UCONN
SCHOOL OF ENGINEERING

Materials Science & Engineering

SENIOR DESIGN

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Team 1: Design of Carbon Fiber Resin Composites for Improved Fatigue Behavior

Sponsored by: MSH1 Bicycle Works
Sponsor Advisor: Matthew Klucha

Shannon Gagne

Design of Carbon Fiber Resin Composites for Improved Fatigue Behavior focuses on the long term behavior of carbon fiber resin composites in bicycle frames. Carbon fiber resin composites are an important development in many industries but especially the transportation industry because of their incredible strength and very low weight. Unfortunately, these composites are generally quite expensive so optimization of the amount of material needed for best performance is important. Because of their relatively new emergence in the industry, the fatigue behavior that governs the material's failure is not well documented. This project seeks to determine what factors affect the fatigue life of carbon fiber resin composites and how. This investigation will help to create a carbon fiber resin composite material with optimum fatigue performance. This project utilizes a vacuum bagging resin infusion process to infuse an epoxy resin in four layers of carbon fiber creating a solid composite plate. These plates are then cut by water-jet into 1"x5" coupon pieces. Each plate is a different type of sample with varying carbon fiber fabric types, fiber orientation, and surface preparation. A factorial design is implemented to obtain data for each individual variable without interference of other factors. The coupons will then be tensile tested to determine ultimate tensile strength and Young's modulus. This information will help in determining the load and frequency for the flexural fatigue tests that will follow. A three-point bend test set-up will be used and the samples will be fatigue tested until failure. The data obtained in these tests will then be reviewed and compared to determine how each variable affects fatigue life and determine which variables provide the optimum fatigue life in carbon fiber resin composites for bicycle frames.

Team 2: Laser Assisted Manufacturing of Inserts for Honeycomb Shelves

Sponsored by: Sikorsky Aircraft Corporation and Sikorsky Innovations, Inc.
Sponsor Advisor: Dr. Michael Urban, Alexander Weintraub, Paul Inguanti

Mackenzie Merrick, Giovann Giarratan

Sikorsky
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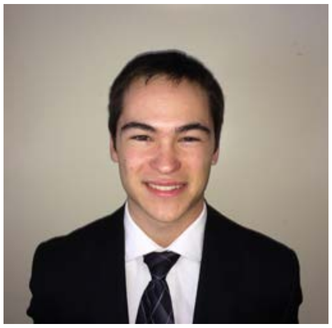
Sikorsky Aircraft is interested in the use of additive manufacturing to produce parts for aircrafts. Specifically, the components we are interested in are inserts, which are used to secure electronics to the honeycomb shelves they will be housed in. Our focus is on designing a new insert using additive manufacturing that maintains the same, if not better, mechanical properties as exhibited in the currently used insert made through traditional manufacturing methods. Additionally, our goal is to make an insert that is lighter than what is currently used through using a lighter material and reducing the volume of the insert. In conjunction with a team of Mechanical Engineers, we have designed a new model through Computer Aided Design software. This design will be printed and installed into the honeycomb panels as it would be in a helicopter, and this component as a whole will be subjected to shear, tension, and torsion tests used to mimic the loads the helicopters experiences. These inserts are not typically prone to failure except in a crash landing. It is important to note that failure generally does not occur in the insert itself, rather in the connection between the insert and the honeycomb structure. The shear, tension, and torsions tests are modeled after tests conducted at Shur-Lok, who is a current supplier of inserts to Sikorsky. We will be conducting 6 repetitions of each test for the new insert design to compare to results we obtain after testing the current insert