstrate the use of three amplifiers using two magic tees by adding a 200 watt Dornier tube to the Varian and Logimetrics combined setup for a total of 400 watts. After that we will use two 200 watt Dorniers for 400 watts and eventually four 200 watt Dornier tubes to demonstrate 800 watts.

After demonstrating the success of power combining, we will need to verify the integrity of a modulated signal sent through the combined tubes. The purpose will be to see what effects separating and recombining will have on the modulated signal and also what effect it will have on combining efficiency. A Bit Error Rate (BER) will be determined by a Bit Error Rate Tester (BERT) by comparing the random information it transmits to what it receives back.

# Statistical and Prediction modeling of the Ka Band Using Experimental Results from ACTS Propagation Terminals at 20.185 and 27.505 GHz

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**Masters Candidate**

Mentor: Dr. Roberto J. Acosta

## ABSTRACT

With the increase in demand for wireless communication services, most of the operating frequency bands have become very congested. The increase of wireless costumers is only fractional contribution to this phenomenon. The demand for more services such as video streams and internet explorer which require a lot of band width has been a more significant contributor to the congestion in a communication system. One way to increase the amount of information or data per unit of time transmitted with in a wireless communication system is to use a higher radio frequency. However in spite the advantage available in the using higher frequency bands such as, the Ka-band, higher frequencies also implies short wavelengths. And shorter wavelengths are more susceptible to rain attenuation.

Until the Advanced Communication Technology Satellite (ACTS) was launched, the Ka-band frequency was virtually unused - the majority of communication satellites operated in lower frequency bands called the C- and Ku- bands. Ka-band is desirable because its higher frequency allows wide bandwidth applications, smaller spacecraft and ground terminal components, and stronger signal strength. Since the Ka-band is a high frequency band, the millimeter wavelengths of the signals are easily degraded by rain. This problem known as rain fade or rain attenuation The Advanced Communication Technology Satellite (ACTS) propagation experiment has collected 5 years of Radio Frequency (RF) attenuation data from December 1993 to November 1997.

The objective of my summer work is to help develop the statistics and prediction techniques that will help to better characterize the Ka Frequency band. The statistical analysis consists of seasonal and cumulative five-year attenuation statistics for the 20.2 and 27.5 GHz. The cumulative five-year results give the link outage that occurs for a given link margin. The experiment has seven ground station terminals that can be attributed to a unique rain zone climate. The locations are White Sands, NM, Tampa, FL, Clarksburg, MD, Norman, OK, Ft. Collins, CO, Vancouver, BC, and Fairbanks, AK. The analysis will help us to develop and define specific parameters that will help system engineers develop the appropriated instrumentation and structure for a Ka-band wireless communication systems and networks.

# **Analysis of Droplet Size during the Ice Accumulation Phase Of Flight Testing**

**Eric James Miller**  
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Aerospace Engineering  
Undergraduate, Sophomore  
**Mentor: Sam Lee**

## **Abstract**

There are numerous hazards associated with air travel. One of the most serious dangers to the pilot and passengers' safety is the result of flying into conditions which are conducive to the formation of ice on the surface of an aircraft. Being a pilot myself I am very aware of the dangers that icing can pose and the effects it can have on an airplane. A couple of the missions of the Icing branch is to make flying safer with more research to increase our knowledge of how ice effects the aerodynamics of an airfoil, and to increase are knowledge of the weather for better forecasting.

The Icing Branch uses three different tools to determine the aerodynamic affects that icing has on a wing. The Icing research tunnel is an efficient way to test various airfoils in a controlled setting. To make sure the data received from the wind tunnel is accurate the Icing branch conducts real flight tests with the DHC-6 Twin Otter. This makes sure that the methods used in the wind tunnel accurately model what happens on the actual aircraft. These two tools are also compared to the LEWICE code which is a program that models the ice shape that would be formed on an airfoil in the particular weather conditions that are input by the user. One benefit of LEWICE is that it is a lot cheaper to run than the wind tunnel or flight tests which make it a nice tool for engineers designing aircraft that don't have the money to spend on icing research. Using all three of these tools is a way to cross check the data received from one and check it against the other two.

The information gathered from these tests is not just used in the aircraft industries, but it is also looked at by weather analysts who are trying to improve forecasting methods. The best way to avoid the troubles of icing encounters is to not go into it in the first place. By looking over the flight data the analyst can determine which conditions will most likely lead to an icing encounter and then this information will aid forecasters when briefing the pilots on the weather conditions.

The project that I am working on will have an effect on the projects just talked about. I am looking at the weather data from certain flights and analyzing the type of precipitation that the plane is flying through. During flight tests there is a probe on the bottom of the aircraft that gathers information on the size and shape of the particles that it is flying through. The data can then be viewed on a computer. After grouping the weather into certain groups we can then pick certain groups which we think should be analyzed farther. The goal is to remove all the ice particles because they do not contribute to the icing on an aircraft. We use a 2D analyzer which measures the droplet size and categorizes the drops into bins of certain sizes. We can then look at what the characteristics of the weather that we were flying through such as the temperature and dew point and compare this with the size of the drops that the 2D analyzer measured. We can then look at what type and shape of ice that formed on the wing during this time period. Having this data will help us to reproduce these conditions using LEWICE and the wind tunnel. Having consistency among the tests will make things more accurate. With respect to weather forecasting we will be able to learn which conditions can lead to icing. Better accuracy in weather reporting will lead to fewer run-ins with icing which will also lead to fewer accidents.

# **Graphical User Interface Development for Representing Air Flow Patterns**

**Nilika Chaudhary**

Massachusetts Institute of Technology

Engineering (Undecided)

Undergraduate, Sophomore

**Mentor: David Ashpis**

## **ABSTRACT**

In the Turbine Branch, scientists carry out experimental and computational work to advance the efficiency and diminish the noise production of jet engine turbines. One way to do this is by decreasing the heat that the turbine blades receive. Most of the experimental work is carried out by taking a single turbine blade and analyzing the air flow patterns around it, because this data indicates the sections of the turbine blade that are getting too hot. Since the cost of doing turbine blade air flow experiments is very high, researchers try to do computational work that fits the experimental data. The goal of computational fluid dynamics is for scientists to find a numerical way to predict the complex flow patterns around different turbine blades without physically having to perform tests or costly experiments.

When visualizing flow patterns, scientists need a way to represent the flow conditions around a turbine blade. A researcher will assign specific zones that surround the turbine blade. In a two-dimensional view, the zones are usually quadrilaterals. The next step is to assign boundary conditions which define how the flow enters or exits one side of a zone.

Researchers such as my mentor, Dr. David Ashpis, need a quick, user-friendly way of setting up computational zones and grids, visualizing flow patterns, and storing all the flow conditions in a file on the computer for future computation. Such a program is necessary because the only method for creating flow pattern graphs is by hand, which is tedious and time-consuming. By using a computer program to create the zones and grids, the graph would be faster to make and easier to edit. Basically, the user would run a program that is an editable graph. The user could click and drag with the mouse to form various zones and grids, then edit the locations of these grids, add flow and boundary conditions, and finally save the graph for future use and analysis.

My goal this summer is to create a graphical user interface (GUI) that incorporates all of these elements. I am writing the program in Java, a language that is portable among platforms, because it can run on different operating systems such as Windows and Unix without having to be rewritten. I had no prior experience of programming in Java at the start of my internship; I am continuously learning as I create the program. I have written the part of the program that enables a user to draw several zones, edit them, and store their locations. The next phase of my project is to allow the user to click on the side of a zone and create a boundary condition for it. A previous intern wrote a program that allows the user to input boundary conditions. I can integrate the two programs to create a larger, more usable program. After that, I will develop a way for the user to save the graph for future reference. Another eventual goal is to make the GUI capable of creating three-dimensional zones as well.

# **Glenn Heat Transfer Simulation and Solver Graphical User Interface: Development and Testing**

**Joseph R. Kardamis**  
Rochester Institute of Technology  
Computer Science  
Junior

**Mentor: Barbara L. Lucci**

## **ABSTRACT**

In the Turbine Branch of the Turbomachinery and Propulsion Systems Division, researching and developing efficient turbine aerothermodynamics technologies is the main objective. Creating effective turbines for jet engines is a process which, if based purely on physical experimental testing, would be extremely expensive. It is for this reason, and also for the reasons of speed and ease, that the Turbine Branch spends a large amount of effort working with simulations of turbines. Specifically, they focus their work on two main fields: Computational Field Dynamics (CFD), and Experimental data analysis. The experimental field involves comparing experimental results to simulated results, whereas the CFD field involves running these simulations. The simulations are applied to aerodynamics and heat transfer cases, for both steady and unsteady flow conditions. By and large this work is applied to the domain of flow and heat transfer in axial turbines.

The main application used to run these heat flow simulations is GlennHT. This program, recently rewritten in FORTRAN 90, allows the user to input a job file which specifies all the necessary parameters needed to simulate flow through a user-defined grid. There are several other executables used as well, ranging in application from converting grid files to and from particular formats, to merging blocks in a connectivity file, to converting connectivity files to a GlennHT compatible format. All of these executables are run from the command line in a terminal; some of them have interactive prompts where the user must specify the files to be manipulated after the program starts, while others take all of their parameters from the command line. With this amount of variation comes a good deal of commands and formats to memorize, which can cause slower and less efficient work, as users may forget how to execute a certain program, or not remember the pathnames of the files they wish to use.

Two years ago, steps were made to expedite this process with a graphical user interface (GUI) that combines the functionality of all the executables along with adding some new functionality, such as residuals graphing and boundary conditions creation. Upon my beginning here at Glenn, many parts of the GUI, which was developed in Java, were nonfunctional. There were also issues with cross-platforming, as systems in the branch were transitioning from Silicon Graphics (SGI) machines to Linux machines. My goals this summer are to finish the parts of the GUI that are not yet completed, fix parts that did not work correctly, expand the functionality to include other useful features, such as grid surface highlighting, and make the system compatible with both Linux and SGI. I will also be heavily testing the system and providing sufficient documentation on how to use the GUI, as no such documentation existed previously.

# **Air Separation Using Hollow Fiber Membranes**

Stephen E. Huang  
California Polytechnic State University San Luis Obispo  
Environmental Engineering  
Undergraduate Senior  
Mentor: Dr. Clarence T. Chang

## **ABSTRACT**

The NASA Glenn Research Center in partnership with the Ohio Aerospace Institute provides internship programs for high school and college students in the areas of science, engineering, professional administrative, and other technical areas. During the summer of 2004, I worked with Dr. Clarence T. Chang at NASA Glenn Research Center's combustion branch on air separation using hollow fiber membrane technology.

In light of the accident of Trans World Airline's flight 800, FAA has mandated that a suitable solution be created to prevent the ignition of fuel tanks in aircrafts. In order for any type of fuel to ignite, three important things are needed: fuel vapor, oxygen, and an energy source. Two different ways to make fuel tanks less likely to ignite are reformulating the fuel to obtain a lower vapor pressure for the fuel and or using an On Board Inert Gas Generating System (OBIGGS) to inert the Central Wing Tank.

The United States military currently uses air separation technology and their primary goal is to accomplish the mission, which means that the Air Separation Module (ASM) tends to be bulky and heavy. The primary goal for commercial aviation companies is to transport as much as they can with the least amount of cost and fuel per person, therefore the ASM must be compact and light as possible.

The plan is to take bleed air from the aircraft's engines to pass air through a filter first to remove particulates and then pass the air through the ASM containing hollow fiber membranes. In the lab, there will be a heating element provided to simulate the temperature of the bleed air that will be entering the ASM and analysis of the separated air will be analyzed by a Gas Chromatograph/Mass Spectrometer (GC/MS). The GC/MS will separate the different compounds in the exit streams of the ASM and provide information on the performance of hollow fiber membranes. Hopefully I can develop ways to improve efficiency of the ASM.

The other side of making air travel safer is to reformulate the fuel. Analyses of three different types of jet fuel were analyzed and data was well represented on SAE Paper 982485. Data consisted of the concentrations of over 300 different hydrocarbons commonly found in JP-8, Jet A, and JP-5 fuels. I researched the major hydrocarbons that has a concentration of greater than 50 parts per million and found the vapor pressure data coefficients for a specific temperature range. The coefficients were applied to Antoine's Equation and Riedel's Equation to calculate the vapor pressures for that specific hydrocarbon in the specific temperature range. With the vapor pressure data scientists can formulate a fuel composition that has a lower vapor pressure profile, therefore making jet fuels less flammable.

My goal this summer is to learn about hollow fiber membrane technologies and how they work, learn how to operate and examine the data from Gas Chromatograph and Mass Spectrometer, and develop new ways in applying hollow fiber membrane technology to other areas of environmental engineering.

## **“We Burn to Learn” About Fuel-Air Mixing Within Aircraft Powerplants**

**Heidi N. Robinson**  
The University of Akron  
Applied Mathematics  
Graduate Student  
**Mentor: Yolanda R. Hicks, Ph.D.**

### **ABSTRACT**

I am working with my branch's advanced diagnostics team to investigate fuel-air mixing in jet-fueled gas turbine combustors and jet-fuel reformers. Our data acquisition begins with bench-top experiments which will help with calibration of equipment for facility testing. While conducting the bench-top experiments I learned to align laser and optical equipment to collect data, to use the data acquisition software, and to process the data into graphs and images.

Thanks to the Low Emissions Alternate Propulsion project, we have a new facility in which jet fuel is to be reformed into hydrogen. Testing will commence shortly, after which we will obtain and analyze data and meet a critical milestone for the end of September.

I am also designing the layout for a Schlieren system that will be used during that time frame. A Schlieren instrument records changes in the refractive index distribution of transparent media like air flows. The refractive index distribution can then be related to density, temperature, or pressure distributions within the flow. I am working on a scheme to quantify this information and add to the knowledge of the fuel-air mixing process.

# **Bubble Combustion**

**Jackie Corrigan**

Mechanical Engineering, Sophomore  
University of Dayton

**Mentor: Dr. Quang-Viet Nguyen (Combustion Branch / 5830)**

## **ABSTRACT**

A method of energy production that is capable of low pollutant emissions is fundamental to one of the four pillars of NASA's Aeronautics Blueprint: Revolutionary Vehicles. Bubble combustion, a new engine technology currently being developed at Glenn Research Center promises to provide low emissions combustion in support of NASA's vision under the Emissions Element because it generates power, while minimizing the production of carbon dioxide ( $\text{CO}_2$ ) and nitrous oxides ( $\text{NO}_x$ ), both known to be Greenhouse gases.

Bubble combustion is a simple process that has no moving parts (increased reliability) and allows the use of alternative fuels such as corn oil, low-grade fuels, and even used motor oil. Bubble combustion is analogous to the inverse of spray combustion: the difference between bubble and spray combustion is that spray combustion is spraying a liquid in to a gas to form droplets, whereas bubble combustion involves injecting a gas into a liquid to form gaseous bubbles. In bubble combustion, the process for the ignition of the bubbles takes place on a time scale of less than a nanosecond and begins with acoustic waves perturbing each bubble. This perturbation causes the local pressure to drop below the vapor pressure of the liquid thus producing cavitation in which the bubble diameter grows, and upon reversal of the oscillating pressure field, the bubble then collapses rapidly with the aid of the high surface tension forces acting on the wall of the bubble. The rapid and violent collapse causes the temperatures inside the bubbles to soar as a result of adiabatic heating. As the temperatures rise, the gaseous contents of the bubble ignite with the bubble itself serving as its own combustion chamber. After ignition, this is the time in the bubble's life cycle where power is generated, and  $\text{CO}_2$ , and  $\text{NO}_x$  among other species, are produced. However, the pollutants  $\text{CO}_2$  and  $\text{NO}_x$  are absorbed into the surrounding liquid. The importance of bubble combustion is that it generates power using a simple and compact device.

We conducted a parametric study using CAVCHEM, a computational model developed at Glenn, that simulates the cavitation collapse of a single bubble in a liquid (water) and the subsequent combustion of the gaseous contents inside the bubble. The model solves the time-dependent, compressible Navier-Stokes equations in one-dimension with finite-rate chemical kinetics using the CHEMKIN package. Specifically, parameters such as frequency, pressure, bubble radius, and the equivalence ratio were varied while examining their effect on the maximum temperature, radius, and chemical species. These studies indicate that the radius of the bubble is perhaps the most critical parameter governing bubble combustion dynamics and its efficiency. Based on the results of the parametric studies, we plan on conducting experiments to study the effect of ultrasonic perturbations on the bubble generation process with respect to the bubble radius and size distribution.

# BATTERY RESISTANCE ANALYSIS OF ISS POWER SYSTEM

**Gregory E. Newstadt**  
Miami University of Ohio  
Electrical Engineering, Physics  
Undergraduate, Junior  
**Mentor: Ann Delleur, Dave McKissock**

## ABSTRACT

The computer package, SPACE (Systems Power Analysis for Capability Evaluation) was created by the members of LT-9D to perform power analysis and modeling of the electrical power system on the International Space Station (ISS). Written in FORTRAN, SPACE comprises thousands of lines of code and has been used proficiently in analyzing missions to the ISS. LT-9D has also used its expertise recently to investigate the batteries onboard the Hubble telescope. During the summer of 2004, I worked with the members of LT-9D, under the care of Dave McKissock.

Solar energy will power the ISS through eight solar arrays when the ISS is completed, although only two arrays are currently connected. During the majority of the periods of sunlight, the solar arrays provide enough energy for the ISS. However, rechargeable Nickel-Hydrogen batteries are used during eclipse periods or at other times when the solar arrays cannot be used (at docking for example, when the arrays are turned so that they will not be damaged by the Shuttle). Thirty-eight battery cells are connected in series, which make up an ORU (Orbital Replacement Unit). An ISS "battery" is composed of two ORUs.

The ISS batteries have been found to be very difficult to model, and LT-9D has dedicated a great deal of time into finding the best way to represent them in SPACE. During my internship, I investigated the resistance of the ISS batteries.

SPACE constructs plots of battery charge and discharge voltages vs. time using a constant current. To accommodate for a time-varying current, the voltages are adjusted using the formula,  $\Delta V = \Delta I * \text{Cell Resistance}$ . To enhance our model of the battery resistance, my research concentrated on several topics: investigating the resistance of a qualification unit battery (using data gathered by LORAL), comparing the resistance of the qualification unit to SPACE, looking at the internal resistance and wiring resistance, and examining the impact of possible recommended changes to SPACE.

My analysis of the qualification unit battery testing (called QM-00) showed that the model for resistance that SPACE and Loral had been using does not apply well to the actual battery resistance as it changes with age. A possible change to accommodate for a more accurate prediction of the change in resistance with age was recommended for inspection. Also, the QM-00 data showed that the resistance during charge periods was consistently greater than the resistance during discharge periods, although this may be due to how the sensors function with current flow. Inspecting the internal resistance and wiring resistance showed that SPACE has been using an overly pessimistic value near 20 mOhms. However, the QM-00 data, along with on-orbit data indicates that this value should be nearer to 3 mOhms. A possible change to accommodate for this smaller internal and wiring resistance was also recommended for inspection. A local version of SPACE that contains these changes was run to test the system impact of the changes. It showed that for an analysis of the current batteries on the ISS, the total resistance was lowered, allowing the batteries to use less voltage during discharge periods and to charge more easily during charge periods.

# **Research Symposium II**

## **Ohio Aerospace Institute**

### **Thursday, August 5, 2004**

#### **OAI Federal Room**

**9:00 A.M. Jessica Fedor, University of Notre Dame, Junior**

**"Metal Foam Analysis: Improving Sandwich Structure Technology for Engine Fan and Propeller Blades"**

5920/Bradley Lerch, Life Prediction Branch

**9:15 Charlene Dvoracek, Rose-Hulman Institute of Technology, Sophomore**

**"Characterization of Composite Fan Case Resins"**

5930/Cheryl Bowman, Structural Mechanics and Dynamics Branch

**9:30 Patrick Kenny, Ohio State University, Freshman**

**"Jet Noise Reduction"**

5940/Clifford Brown, Acoustics Branch

**9:45 Joshua France, University of Cincinnati, Sophomore**

**"Fan Noise Prediction"**

5940/Edmane Envia, Acoustics Branch

**10:00 Timothy Unton, Embry-Riddle Aero University, Freshman**

**"Improving Rotor-Stator Interaction Noise Code Through Analysis of Input Parameters"**

5940/Edmane Envia, Acoustics Branch

**10:15 Marta Bastrzyk, Illinois Institute of Technology, Junior**

**"Solid Oxide Fuel Cells Seals Leakage Setup and Testing"**

5950/Christopher Daniels, Mechanical Components Branch

**10:30 Vivake Asnani, Ohio State University, Masters**

**"Experimentation Toward the Analysis of Gear Noise Sources Controlled by Sliding Friction and Surface Roughness"**

5950/Timothy Krantz, Mechanical Components Branch

**10:45 Christina Maldonado, University of Toledo, Freshman**

**"Determining the Thermal Properties of Space Lubricants"**

5950/Wilfredo Morales, Mechanical Components Branch

**11:00 LUNCH**

**1:00 Joshua Neville, Ohio University, PhD**

**"Wireless Channel Characterization in the Airport Surface Environment"**

6120/Israel Greenfeld, Project Development Branch

**1:15 Justine Casselle, Xavier University, Freshman**

**"Resource Management in the Microgravity Science Division"**

6701/Janice Gassaway, Business Management Office

**1:30 Heather Angel, Colorado School of Mines, Junior**

"Using Piezoelectric Ceramics for Dust Mitigation on Space Suits"

6712/Juan Agui, Microgravity Fluid Physics Branch

**1:45 Phi Hung X Thanh, Colorado School of Mines, Junior**

"Wave Propagation in 2-D Granular Matrix and Dust Mitigation of Fabrics for Space Exploration Mission"

6712/Juan Agui, Microgravity Fluid Physics Branch

**2:00 Chad Zivich, Case Western Reserve University, Senior**

"Microgravity Spray Cooling Research for High Powered Laser Applications"

6712/Eric Gollhofer, Microgravity Fluid Physics Branch

**2:15 Arati Deshpande, Ohio State University, Freshman**

"The Effects of Protein Regulators on the Vascular Remodeling of Japanese Quail Chorioallantoic Membrane"

6712/Patricia Parsons-Wingerter, Microgravity Fluid Physics Branch

**2:30 Lauren Makuch, Penn State University, Senior**

"Response of Mineralizing and Non-Mineralizing Bone Cells to Fluid Flow: an *In Vitro* Model for Mechanotransduction"

6712/Gregory Zimmerli, Microgravity Fluid Physics Branch

**2:45 Julie Holda, Ohio Northern University, Senior**

"Methodolgy for Evaluation of Technology Impacts in Space Electric Power Systems"

6920/Jose Davis, Analysis and Management Branch

**3:00 Tamarcus Jeffries, Tennessee State University, Junior**

"Motor/Generator and Inverter Characterization for Flywheel System Applications"

5450/Walter Santiago, Electrical Systems Development Branch

**3:15 Christopher Dorais, Nashville State Technical Community College, Sophomore**

"Dissemination of information about the technologies of the Vision Research Lab through the World Wide Web"

6712/Rafat Ansari, Microgravity Fluid Physics Branch

**3:30 ADJOURN**

# METAL FOAM ANALYSIS: IMPROVING SANDWICH STRUCTURE TECHNOLOGY FOR ENGINE FAN AND PROPELLER BLADES

**Jessica L. Fedor**  
University of Notre Dame  
Mechanical Engineering  
Undergraduate, Junior  
**Mentor: Bradley A. Lerch**

## ABSTRACT

The Life Prediction Branch of the NASA Glenn Research Center is searching for ways to construct aircraft and rotorcraft engine fan and propeller blades that are lighter and less costly. One possible design is to create a sandwich structure composed of two metal faces sheets and a metal foam core. The face sheets would carry the bending loads and the foam core would have to resist the transverse shear loads.

Metal foam is ideal because of its low density and energy absorption capabilities, making the structure lighter, yet still stiff. The material chosen for the face sheets and core was 17-4PH stainless steel, which is easy to make and has appealing mechanical properties. This material can be made inexpensively compared to titanium and polymer matrix composites, the two current fan blade alternatives.

Initial tests were performed on design models, including vibration and stress analysis. These tests revealed that the design is competitive with existing designs; however, some problems were apparent that must be addressed before it can be implemented in new technology. The foam did not hold up as well as expected under stress. This could be due to a number of issues, but was most likely a result of a large number of pores within the steel that weakened the structure. The brazing between the face sheets and the foam was also identified as a concern. The braze did not hold up well under shear stress causing the foam to break away from the face sheets.

My role in this project was to analyze different options for improving the design. I primarily spent my time examining various foam samples, created with different sintering conditions, to see which exhibited the most favorable characteristics for our purpose. Methods of analysis that I employed included examining strut integrity under a microscope, counting the number of cells per inch, measuring the density, testing the microhardness, and testing the strength under compression. Shear testing will also be done to examine the strengths of different types of brazes.

# CHARACTERIZATION OF COMPOSITE FAN CASE RESINS

**Charlene M. Dvoracek**  
Rose-Hulman Institute of Technology  
Mechanical Engineering  
Undergraduate, Sophomore  
**Mentors: Cheryl L. Bowman**  
**Gary D. Roberts**

## ABSTRACT

The majority of commercial turbine engines that power today's aircraft use a large fan driven by the engine core to generate thrust which dramatically increases the engine's efficiency. However, if one of these fan blades fails during flight, it becomes high energy shrapnel, potentially impacting the engine or puncturing the aircraft itself and thus risking the lives of passengers. To solve this problem, the fan case must be capable of containing a fan blade should it break off during flight. Currently, all commercial fan cases are made of either just a thick metal barrier or a thinner metal wall surrounded by Kevlar—an ultra strong fiber that elastically catches the blade. My summer 2004 project was to characterize the resins for a composite fan case that will be lighter and more efficient than the current metal.

The composite fan case is created by braiding carbon fibers and injecting a polymer resin into the braid. The resin holds the fibers together, so at first using the strongest polymer appears to logically lead to the strongest fan case. Unfortunately, the stronger polymers are too viscous when melted. This makes the manufacturing process more difficult because the polymer does not flow as freely through the braid, and the final product is less dense. With all of this in mind, it is important to remember that the strength of the polymer is still imperative; the case must still contain blades with high impact energy. The research identified which polymer had the right balance of properties, including ease of fabrication, toughness, and ability to transfer the load to the carbon fibers. Resin deformation was studied to better understand the composite response during high speed impact. My role in this research was the testing of polymers using dynamic mechanical analysis and tensile, compression, and torsion testing.

Dynamic mechanical analysis examines the response of materials under cyclic loading. Two techniques were used for dynamic mechanical analysis. The ARES Instrument analyzed the material through torsion. The second machine, TA Instruments' apparatus, applied a bending force to the specimen. These experiments were used to explore the effects of temperature and strain rate on the stiffness and strength of the resins. The two different types of loading allowed us to verify our results. An axial-torsional load frame, manufactured by MTS Systems, Inc., was used to conduct the tensile, compression, and torsional testing. These tests were used to determine the stress-strain curves for the resins. The elastic and plastic deformation data was provided to another team member for characterization of high fidelity material property predictions.

This information was useful in having a better understanding of the polymers so that the fan cases could be as sturdy as possible. Deformation studies are the foundation for the computational modeling that provides the structural design of a composite engine case as well as detailed analysis of the blade impact event.

## **Jet Noise Reduction**

**Patrick Kenny**  
Ohio State University  
Electrical Engineering  
Freshman  
**Mentor: Clifford Brown**

### **ABSTRACT**

The Acoustics Branch is responsible for reducing noise levels for jet and fan components on aircraft engines. To do this, data must be measured and calibrated accurately to ensure validity of test results. This noise reduction is accomplished by modifications to hardware such as jet nozzles, and by the use of other experimental hardware such as fluidic chevrons, elliptic cores, and fluidic shields. To insure validity of data calibration, a variety of software is used. This software adjusts the sound amplitude and frequency to be consistent with data taken on another day. Both the software and the hardware help make noise reduction possible.

The task was to test the data reduction software and ensure that the programs work properly. These software programs were designed to make corrections for atmosphere, shear, attenuation, electronic, and background noise. All data can be converted to a one-foot lossless condition, using the proper software corrections, making a reading independent of weather and distance. Also, data can be transformed from model scale to full scale for noise predictions of a real flight. Other programs included calculations of Over All Sound Pressure Level (OASPL), Effective Perceived Noise Level (EPNL). OASPL is the integration of sound with respect to frequency, and EPNL is weighted for a human's response to different sound frequencies and integrated with respect to time. With the proper software correction, data taken in the NATR are useful in determining ways to reduce noise.

To test the software correction programs, a comparison program was written to display any difference between two or more data files. Using this program and graphs of the data, the actual and predicted data can be compared. This software was tested on data collected at the Aero Acoustic Propulsion Laboratory (AAPL) using a variety of window types and overlaps. Similarly, short scripts were written to test each individual program in the software suite for verification. Each graph displays both the original points and the adjusted points connected with lines.

During this summer, data points were taken during a live experiment at the AAPL to measure Nozzle Acoustic Test Rig (NATR) background noise levels. Six condenser microphones were placed in strategic locations around the dome and the inlet tunnel to measure different noise sources. From the control room the jet was monitored with the help of video cameras and other sensors. The data points were recorded, reduced, and plotted, and will be used to plan future modifications to the NATR.

The primary goal to create data reduction test programs and provide verification was completed. As a result of the internship, I learned C/C++, UNIX/LINUX, Excel, and acoustic data processing methods. I also recorded data at the AAPL, then processed and plotted it. These data would be useful to compare against existing data. In addition, I adjusted software to work on the Mac OSX platform. And I used the available training resources.

## **Fan Noise Prediction**

**Joshua I. France**

University of Cincinnati

Aerospace Engineering

Undergraduate, Sophomore

**Mentor: Dr. Edmane Eniva**

### **ABSTRACT**

Aircraft noise emission level restrictions in and around airports continue to grow more stringent every few years. Thus, it is important to predict noise emissions from aircraft accurately. Predicting noise from the engine(s) is an integral part of the efforts to characterize the noise signature of an aircraft. An important source of engine noise is the rotor-stator interaction noise produced as a result of impingement of fan rotor wakes on the fan exit guide vanes. Interaction noise propagates through the inlet and exhaust ducts of the engine and radiates to the far field.

The subject of this study is to compare the predicted to the measured far field noise levels for a range of model fans stages that represent current aircraft engine designs. Eversman's radiation codes calculate both the inlet and exhaust noise radiation by propagating the internally measured rotor-stator interaction noise to the far field. Predicted far field sound pressure levels are then compared to the measured levels from wind tunnel tests. This effort's objective is to prove that the predicted levels actually describe the measured levels.

# **Improving Rotor-Stator Interaction Noise Code Through Analysis of Input Parameters**

**Timothy J. Unton**

**Embry-Riddle Aeronautical University**

**Aerospace Engineering**

**Undergraduate, Freshman**

**Mentor: Dr. Edmane Envia**

## **ABSTRACT**

There are two major sources of aircraft noise. The first is from the airframe and the second is from the engines. The focus of the acoustics branch at NASA Glenn is on the engine noise sources. There are two major sources of engine noise; fan noise and jet noise. Fan noise, produced by rotating machinery of the engine, consists of both tonal noise, which occurs at discrete frequencies, and broadband noise, which occurs across a wide range of frequencies. The focus of my assignment is on the broadband noise generated by the interaction of fan flow turbulence and the stator blades.

The objective of this study is to investigate the influence of geometric parameters such as the sweep and stagger angles and blade count, as well as the flow parameters such as intensity of turbulence in the flow. The tool I employed in this work is a computer program that predicts broadband noise from fans. The program assumes that the complex shape of the curved blade can be represented as a single flat plate, allowing it to use fairly simple equations that can be solved in a reasonable amount of time. While the results from such representation provided reasonable estimates of the broadband noise levels, they did not usually represent the entire spectrum accurately. My investigation found that the discrepancy between data and theory can be improved if the leading edge and the trailing edge of the blade are treated separately. Using this approach, I reduced the maximum error in noise level from a high of 30% to less than 5% for the cases investigated. Detailed results of this investigation will be discussed at my presentation.

# **SOLID OXIDIZED FUEL CELLS SEALS LEAKAGE SETUP AND TESTING**

**Marta B. Bastrzyk**

Illinois Institute of Technology in Chicago  
Aerospace Engineering and Applied Mathematics

Junior

**Mentor: Christopher C. Daniels**

## **ABSTRACT**

As the world's reserves of fossil fuels are depleted, the U.S. Government, as well as other countries and private industries, is researching solutions for obtaining power, answers that would be more efficient and environmentally friendly. For a long time engineers have been trying to obtain the benefits of clean electric power without heavy batteries or pollution-producing engines. While some of the inventions proved to be effective (i.e. solar panels or windmills) their applications are limited due to dependency on the energy source (i.e. sun or wind). Currently, as energy concerns increase, research is being carried out on the development of a Solid Oxide Fuel Cell (SOFC). The United States government is taking a proactive role in expanding the technology through the Solid State Energy Conversion Alliance (SECA) Program, which is coordinated by the Department of Energy.

A fuel cell is an electrochemical device that converts the chemical energy in fuels into an electrical energy. This occurs by the means of natural tendency of oxygen and hydrogen to chemically react. While controlling the process, it is possible to harvest the energy given off by the reaction. SOFCs use currently available fossil fuels and convert a variety of those fuels with very high efficiency (about 40% more efficient than modern thermal power plants). At the same time they are almost entirely nonpolluting and due to their size they can be placed in remote areas. The main fields where the application of the fuel cells appears to be the most useful for are stationary energy sources, transportation, and military applications.

However, before the SOFC technology can be fully operational, issues with its structure and materials must be resolved. All the components must be operational in harsh environments including temperatures reaching 800°C and cyclic thermal-mechanical loading. Under these conditions, the main concern is the requirement for hermetic seals to (1) prevent mixing of the fuel and oxidant within the stack, (2) prevent parasitic leakage of the fuel from the stack, (3) prevent contamination of the anode by air leaking into the stack, (4) electrically isolate the individual cells within the stack, and (5) mechanically bond the cell components. The sealing challenges are aggravated by the need to maintain hermetic boundaries between the different flow paths within the fuel cell throughout cycled operation. Within the timeframe of my tenure, the main objective is to assist in building a state-of-art test facility.

# **EXPERIMENTATION TOWARD THE ANALYSIS OF GEAR NOISE SOURCES CONTROLLED BY SLIDING FRICTION AND SURFACE ROUGHNESS**

**Vivake M. Asnani**

The Ohio State University

B.S. Electrical and Computer Engineering

M.S. Mechanical Engineering (In Progress)

Graduate Student

**Mentor: Dr. Timothy L Krantz**

## **ABSTRACT**

In helicopters and other rotorcraft, the gearbox is a major source of noise and vibration (N&V). The two N&V excitation mechanisms are the relative displacements between mating gears (transmission errors) and the friction associated with sliding between gear teeth. Historically, transmission errors have been minimized via improved manufacturing accuracies and tooth modifications. Yet, at high torque loads, noise levels are still relatively high though transmission errors might be somewhat minimal. This suggests that sliding friction is indeed a dominant noise source for high power density rotorcraft gearboxes. In reality, friction source mechanism is associated with surface roughness, lubrication regime properties, time-varying friction forces/torques and gear-mesh interface dynamics. Currently, the nature of these mechanisms is not well understood, while there is a definite need for analytical tools that incorporate sliding resistance and surface roughness, and predict their effects on the vibro-acoustic behavior of gears. Toward this end, an experiment was conducted to collect sound and vibration data on the NASA Glenn Gear-Noise Rig. Three iterations of the experiment were accomplished: Iteration 1 tested a baseline set of gears to establish a benchmark. Iteration 2 used a gear-set with low surface asperities to reduce the sliding friction excitation. Iteration 3 incorporated low viscosity oil with the baseline set of gears to examine the effect of lubrication. The results from this experiment will contribute to a two year project in collaboration with the Ohio State University to develop the necessary mathematical and computer models for analyzing geared systems and explain key physical phenomena seen in experiments. Given the importance of sliding friction in the gear dynamic and vibro-acoustic behavior of rotorcraft gearboxes, there is considerable potential for research & developmental activities. Better models and understanding will lead to quiet and reliable gear designs, as well as the selection of optimal manufacturing processes.

## Determining the Thermal Properties of Space Lubricants

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Chemical Engineering  
Undergraduate  
Mentor: Wilfredo Morales

### Abstract

Many mechanisms used in spacecrafts, such as satellites or the space shuttle, employ ball bearings or gears that need to be lubricated. Normally this is not a problem, but in outer space the regular lubricants that are used on Earth will not function properly. Regular lubricants will quickly vaporize in the near vacuum of space. A unique liquid called a perfluoropolyalkylether (PFPE) has an extremely low vapor pressure, around  $10^{-10}$  torr at 20°C, and has been used in numerous satellites and is currently used in the space shuttle. Many people refer to the PFPEs as "liquid Teflon". PFPE lubricants however, have a number of problems with them. Lubricants need many soluble additives, especially boundary and anti-wear additives, in them to function properly. All the regular known boundary additives are insoluble in PFPEs and so PFPEs lubricate poorly under highly loaded conditions leading to many malfunctioning ball bearings and gears. JAXA, the Japanese Space Agency, is designing and building a centrifuge rotor to be installed in the International Space Station. The centrifuge rotor is part of a biology lab module. They have selected a PFPE lubricant to lubricate the rotor's ball bearings and NASA bearing experts feel this is not a wise choice. An assessment of the centrifuge rotor design is being conducted by NASA and part of the assessment entails knowing the physical and thermal properties of the PFPE lubricant. One important property, the thermal diffusivity, is not known. An experimental apparatus was set up in order to measure the thermal diffusivity of the PFPE. The apparatus consists of a constant temperature heat source, cylindrical Pyrex glassware, a thermal couple and digital thermometer. The apparatus was tested and calibrated using water since the thermal diffusivity of water is known.

# **Wireless Channel Characterization in the Airport Surface Environment**

**Joshua T. Neville**  
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Electrical Engineering  
PhD Student  
**Mentor: Israel Greenfeld**

## **ABSTRACT**

Given the anticipated increase in air traffic in the coming years, modernization of the National Airspace System (NAS) is a necessity. Part of this modernization effort will include updating current communication, navigation, and surveillance (CNS) systems to deal with the increased traffic as well as developing advanced CNS technologies for the systems.

An example of such technology is the integrated CNS (ICNS) network being developed by the Advanced CNS Architecture and Systems Technology (ACAST) group for use in the airport surface environment. The ICNS network would be used to convey voice/data between users in a secure and reliable manner. The current surface system only supports voice and does so through an obsolete physical infrastructure. The old system is vulnerable to outages and costly to maintain.

The proposed ICNS network will include a wireless radio link. To ensure optimal performance, a thorough and accurate characterization of the channel across which the link would operate is necessary. The channel is the path the signal takes from the transmitter to the receiver and is prone to various forms of interference. Channel characterization involves a combination of analysis, simulation, and measurement.

My work this summer was divided into four tasks. The first task required compiling and reviewing reference material that dealt with the characterization and modeling of aeronautical channels. The second task involved developing a systematic approach that could be used to group airports into classes, e.g. small airfields, medium airports, large open airports, large cluttered airports, etc. The third task consisted of implementing computer simulations of existing channel models. The fourth task entailed measuring possible interference sources in the airport surface environment via a spectrum analyzer.

# **Resource Management in the Microgravity Science Division**

**Justine Casselle**  
Xavier University  
International Business  
Undergraduate, Freshman  
**Mentor: Margie Allen**

## **ABSTRACT**

In the Microgravity Science Division, the primary responsibilities of the Business Management Office are resource management and data collection. Resource management involves working with a budget to do a number of specific projects, while data collection involves collecting information such as the status of projects and workforce hours. This summer in the Business Management Office I assisted Margie Allen with resource planning and the implementation of specific microgravity projects.

One of the main duties of a Project Control Specialists, such as my mentor, is to monitor and analyze project manager's financial plans. Project managers work from the bottom up to determine how much money their project will cost. They then set up a twelve month operating plan which shows when money will be spent. I assisted my mentor in checking for variances in her data against those of the project managers.

In order to successfully check for those variances, we had to understand: where the project is including plans vs. actual performance, why it is in its present condition, and what the future impact will be based on known budgetary parameters. Our objective was to make sure that the plan, or estimated resources input, are a valid reflection of the actual cost. To help with my understanding of the process, over the course of my tenure I had to obtain skills in Microsoft Excel and Microsoft Access.

# USING PIEZOELECTRIC CERAMICS FOR DUST MITIGATION ON SPACE SUITS

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Colorado School of Mines

Mechanical Engineering

Undergraduate Junior

**Mentors: Juan H. Agui and Masami Nakagawa**

## ABSTRACT

The particles that make up moon dust and Mars soil can be hazardous to an astronaut's health if not handled properly. In the near future, while exploring outer space, astronauts plan to wander the surfaces of unknown planets. During these explorations, dust and soil will cling to their space suits and become imbedded in the fabric. The astronauts will track moon dust and mars soil back into their living quarters. This not only will create a mess with millions of tiny air-born particles floating around, but will also be dangerous in the case that the fine particles are breathed in and become trapped in an astronaut's lungs.

In order to mitigate this problem, engineers and scientists at the NASA-Glenn research center are investigating ways to remove these particles from space suits. This problem is very difficult due to the nature of the particles: They are extremely small and have jagged edges which can easily latch onto the fibers of the fabric. For the past summer, I have been involved in researching the potential problems, investigating ways to remove the particles, and conducting experiments to validate the techniques.

The current technique under investigation uses piezoelectric ceramics imbedded in the fabric that vibrate and shake the particles free. The particles will be left on the planet's surface or collected a vacuum to be disposed of later. The ceramics vibrate when connected to an AC voltage supply and create a small scale motion similar to what people use at the beach to shake sand off of a beach towel. Because the particles are so small, similar to volcanic ash, caution must be taken to make sure that this technique does not further imbed them in the fabric and make removal more difficult. Only a very precise range of frequency and voltage will produce a suitable vibration. My summer project involved many experiments to determine the correct range. Analysis involved hands on experience with oscilloscopes, amplifiers, piezoelectrics, a high speed camera, microscopes and computers.

Further research and experiments are planned to better understand and ultimately perfect this technology. Someday, vibration to remove dust may a vital component to the space exploration program.

# **Wave Propagation in 2-D Granular Matrix and Dust Mitigation of Fabrics for Space Exploration Mission**

**Phi Hung X. Thanh**  
Colorado School of Mines  
Physics/Mechanical Engineering  
Undergraduate, Junior  
**Mentor: Juan Agui and Masami Nakagawa**

## **ABSTRACT**

Wave Propagation study is essential to exploring the soil on Mars or Moon and Dust Mitigation is a necessity in terms of crew's health in exploration missions.

The study of Dust Mitigation has a significant impact on the crew's health when astronauts track dust back into their living space after exploration trips. We are trying to use piezoelectric fiber to create waves and vibrations at certain critical frequencies and amplitudes so that we can shake the particles off from the astronaut's fabrics. By shaking off the dust and removing it, the astronauts no longer have to worry about breathing in small and possibly hazardous materials, when they are back in their living quarters.

The Wave Propagation in 2-D Granular Matrix studies how the individual particles interact with each other when a pressure wave travels through the matrix. This experiment allows us to understand how wave propagates through soils and other materials. By knowing the details about the interactions of particles when they act as a medium for waves, we can better understand how wave propagates through soils and other materials. With this experiment, we can study how less gravity effects the wave propagation and hence devise a way to study soils in space and on Moon or Mars.

Some scientists treat the medium that waves travel through as a "black box," they did not pay much attention to how individual particles act as wave travels through them. With this data, I believe that we can use it to model ways to measure the properties of different materials such as density and composition.

In order to study how the particles interact with each other, I have continued Juan Agui's experiment of the effects of impacts on a 2-D matrix. By controlling the inputs and measuring the outputs of the system, I will be able to study now the particles in that system interact with each other. I will also try to model this with the software called PFC<sup>2D</sup> in order to obtain theoretical data to compare with the experiment.

PFC-2D is a program that allows the user to control the number of particles, the particle's characteristic, and the environment of the particle. With this I can run simulations that mimic the impulse test. This software uses a language called FISH, probably created by the creator of the software. This means that in order to model anything, one must use the command terminal instead of GUI's. I will also use this program to simulate the Moon/Mars simulate adhering to the fabric for the Dust Mitigation project.

My goals for this summer are just to complete preliminary studies of the feasibility of the Shaking Fabric, learn the PFC-2D program, and to complete building and testing the wave propagation experiment.

# Microgravity Spray Cooling Research for High Powered Laser Applications

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Mechanical Engineering  
Senior Undergraduate  
Mentor: Eric L. Golliher

## ABSTRACT

An extremely powerful laser is being developed at Goddard Space Flight Center for use on a satellite. This laser has several potential applications. One application is to use it for upper atmosphere weather research. In this case, the laser would reflect off aerosols in the upper atmosphere and bounce back to the satellite, where the aerosol velocities could be calculated and thus the upper atmosphere weather patterns could be monitored. A second application would be for the U.S. Air Force, which wants to use the laser strategically as a weapon for satellite defense. The Air Force fears that in the coming years as more and more nations gain limited space capabilities that American satellites may become targets, and the laser could protect the satellites.

Regardless of the ultimate application, however, a critical step along the way to putting the laser in space is finding a way to efficiently cool it. While operating the laser becomes very hot and must be cooled to prevent overheating. On earth, this is accomplished by simply running cool tap water over the laser to keep it cool. But on a satellite, this is too inefficient. This would require too much water mass to be practical. Instead, we are investigating spray cooling as a means to cool the laser in microgravity. Spray cooling requires much less volume of fluid, and thus could be suitable for use on a satellite.

We have inherited a 2.2 second Drop Tower rig to conduct our research with. In our experiments, water is pressurized with a compressed air tank and sprayed through a nozzle onto our test plate. We can vary the pressure applied to the water and the temperature of the plate before an experiment trial. The whole process takes place in simulated microgravity in the 2.2 second Drop Tower, and a high speed video camera records the spray as it hits the plate.

We have made much progress in the past few weeks on these experiments. The rig originally did not have the capability to heat the test plate, but I did some heat transfer calculations and picked out a heater to order for the rig. I learned QBasic programming language to change the operating code for our drops, allowing us to rapidly cycle the spray nozzle open and closed to study the effects. We have derived an equation for flow rate vs. pressure for our experiment. We have recorded several videos of drops at different pressures, some with heated test plate and some without, and have noticed substantial differences in the liquid behavior. I have also changed the computer program to write a file with temperature vs. time profiles for the test plate, and once the necessary thermocouple comes in (it was ordered last week), we will have temperature profiles to accompany the videos.

Once we have these temperature profiles to go with the videos, we will be able to see how the temperature is affected by the spray at different pressures, and how the spray changes its behavior once as the plate changes from hot to cool. With quantitative temperature data, we can then mathematically model the heat transfer from the plate to the cooling spray. Finally, we can look at the differences between trials in microgravity and those in normal earth gravity.

# **The Effects of Protein Regulators on the Vascular Remodeling of Japanese Quail Chorioallantoic Membrane**

**Arati Deshpande**  
Ohio State University  
Health Sciences  
Freshman

**Mentor: Patricia Parsons-Wingerter & Glenda Yee**

## **ABSTRACT**

Contributing to NASA's mission, the Microgravity Fluid Physics research program conducts experiments to promote space exploration and improvement of processes and products on Earth. One of the projects through this program deals with the affect of regulators on vascular remodeling and angiogenesis.

This project is being led by Dr. Patricia Parsons-Wingerter. To perform the experiments, protein regulators are tested on the chorioallantoic membrane (CAM) of the Japanese quail embryos. The different types of regulators used can be broken down into two major groups of stimulators, and inhibitors. Stimulators increase the rate of blood vessel growth and inhibitors decrease of blood vessel growth. The specified regulator proteins include thrombospondin 1 (TSP-1) and a novel vessel tortuosity factor (TF), these are just the ones used in this specific experiment; other various protein regulators can also be used. The novel vessel tortuosity factor (TF) is a special kind of stimulator because it stimulates vessel tortuosity and curvature, rather than actual blood vessel growth. These regulators are being tested on Japanese quail embryos. The Japanese quail embryos naturally form a chorioallantoic membrane (CAM) from which blood flow, vascular remodeling, and angiogenesis can be observed. Chorioallantoic membranes are also easier to use because they are two dimensional when mounted onto a slide for examination. The analysis of the affect of the regulators on the CAM can be studied through PIVPROC; the program is used to analyze the altered blood flow in response to application of TF.

Regulators are being thoroughly studied because cardiovascular alterations are the second highest, NASA-defined, risk categories in human space exploration. This research done on the quail is extending to even more projects that will be done on lab animals such as mice and also in human clinical studies like the diabetic retina. Not only will this research be beneficial to further space exploration, but it will also help life here on Earth. The higher understanding of the formation of blood vessels can also help further research in health problems such as diabetes and heart disease.

# RESPONSE OF MINERALIZING AND NON-MINERALIZING BONE CELLS TO FLUID FLOW: AN *IN VITRO* MODEL FOR MECHANOTRANSDUCTION

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Biochemistry and Molecular Biology  
Senior

Mentors: Gregory A. Zimmerli and Nicole R. Compitello

## ABSTRACT

Humans reach peak bone mass at age 30. After this point, we lose 1 to 2 percent of bone mass each decade. In the microgravity environment of space, astronauts lose bone mass at an accelerated rate of 1 to 2 percent each month. When astronauts travel to Mars, they may be in space for as long as 3 years. During this time, they may lose about half of their bone mass from weight-bearing bones. This loss may be irreversible. The drastic loss in bone that astronauts experience in space makes them much more vulnerable to fractures. In addition, the corresponding removal of calcium from bone results in higher levels of calcium in the blood, which increases the risk of developing kidney stones. Currently, studies are being conducted which investigate factors governing bone adaptation and mechanotransduction.

Bone is constantly adapting in response to mechanical stimuli. Increased mechanical loading stimulates bone formation and suppresses bone resorption. Reduction in mechanical loading caused by bedrest, disuse, or microgravity results in decreased bone formation and possibly increased bone resorption. Osteoblasts and osteoclasts are the two main cell types that participate in bone remodeling. Osteoblasts are anabolic (bone-forming) cells and osteoclasts are catabolic (bone-resorbing) cells. In microgravity, the activity of osteoblasts slows down and the activity of osteoclasts may speed up, causing a loss of bone density.

Mechanotransduction, the molecular mechanism by which mechanical stimuli are converted to biochemical signals, is not yet understood. Exposure of cells to fluid flow imposes a shear stress on the cells. Several studies have shown that the shear stress that results from fluid flow induces a cellular response similar to that induced by mechanical loading. Thus, fluid flow can be used as an *in vitro* model to simulate the mechanical stress that bone cells experience *in vivo*. Previous *in vitro* studies have shown that fluid flow induces several responses in osteoblasts, including increased proliferation, osteoblastic differentiation, alkaline phosphatase activity, and production of nitric oxide, prostaglandins, and osteopontin. Several proteins have been implicated in osteoblastic mechanotransduction including Bone Morphogenetic Protein-2 (BMP-2), parathyroid hormone, 1,25-dihydroxyvitamin D3 receptor, osteopontin (OPN), osteoprotegerin (OPG), and alkaline phosphatase (AP). We will characterize relative levels of each protein in mineralizing or non-mineralizing MC3T3 osteoblastic cells that have been exposed to fluid flow compared to non-fluid flow using immunofluorescent staining and two-photon laser microscopy as well as western blotting. Because calcium-mediated pathways are important in osteoblastic signaling, we will transfect MC3T3 cells with cameleon probes for  $\text{Ca}^{2+}$  containing YFP and CFP. Results will be analyzed using FRET/ FLIM to study differential release of intracellular  $\text{Ca}^{2+}$  in response to fluid flow and conditions inducing matrix mineralization. In addition, we plan to conduct several microarray experiments to determine differential gene expression in MC3T3 cells in response to fluid flow and conditions inducing mineralization.

# METHODOLOGY FOR EVALUATION OF TECHNOLOGY IMPACTS IN SPACE ELECTRIC POWER SYSTEMS

**Julie Holda**

Ohio Northern University

Mathematics/Statistics

Undergraduate, Senior

**Mentors: Jose Davis and Timothy Sarver-Verhey**

## ABSTRACT

The Analysis and Management branch of the Power and Propulsion Office at NASA Glenn Research Center is responsible for performing complex analyses of the space power and In-Space propulsion products developed by GRC. This work quantifies the benefits of the advanced technologies to support on-going advocacy efforts. The Power and Propulsion Office is committed to understanding how the advancement in space technologies could benefit future NASA missions. They support many diverse projects and missions throughout NASA as well as industry and academia.

The area of work that we are concentrating on is space technology investment strategies. Our goal is to develop a Monte-Carlo based tool to investigate technology impacts in space electric power systems. The framework is being developed at this stage, which will be used to set up a computer simulation of a space electric power system (EPS). The outcome is expected to be a probabilistic assessment of critical technologies and potential development issues. We are developing methods for integrating existing spreadsheet-based tools into the simulation tool. Also, work is being done on defining interface protocols to enable rapid integration of future tools.

The first task this summer was to evaluate, install, and integrate the various Monte Carlo-based simulation programs for statistical modeling of the EPS Model. I decided to learn and evaluate Palisade's @Risk and Risk Optimizer software, and utilize its capabilities for the Electric Power System (EPS) model. I also looked at similar software packages (JMP, SPSS, Crystal Ball, VenSim, Analytica) available from other suppliers and evaluated them.

The second task was to develop the framework for the tool, in which we had to define technology characteristics using weighing factors and probability distributions. Also we had to define the simulation space and add hard and soft constraints to the model.

The third task is to incorporate (preliminary) cost factors into the model. A final task is developing a cross-platform solution of this framework.

# **Motor/Generator and Inverter Characterization for Flywheel System Applications**

**Tamarcus L. Jeffries**  
Tennessee State University  
Electrical Engineering  
Undergraduate: Senior  
**Mentor: Mr. Walter Santiago**

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## ***Abstract:***

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The Advanced Electrical Systems Development Branch at NASA Glenn Research Center (GRC) has been involved in the research and development of high speed flywheels systems for satellite energy storage and attitude applications. These flywheels will serve as replacement for chemical nickel hydrogen, nickel cadmium batteries and gyroscopic wheels. The advantages of using flywheel systems for energy storage on satellites are high energy density, high power density, long life, deep depth of discharge, and broad operating temperature ranges.

A flywheel system for space applications consist of a number of flywheel modules, the motor/generator and magnetic bearing, and an electronics package. The motor/generator electronics package includes a pulse-width modulated inverter that drives the flywheel permanent magnet motor/generator located at one end of the shaft.

This summer, I worked under the direct supervision of my mentor, Walter Santiago, and the goal for this summer was to characterize motor generator and inverter attributes in order to increase their viability as a more efficient energy storage source for space applications. To achieve this goal, magnetic field measurements around the motor/generator permanent magnet and the impedance of the motor/generator three phase windings were characterized, and a recreation of the inverter pulse width modulated control system was constructed.

The Flywheel modules for space use are designed to maximize energy density and minimize loss, and attaining these values will aid in locating and reducing losses within the flywheel system as a whole, making flywheel technology more attractive for use as energy storage in future space applications.

# **Dissemination of information about the technologies of the Vision Research Lab through the World Wide Web.**

**Christopher M. Dorais**  
Nashville State Community College  
Electronic Engineering Technologies  
Sophomore  
**Mentor: Rafat Ansari**

## **Abstract**

The Vision Research Lab at NASA John Glenn Research Center is headed by Dr. Rafat Ansari. Dr. Ansari and other researchers have developed technologies that primarily use laser and fiber optics to non-invasively detect different ailments and diseases of the eye. One of my goals as a LERCIP intern and ACCESS scholar for the 2004 summer is to inform other NASA employees, researchers and the general public about these technologies through the development of a website.

The website incorporates the theme that the eye is a window to the body. Thus by investigating the processes of the eye, we can better understand and diagnosis different ailments and diseases. These ailments occur in not only earth bound humans, but astronauts as well as a result of exposure to elevated levels of radiation and microgravity conditions. Thus the technologies being developed at the Vision Research Lab are invaluable to humans on Earth in addition to those astronauts in space.

One of my first goals was to research the technologies being developed at the lab. The first several days were spent immersing myself in the various articles, journals and reports about the theories behind Dynamic Light Scattering, Laser Doppler Flowmetry, Autofluorescence, Raman Spectrophpy, Polarimetry and Oximetry. Interviews with the other researchers proved invaluable to help understand these theories as well gain hands on experience with the devices being developed using these technologies.

The rest of the Vision Research Team and I sat down and discussed how the overall website should be presented. Combining this information with the knowledge of the theories and applications of the hardware being developed, I worked out different ideas to present this information. I quickly learned Paint Shop Pro 8 and FrontPage 2002, as well as using online tutorials and other resources to help design an effective website.

The Vision Research Lab website incorporates the anatomy and physiology of the eye, different diseases that affect the eye and the technologies being develop at the lab to help diagnosis these diseases. It also includes background information on Dr. Ansari as well as other researchers involved in the lab and it includes segments on patents, awards and achievements. There are links to help viewers navigate to internal and external websites to further investigate different ideas and further understand the implications of these technologies at being developed.

# **Research Symposium II**

## **Ohio Aerospace Institute**

### **Thursday, August 5, 2004**

#### **OAI Industry Room**

**9:00 A.M. Laquilia Graham, Hiram College, Freshman**

“A Three-fold Outlook of the Ultra-Efficient Engine Technology Program Office (UEET)”

2100/Kathy Zona, Ultra-Efficient Engine Technology Office

**9:15 Jonathan Chennault, Ohio State University, Freshman**

“Icing Research Tunnel”

7600/Richard DelRosio, Research Testing Division

**9:30 Alexander Padgett, Purdue University, Freshman**

“Refining the W1 and SE1 Facilities”

7600/Mary Gibson, Research Testing Division

**9:45 Ashley Thomas, University of Akron, Freshman**

“Construction and Analysis of Electronic circuits”

7600/Yves Lamothe, Research Testing Division

**10:00 Rodney Chambers, Ohio State University, Junior**

“Space Electronic Test Engineering”

7630/Don Fong, Space Power and Propulsion Test Engineering Branch

**10:15 Abdullahi Audu, Cleveland State University, Senior**

“Upgrades at the Propulsion Systems Lab (PSL)”

7660/Robert Smalley, Electronic and Special Systems Branch

**10:30 Nicholas Hawes, Cleveland Institute of Art, Senior**

“Medical/Scientific Illustration and Production of Otological Health Awareness Materials”

7735/Beth Cooper, Structural Systems Dynamics Branch

**10:45 Carly Weiler, University of Cincinnati, Sophomore**

“Operating the Central Process Systems at Glenn Research Center”

7010/Dennis Vano, Business Systems Office

**11:00 LUNCH**

**1:00 Paul Struhar, University of Akron, Freshman**

“Work Done for the Safety and Assurance Directorate”

8000/Sandra Hardy, Safety and Assurance Directorate

**1:15 Jamarr Threatt, Columbus College of Art and Design, Freshman**

“Software Assurance of PLCs Training Course”

8100, Cynthia Calhoun, Risk Management Office

**1:30 Shayla Wright, University of Toledo, Freshman**

“Risk Management Implementation Tool”

8100, Cynthia Calhoun, Risk Management Office

**1:45 Frank Pokorny, University of Cincinnati, Sophomore**

“The NASA Continuous Risk Management Process”

8100, Gary Kelm, Risk Management Office

**2:00 Session Break**

**2:15 Traci Barnett, Kent State University, Senior**

“Emergency Response Manual”

8500, Richard Soppet, Security Management Office

**2:30 Brittany Neal, Allegheny College, Freshman**

“College Bound with the Office of Educational Programs”

9200/Marie Borowski, Educational Programs Office

**2:45 Nykkita Riveras, University of Maryland-Baltimore County, Masters**

“Conversion of the Aeronautics Interactive Workstation”

9200/Dovie Lacy, Educational Programs Office

**3:00 Jeffrey Rios, Case Western Reserve University, Freshman**

“MOBI and FEANICS Programming in LabView”

7140/Rochelle May, Flight Software Engineers Branch

**3:15 Chika Okoro, Florida Agricultural & Mechanical University, PhD**

“Effects of Initial Powder Size on the Mechanical Properties and Microstructure of As-Extruded GRCop-84”

5120/David Ellis, Advanced Metallics Branch

**3:30 ADJOURN**

## A Three-fold Outlook of the Ultra-Efficient Engine Technology Program Office (UEET)

**La Quillia E. Graham**  
Hiram College  
Business Management/Biomedical Humanities  
Freshman  
**Mentor: Kathleen A. Zona**

### ABSTRACT

The Ultra-Efficient Engine Technology (UEET) Office at NASA Glenn Research Center is a part of the Aeronautics Directorate. Its vision is to develop and hand off *revolutionary* turbine engine propulsion technologies that will enable future generation vehicles over a wide range of flight speeds. There are seven different technology area projects of UEET.

During my tenure at NASA Glenn Research Center, my assignment was to assist three different areas of UEET, simultaneously. I worked with Kathy Zona in Education Outreach, Lynn Boukalik in Knowledge Management, and Denise Busch with Financial Management. All of my tasks were related to the business side of UEET.

As an intern with Education Outreach I created a word search to partner with an exhibit of a Turbine Engine developed out of the UEET office. This exhibit is a portable model that is presented to students of varying ages. The word search complies with National Standards for Education which are part of every science, engineering, and technology teachers' curriculum. I also updated a Conference Planning/Workshop Excel Spreadsheet for the UEET Office. I collected and inputted facility overviews from various venues, both on and off site to determine where to hold upcoming conferences. I then documented which facilities were compliant with the Federal Emergency Management Agency's (FEMA) Hotel and Motel Fire Safety Act of 1990.

The second area in which I worked was Knowledge Management. The UEET Office has a large knowledge management system online which has extensive documentation that continually needs reviewing, updating, and archiving. Knowledge management is the ability to bring individual or team knowledge to an organizational level so that the information can be stored, shared, reviewed, archived. Livelink and a secure server are the Knowledge Management systems that UEET utilizes. Through these systems, I was able to obtain the documents needed for archiving. My assignment was to obtain intellectual property including reports, presentations, or any other documents related to the project. My next task was to document the author, date of creation, and all other properties of each document. To archive these documents I worked extensively with Microsoft Excel.

The final area of my internship was Financial Management of UEET. I first learned the different financial systems of accounting such as the SAP business accounting system. I also learned the best ways to present financial data and shadowed my mentor as she presented financial data to both UEET's project management and the Resources Analysis and Management Office (RAMO). I analyzed the June 2004 financial data of UEET and used Microsoft Excel to input the results of the data. This process made it easier to present the full cost of the project in the month of June. In addition I assisted in the End of the Year 2003 Reconciliation of Purchases of UEET.

**Icing Research Tunnel**  
**Jonathan Chennault**  
Ohio State University  
Computer/Electrical Engineering  
**Mentor: Richard DelRosa**

**ABSTRACT**

The Icing Research Tunnel in Building 11 at the NASA Glenn Research Center is committed to researching the effects of in flight icing on aircraft and testing ways to stop the formation of hazardous icing conditions on planes. During this summer, I worked here with Richard DelRosa, the lead engineer for this area.

Icing Research Tunnel (IRT), built close to the end of World War 2, was created to address one of the major concerns of aviation: icing conditions. During the war, many planes crashed (especially supply planes going over the Himalayas) because ice built up in their wings and clogged the engines. To this day, it remains the largest ice tunnel in the world, with a test section that measures 6 feet high, 9 feet long, and 20 feet wide. It can simulate airspeeds from 50 to 300 miles per hour at temperatures as low as -50 Fahrenheit. Using these capabilities, IRT can simulate actual conditions at high altitudes.

My main job in the IRT is creating a reference guide for the technicians and engineers. The first thing I did was creating a cross reference in Microsoft Excel. It lists commands for the DPU units that control the pressure and temperature variations in the tunnel, as well as the type of command (keyboard, multiplier, divide, etc). The cross reference also contains the algorithm for every command, and which page it is listed in on the control sheet (visual Auto-CAD graphs, which I helped to make). I actually spent most of the time on the computer using Auto-CAD. I drew a diagram of the entire icing tunnel and then drew diagrams of its various parts. Between my mentor and me, we have drawings of every part of it, from the spray bars to the thermocouples, power cabinets, input-output connectors for power systems, and layouts of various other machines. I was also responsible for drawing schematics for the Escort system (which controls the spray bars), the power system, DPUs, and other electrical systems.

In my spare time, I am attempting to build and program the "toddler". Toddler is a walking robot that I have to program in PBASIC language. When complete, it should be able to walk on level terrain while avoiding obstacles in real-time. It features an infrared detector that can keep it from falling over edges, as well as follow or avoid a light source. The toddler is giving me a much better understanding of the basics of electronic circuitry and computer programming.

## **Refining the W1 and SE1 Facilities**

**Alexander D. Padgett**

Purdue University

Aerospace Engineering

Undergraduate, freshman

**Mentor: Mary Gibson**

### **ABSTRACT**

The Engine Research Building (ERB) houses more than 60 test rigs that study all aspects of engine development. By working with Mary Gibson in the SE1 and W1A Turbine Facilities, I became aware of her responsibilities and better acquainted with the inner workings of the ERB.

The SE1 Supersonic/Subsonic Wind Tunnel Facility contains 2 small wind tunnels. The first tunnel uses an atmospheric inlet, while the second uses treated 40-psig air. Both of the tunnels are capable of subsonic and supersonic operation. An auxiliary air supply and exhaust piping providing both test sections with suction, blowing, and crossfire capabilities. The current configuration of SE1 consists of a curved diffuser that studies the blockage along the endwalls.

The W1A Low Speed Compressor Facility provides insight for the complex flow phenomena within its 4-stage axial compressor, and the data obtained from W1A is used to develop advanced models for fluid dynamic assessment. W1A is based off of a low speed research compressor developed by GE in the 1950's. This compressor has a removable casing treatment under rotor 1, which allows for various tip treatment studies. The increased size and low speed allows instrumentation to be located in the compressor's complex flow paths. Air enters the facility through a filtered roof vent, conditioned for temperature and turbulence, and then passed through the compressor

W1A is described as a dynamic facility with many projects taking place simultaneously. This current environment makes it challenging to follow the various affairs that are taking place within the area. During my first 4 weeks at the NASA Glenn Research Center, I have assisted Mary Gibson in multiple tasks such as facility documents, record keeping, maintenance and upgrades. The facility has lube systems for its gearbox and compressor. These systems are critical in the successful operation of the facility. I was assigned the task of creating a facility estimate list, which included the filters and strainers required for the compressor. For my remaining time spent here, we expect to complete a facility parts listing and a virtual project summary so that W1A and SE1 will become ergonomic facilities that will make it easier for people to observe the capabilities and history of the area and the employees that operate. Bolstering our efforts in achieving these goals are the online technical tutorials, software such as Microsoft Excel, Macromedia Flash MX, Macromedia Dreamweaver MX, Photoshop 6.0 and the assistance of several NASA employees.

# ***Construction and Analysis of Electronic circuits***

*Ashley N. Thomas*

**The University of Akron**

**Electrical Engineering**

*Entering freshman*

*Yves C. Lamothe*

The Aviation Environmental Technical Branch produces many various types of aeronautical research that benefits the NASA mission for space exploration and in turn, produces new technology for our nation. One of the present goals of the Aviation Environmental Technical Branch is to create better engines for airplanes by testing supersonic jet propulsion and safe fuel combustion. During the summer of 2004, I was hired by Vincent Satterwhite Chief executive of the Aviation Environmental Technical Branch to Assist Yves Lamothe with a fuel igniter circuit.

Yves Lamothe is an electrical engineer who is currently working on safe fuel combustion testing. This testing is planned to determine the minimum ignition energy for fuel and air vapors of current and alternative fuels under simulated flight conditions. An air temperature bath will provide simulated flight profile temperatures and the heat fluxes to the test chamber. I was assigned with Yves to help complete the igniter circuit which consists of a 36k voltage supply an oscilloscope, and a high voltage transistor switch.

During my tenure in the L.E.C.I.R.P. program I studied the basics of electricity and circuitry along with two other projects that I completed. In the beginning of my internship, I devote all of my time to research the aspects of circuitry so that I would be prepared for the projects that I was assigned to do. I read about lessons on; the basic physical concepts of electronics, Electrical units, Basic dc circuits, direct current circuit analysis, resistance and cell batteries, various types of magnetism , Alternating current basics, inductance, and power supplies. I received work sheets and math equations from my Mentor so that I could be able to apply these concepts into my work.

After I complete my studies, I went on to construct a LED chaser circuit which displays a series of light patterns using a 555 timer. I incorporated a switch and motion detector into the circuit to create basic alarm system. This project challenged my ability to interpret a schematic and expand it.

While I was still completing the LED chaser circuit I Also was given A Basic Stamp Toddler Robot to build and program. The Toddler robot can walk in 36 various styles using advanced robotics. I used many different programs to create movement and direction of the robot. Also the Toddler can use infrared vision to sense objects. This enables the robot to maneuver indefinitely without running into objects. During my tenure at the NASA Glen Research Center I definite utilized the NASA mission to educate. I learned valuable information to help in my up coming year as a freshman in college.

## SPACE ELECTRONIC TEST ENGINEERING

**Rodney D. Chambers**  
The Ohio State University  
Electrical Engineering  
Undergraduate Junior  
**Mentor: Don Fong**

### ABSTRACT

The Space Power and Propulsion Test Engineering Branch at NASA Glenn Research center has the important duty of controlling electronic test engineering services. These services include test planning and early assessment of Space projects, management and/or technical support required to safely and effectively prepare the article and facility for testing, operation of test facilities, and validation/delivery of data to customer. The Space Electronic Test Engineering Branch is assigned electronic test engineering responsibility for the GRC Space Simulation, Microgravity, Cryogenic, and Combustion Test Facilities.

While working with the Space Power and Propulsion Test Engineering Branch I am working on several different assignments. My primary assignment deals with an electrical hardware unit known as Sunny Boy. Sunny Boy is a DC load Bank that is designed for solar arrays in which it is used to convert DC power from the solar arrays into AC power at 60 hertz to pump back into the electricity grid. However, there are some researchers who decided that they would like to use the Sunny Boy unit in a space simulation as a DC load bank for a space shuttle or even the International Space Station hardware. In order to do so I must create a communication link between a computer and the Sunny Boy unit so that I can preset a few of the limits (such power, set & constant voltage levels) that Sunny Boy will need to operate using the applied DC load.

Apart from this assignment I am also working on a hi-tech circuit that I need to have built at a researcher's request. This is a high voltage analog to digital circuit that will be used to record data from space ion propulsion rocket booster tests. The problem that makes building this circuit so difficult is that it contains high voltage we must find a way to lower the voltage signal before the data is transferred into the computer to be read. The solution to this problem was to transport the signal using infrared light which will lower the voltage signal down low enough so that it is harmless to a computer.

Along with my involvement in the Space Power and Propulsion Test Engineering Branch, I am obligated to assist all other members of the branch in their work. This will help me to strengthen and extend my knowledge of Electrical Engineering.

## Upgrades at the Propulsion Systems Lab (PSL)

Abdullahi M Audu  
Cleveland State University  
Electronic Engineering Technology  
Senior  
Mentor: John Leone

### ABSTRACT

The Propulsion Systems Lab (PSL) does ground testing on full size air breathing engines. These engines range from those on commercial airplanes to fighter jets. At the PSL, engineers receive test requirements from customers and put together the necessary instrumentation, data systems, power requirements, electrical control valves, and engine controls. The engineers are also responsible for facility maintenance, repairs and upgrades.

There are four major sections at the PSL; the Test floor, the Data room, the Control room and, the WDPF room. On the test floor are two test cells, cell #3 and cell #4. It is within these cells that the actual engine resides for ground testing. The cells, once sealed and taken up to altitude, are capable of reaching engine inlet temperatures of 1000° F to -90°F, and various atmospheric pressures. The engine, when operational, takes in air and gives out exhaust of up to 2000°F. The exhaust is led to another section of the cell where it is cooled to 150°F before finally redirected to the appropriate disposer. Temperature and pressure transducers detect the conditions within the cell and transmit them to the data room where the results are captured, processed, analyzed, and translated to a more comprehensive language. This is made possible with the aid of several programmable logic controllers (PLCs) and instrumentation and control systems. The translated data is then sent, via the LAN, to the control room where the results can be viewed on monitors by the engineers and customers. From the control room, the test cell conditions can be changed whenever desired. During tests, a lot takes place in the facility. The WDPF control system monitors and controls all facility parameters.

This summer, I will assist the engineers; on an upgrade to the facility's distributed control and dynamic data system, in preparation for an engine test that will begin in September, the installation of control systems and various miscellaneous projects around the PSL.

## **MEDICAL/SCIENTIFIC ILLUSTRATION AND PRODUCTION OF OTOLOGICAL HEALTH AWARENESS MATERIALS**

**Nicholas E. Hawes**  
Cleveland Institute of Art  
Medical Illustration  
5<sup>th</sup> year, Undergraduate  
**Mentor: Beth A. Cooper**

Over the past year, I have worked for my mentor, Beth Cooper, on a large variety of projects. Beth is the Manager of the Acoustical Testing Laboratory, which tests the acoustical emissions of payloads destined for the International Space Station. She is also responsible for educating, and developing new methods of educating, people of all occupational and educational backgrounds in hearing conservation.

Beth spends much of her time developing new materials and strategies with which to train people and teach other people to train people in hearing conservation and noise emissions control. I have been helping Beth develop and market these materials by way of graphic design and scientific illustration.

Last summer, I spent much of my time creating educational illustrations that visually explained particular concepts in Beth's presentations. Sometimes these illustrations were small "comics" while, at other times, they were an instructional series of illustrations.

Since then, Beth and her lab have been developing and updating some materials which will be distributed free to hearing conservation and noise control professionals and others in related fields. I have helped with these projects by designing their packaging. In each instance, it was my responsibility to develop an aesthetically appealing package that would also, through its imagery, describe or summarize the contents of the product. I did this for 3 CD's (Auditory Demonstrations II, MACSUG, and JeopEARdy) and saw them through their actual production and distribution.

In addition to working with Beth, I work with the Imaging Technology Center on various imaging projects. Some of my activities include photo retouching and manipulation for videos and print. This summer, I also had the opportunity to develop a screen saver that would show some of the photography contained on the soon-to-be-released "Highlights of the GRC Image Archives, vol. 2". I was also able to utilize my medical training to help several of ITC's videographers identify the best histological examples of cancerous cells for incorporation in one of their videos.

Over the last part of this summer and then throughout the school year, I will be working with Beth to develop a "pre-packaged" lecture series about the physics of acoustics in the context of hearing conservation. These lectures will be used to teach people of all backgrounds the fundamental concepts involved in acoustical physics so they might be better aware of their own and others' auditory health in and out of the work place, and, in the case of payload developers, to design and build more quiet science experiments for the ISS.

Even though it may not seem as such, this project is precisely what I am learning to do as a student of the Cleveland Institute of Art's Medical Illustration Department. From my perspective, this project is about taking technical information and translating it into terms that anyone, regardless of background, can understand.

OPERATING THE CENTRAL PROCESS SYSTEMS  
AT GLENN RESEARCH CENTER

**Carly P. Weiler**  
University of Cincinnati  
Operations Management  
Undergraduate, Sophomore  
**Mentor: Dennis Vano**

ABSTRACT

As a research facility, the Glenn Research Center (GRC) trusts and expects all the systems controlling their facilities to run properly and efficiently in order for their research and operations to occur proficiently and on time. While there are many systems necessary for the operations at GRC, one of those most vital systems is the Central Process Systems (CPS). The CPS controls operations used by GRC's wind tunnels, propulsion systems lab, engine components research lab, and compressor, turbine and combustor test cells. Used widely throughout the lab, it operates equipment such as exhausters, chillers, cooling towers, compressors, dehydrators, and other such equipment. Through parameters such as pressure, temperature, speed, flow, etc., it performs its primary operations on the major systems of Electrical Dispatch (ED), Central Air Dispatch (CAD), Central Air Equipment Building (CAEB), and Engine Research Building (ERB).

In order for the CPS to continue its operations at Glenn, a new contract must be awarded. Consequently, one of my primary responsibilities was assisting the Source Evaluation Board (SEB) with the process of awarding the recertification contract of the CPS. The job of the SEB was to evaluate the proposals of the contract bidders and then to present their findings to the Source Selecting Official (SSO).

Before the evaluations began, the Center Director established the level of the competition. For this contract, the competition was limited to those companies classified as a small, disadvantaged business. After an industry briefing that explained to qualified companies the CPS and type of work required, each of the interested companies then submitted proposals addressing three components: Mission Suitability, Cost, and Past Performance. These proposals were based off the Statement of Work (SOW) written by the SEB. After companies submitted their proposals, the SEB reviewed all three components and then presented their results to the SSO. While the SEB does not select the company receiving the contract, they can make recommendations based on their findings to the SSO, who actually awards the contract. The SEB began work for this contract in July 2003 by writing the SOW and the selection will tentatively occur July 30, 2004. Contract awarding will take place Aug. 15. Following the awarding, the winning company has a 30-day Phase-in Period beginning Sept. 1, 2004 and full performance will begin October 1.

## **Work Done For the Safety and Assurance Directorate**

**Paul T. Struhar Jr.**

University of Akron

Freshman

**Mentor: Sandra Hardy**

### **Abstract**

The Safety and Assurance Directorate (SAAD) has a vision. The vision is to be an essential part of NASA Glenn's journey to excellence. SAAD is in charge of leading safety, security, and quality and is important to our customers. When it comes to programmatic and technical decision making and implementation, SAAD provides clear safety, reliability, maintainable, quality assurance and security.

I worked on a couple different things during my internship with Sandra Hardy. I did a lot of logistics for meeting and trips. I helped run the budget for the SADD directorate. I also worked with Rich Miller for one week and we took water samples and ran tests. We also calibrated the different equipment.

There is a lot more to meetings are party than people see. I did the logistics for meetings and I did one for a retirement party. I had to get work orders and set up the facilities where the event is going to take place. I also set up a trip to Plum Brook Station. I had to order vans and talk with the people up there to see when a good time was. I also had to make invitations and coordinate everything. I also help Sandy run the numbers in the budget. We use excel to do this, which makes it a lot easier.

I worked with Rich Miller for a week and learned a lot of new and interesting things. He is in the environmental safety office. I learned how to collaborate the equipment using alpha and beta sources. I went out with him and we took water samples and tested them for conductivity and chlorine.

I have learned a lot in the short time I've been here. It has been a great experience and I have had the pleasure of meeting and working with great people.

# Software Assurance of PLCs Training Course

**Jamarr Threatt**

Columbus College of Art and Design

Computer Animation

Undergraduate, Freshman

**Mentor: Cynthia Calhoun**

## ABSTRACT

Being heavily visually-oriented, I am a firm believer in communication and conveying emotions through the art of color, motion, and transformation. A four-part online training course was created in PowerPoint and needed to be translated over into a Flash format. Issues with the PowerPoint were that the size of the files caused noticeable delays when placed online, there were compatibility issues, and from a composition and design perspective, color schemes and layout left much to be desired. High contrast, pixilated yellow text spiraling and flying on to a background of overly rich hues of blue with cheesy gradient patterns was just not appealing to my eye, along with the menu directory buttons located at the top resembling blue pills of NyQuil on top of a stale gray border that had nothing to do with the background. The course itself is extremely broad and verbose, and will get monotonous very soon after starting. Moving about the course was very cumbersome as well.

My task was to convert the course into a Flash format, which would make it much more efficient by drastically reducing the size (The file size of all four parts of the actual course combined will ultimately not even be a *fifth* as big as one part of the original PowerPoint alone!); along with that, the course was made to be more interactive and user-friendly, as well as pleasing to the eye. Upon being viewed by fellow co-workers, nothing but positive feedback has been received. When beginning the presentation, onscreen comes a 3'2'', chubby, balding professor, who is a master in his knowledge of Programmable Logic Controllers (PLCs). He introduces himself and presents all of his vast knowledge over PLCs in a fun and innovative manner, making it much easier to acquire the information presented. A Scene Selection feature has been added making it a lot easier to jump from part to part and the back and forth arrows are much easier to utilize, and they are both less obtrusive than its PowerPoint predecessor. The user can also go at their pace, as the presentation pauses after at the end of each statement.

My project surprisingly somewhat dealt with my field of interest—though it was not computer animation, it was...still...animation done on a computer. I was able to incorporate my artistic talent and intuitive creativity into it, one thing I am very proficient at doing when it comes to what I do and what I will do in my profession as an artist/ computer animator. At first, I felt that there was no place for an artist within a faculty of scientists, engineers, chemists, mathematicians, and programmers, but I managed to fit in quite successfully.

## **Risk Management Implementation Tool**

**Shayla L. Wright**  
University Of Toledo  
Biomedical Engineering  
Freshman  
**Mentor: Cynthia Calhoun**

### **ABSTRACT**

Continuous Risk Management (CM) is a software engineering practice with processes, methods, and tools for managing risk in a project. It provides a controlled environment for practical decision making, in order to assess continually what could go wrong, determine which risk are important to deal with, implement strategies to deal with those risk and assure the measure effectiveness of the implemented strategies. Continuous Risk Management provides many training workshops and courses to teach the staff how to implement risk management to their various experiments and projects. The steps of the CRM process are identification, analysis, planning, tracking, and control. These steps and the various methods and tools that go along with them, identification, and dealing with risk is clear-cut.

The office that I worked in was the Risk Management Office (RMO). The RMO at NASA works hard to uphold NASA's mission of exploration and advancement of scientific knowledge and technology by defining and reducing program risk. The RMO is one of the divisions that fall under the Safety and Assurance Directorate (SAAD). I worked under Cynthia Calhoun, Flight Software Systems Engineer. My task was to develop a help screen for the Continuous Risk Management Implementation Tool (RMIT). The Risk Management Implementation Tool will be used by many NASA managers to identify, analyze, track, control, and communicate risks in their programs and projects. The RMIT will provide a means for NASA to continuously assess risks. The goals and purposes for this tool is to provide a simple means to manage risks, be used by program and project managers throughout NASA for managing risk, and to take an aggressive approach to advertise and advocate the use of RMIT at each NASA center.

# **The NASA Continuous Risk Management Process**

**Frank M. Pokorny**  
University of Cincinnati  
Aerospace Engineering  
Undergraduate, Sophomore  
**Mentor: Gary G. Kelm**

## **ABSTRACT**

As an intern this summer in the GRC Risk Management Office, I have become familiar with the NASA Continuous Risk Management Process. In this process, risk is considered in terms of the probability that an undesired event will occur and the impact of the event, should it occur (ref., NASA-NPG: 7120.5). Risk management belongs in every part of every project and should be ongoing from start to finish. Another key point is that a risk is not a problem until it has happened. With that in mind, there is a six step cycle for continuous risk management that prevents risks from becoming problems. The steps are: identify, analyze, plan, track, control, and communicate & document.

Incorporated in the first step are several methods to identify risks such as brainstorming and using lessons learned. Once a risk is identified, a risk statement is made on a risk information sheet consisting of a single condition and one or more consequences. There can also be a context section where the risk is explained in more detail. Additionally there are three main goals of analyzing a risk, which are evaluate, classify, and prioritize. Here is where a value is given to the attributes of a risk (i.e., probability, impact, and timeframe) based on a multi-level classification system (e.g., low, medium, high). It is important to keep in mind that the definitions of these levels are probably different for each project. Furthermore the risks can be combined into groups. Then, the risks are prioritized to see what risk is necessary to mitigate first. After the risks are analyzed, a plan is made to mitigate as many risks as feasible. Each risk should be assigned to someone in the project with knowledge in the area of the risk. Then the possible approaches to choose from are: research, accept, watch, or mitigate. Next, all risks, mitigated or not, are tracked either individually or in groups. As the plan is executed, risks are re-evaluated, and the attribute values are adjusted as necessary. Metrics are established and monitored as tools for risk tracking. Also a trigger or threshold should be set on the metric data that indicates when an action is needed. Results of this tracking are usually evaluated and reported in a relevant format at weekly or monthly meetings. Choosing controls is the subsequent step, which involves the effects of the tracking. The three basic controls are: close, continue tracking, and re-plan. Finally communicate & document is the last step, but occurs throughout the process. It is vital that main risks, plans, changes, and progress are known by everyone in the project. A good way to keep everyone updated and inform other projects of common issues is by thoroughly documenting project risks. NASA sees value in risk management and believes that projects have greater probability for success by using the NASA Continuous Risk Management Process.

# Emergency Response Manual

**Traci M. Barnett**

Kent State University

Political Science

Senior

**Mentor: Dr. Richard Soppet**

Safety and security is very important at NASA. The Security Management and Safeguards Office goal is ensure safety and security for all NASA Lewis and Plum Brook Station visitors and workers. The office protects against theft, sabotage, malicious damage, espionage, and other threats or acts of violence.

There are three types of security at NASA: physical, IT, and personnel. IT is concerned with sensitive and classified information and computers. Physical security includes the officers who check visitors and workers in and patrol the facility. Personnel security is concerned with background checks during hiring. During my internship, I met people from and gained knowledge about all three types of security. I primarily worked with Dr. Richard Soppet in physical security.

During my experience with physical security, I observed and worked with many aspects of it. I attended various security meetings at both NASA Lewis and Plum Brook. The meetings were about homeland security and other improvements that will be made to both facilities. I also spent time with a locksmith. The locksmith makes copies of keys and unlocks doors for people who need them. I rode around in a security vehicle with an officer as he patrolled. I also observed the officer make a search of a visitor's vehicle. All visitors' vehicles are searched upon entering NASA. I spent time and observed in the dispatch office. The officer answers calls and sends out officers when needed. The officer also monitors the security cameras.

My primary task was completing an emergency response manual. This manual would assist local law enforcement and fire agencies in case of an emergency. The manual has pictures and descriptions of the buildings. It also contains the information about hazards inside of the buildings. This information will be very helpful to law enforcement so that when called upon during an emergency, they will not create an even bigger problem with collateral damage.

# **College Bound with the Office of Educational Programs**

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**Mentor: Marie L. Borowski**

## **Abstract**

The Educational Programs Office at NASA Glenn Research Center hosts a variety of programs that takes on the hard task of getting students of all ages interested in pursuing careers in science, mathematics, and engineering. To help assist students along the way there are many programs to participate in such as: the explorers, shadowing opportunities, and paid internships. The Educational Programs Office not only creates learning opportunities for students, they also host workshops to help educators enhance their knowledge these fields. This summer I assisted Marie Borowski in the Educational Programs Office with the Tennessee State University College Bound Program.

The Tennessee state University College Bound Program is an intensive two-week summer academic workshop designed to introduce minority students to the profession of engineering. NASA Glenn Research Center sent forty dedicated students on a bus to Nashville, Tennessee to experience college life as a whole. At the college the students day consisted of a math class, aeronautics, ACT/SAT preparation, writing and research, African American Culture, computer science, and study sessions. The students also went on educational field trips to the Fisk Museum, the Space and Rocket Center, and the Parthenon Museum. On the last day of the program the students competed in an oratorical contest where the students made a PowerPoint presentation on the class that they enjoyed the most.

There were many processes that had to be put into action for the college bound program to run smoothly. The process started in early January with the preparation of applications. Once prepared, the applications were then sent to schools and past participants in hopes of receiving a well- qualified pool of applicants. Once the applications were received, a prescreening is done which ensures all of the information is complete. Then, they are reviewed by a panel, using a rubric to evaluate them, and the semifinalists are then selected. Interviews are held with the students and their parents had to be interviewed by a panel of judges and graded on a rubric. The scores were added up and the forty students were selected. My job this summer was getting the students ready to leave for Tennessee.

My job consisted of working very closely with my mentor, Marie Borowski, to compile the student data to provide it to the chaperones, TSU records, and NASA records. I learned about the vital communication between the NASA and the TSU program managers. After all the planning was done and the program had begun I had a chance to fly to Tennessee for six days to observe the students daily activities. The students had adjusted very well to the intense schedule, and seemed very enthusiastic about the activities to follow. The whole group was very attentive and enthusiastic program be longer.

My goals for the summer were all met. I wanted to learn and retain all the information I possibly could on the job I was given. I was very happy with the end result.

## **Conversion of the Aeronautics Interactive Workstation**

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This summer I am working in the Educational Programs Office. My task is to convert the Aeronautics Interactive Workstation from a Macintosh (Mac) platform to a Personal Computer (PC) platform. The Aeronautics Interactive Workstation is a workstation in the Aerospace Educational Laboratory (AEL), which is one of the three components of the Science, Engineering, Mathematics, and Aerospace Academy (SEMAA). The AEL is a state-of-the-art, electronically enhanced, computerized classroom that puts cutting-edge technology at the fingertips of participating students. It provides a unique learning experience regarding aerospace technology that features activities equipped with aerospace hardware and software that model real-world challenges. The Aeronautics Interactive Workstation, in particular, offers a variety of activities pertaining to the history of aeronautics.

When the Aeronautics Interactive Workstation was first implemented into the AEL it was designed with Macromedia Director 4 for a Mac. Today it is being converted to Macromedia DirectorMX2004 for a PC. Macromedia Director is the proven multimedia tool for building rich content and applications for CDs, DVDs, kiosks, and the Internet. It handles the widest variety of media and offers powerful features for building rich content that delivers real results, integrating interactive audio, video, bitmaps, vectors, text, fonts, and more. Macromedia Director currently offers two programming/scripting languages: Lingo, which is Director's own programming/scripting language and JavaScript. In the workstation, Lingo is used in the programming/scripting since it was the only language in use when the workstation was created.

Since the workstation was created with an older version of Macromedia Director it hosted significantly different programming/scripting protocols. In order to successfully accomplish my task, the final product required correction of Xtra and programming/scripting errors. I also had to convert the Mac platform file extensions into compatible file extensions for a PC.

## **MOBI and FEANICS Programming in LabView**

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**Mentor: Rochelle L. May**

The flight software engineering branch provides design and development of embedded real-time software applications for flight and supporting ground systems to support the NASA Aeronautics and Space Programs. In addition, this branch evaluates, develops and implements new technologies for embedded real-time systems, and maintains a laboratory for applications of embedded technology. This branch supports other divisions and is involved with many other projects. My mentor Rochelle and I are involved in the Fluids and Combustion Facility (FCF) project, the MOBI project, and the FEANICS project.

The Fluids and Combustion Facility (FCF) will occupy two powered racks on the International Space Station (ISS). It will be a permanent modular, multiuser facility to accommodate microgravity science experiments onboard the ISS's U.S. Laboratory Module. FCF will support NASA Human Exploration and Development of Space program objectives requiring sustained, systematic research in the disciplines of fluid physics and combustion science. The fluids experiment is called FIR and the combustion experiment is called CIR.

The MOBI Experiment is an experiment that is performed to understand the physics of bubble segregation and resuspension in an inertia, monodisperse gas-liquid suspension, and to understand how bubble pressure resists segregation in suspensions with continuous phase inertia.

The main focus of FEANICS and the solid combustion experiments will be to conduct basic and applied scientific investigations in fire-safety to support NASA's Bioastronautics Initiative. Based on data obtained in microgravity and experience gained from the beginning of the U.S. manned space program, these normal gravity flammability assessments have been assumed to be conservative with respect to flammability in all environments. However, some of the complex interactions that govern ignition and flame growth can only be evaluated in the long durations of microgravity available on the ISS.

Before any of these projects actually go to the ISS, they are going to be tested on NASA's KC-135 0g airplane, the KC-135 Low-G Flight Research aircraft (a predecessor of the Boeing 707) is used to fly parabolas to create 20-25 seconds of weightlessness so that the astronauts can experience and researchers can investigate the effects of "zero" gravity.

My mentor and I have been working with Labview to write the programs that are going to acquire, analyze and present the data acquired from these Test flights on the KC-135. We have been working closely with electrical, and mechanical engineers to make sure the program and the hardware can communicate and perform the operations necessary for the flight test.

LabVIEW delivers a powerful graphical development environment for signal acquisition, measurement analysis, and data presentation, giving you the flexibility of a programming language without the complexity of traditional development tools. The programming of the control panel and the code are both done in GUIs which allow for flexibility in the code and the program.

# **Effects of Initial Powder Size on the Mechanical Properties and Microstructure of As-Extruded GRCop-84**

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GRCop-84 was developed to meet the mechanical and thermal property requirements for advanced regeneratively cooled rocket engine main combustion chamber liners. It is a ternary Cu-Cr-Nb alloy having approximately 8 at% Cr and 4 at% Nb. The chromium and niobium constituents combine to form 14 vol% Cr<sub>2</sub>Nb, the strengthening phase. The alloy is made by producing GRCop-84 powder through gas atomization and consolidating the powder using extrusion, hot isostatic pressing (HIP) or vacuum plasma spraying (VPS). GRCop-84 has been selected by Rocketdyne, Pratt & Whitney and Aerojet for use in their next generation of rocket engines.

GRCop-84 demonstrates favorable mechanical and thermal properties at elevated temperatures. Compared to NARloy-Z, the currently used material in the Space Shuttle, GRCop-84 has approximately twice the yield strength, 10-1000 times the creep life, and 1.5-2.5 times the low cycle fatigue life. The thermal expansion of GRCop-84 is 7.5-15% less than NARloy-Z which minimizes thermally induced stresses. The thermal conductivity of the two alloys is comparable at low temperature but NARloy-Z has a 20-50 W/mK thermal conductivity advantage at typical rocket engine hot wall temperatures. GRCop-84 is also much more microstructurally stable than NARloy-Z which translates into better long term stability of mechanical properties.

Previous research into metal alloys fabricated by means of powder metallurgy (PM), has demonstrated that initial powder size can affect the microstructural development and mechanical properties of such materials. Grain size, strength, ductility, size of second phases, etc., have all been shown to vary with starting powder size in PM-alloys. This work focuses on characterizing the effect of varying starting powder size on the microstructural evolution and mechanical properties of as-extruded GRCop-84.

Tensile tests and constant load creep tests were performed on extrusions of four powder meshes: +140 mesh (>105  $\mu\text{m}$  powder size), -140 mesh ( $\leq 105 \mu\text{m}$ ), -140/+270 (53 - 105  $\mu\text{m}$ ), and -270 mesh ( $\leq 53 \mu\text{m}$ ). Samples were tested in tension at room temperature and at 500°C (932°F). Creep tests were performed under vacuum at 500°C using a stress of 111 MPa (16.1 ksi). The fracture surfaces of selected samples from both tests were studied using a Scanning Electron Microscope (SEM). The as-extruded materials were also studied, using both optical microscopy and SEM analysis, to characterize changes within the microstructure.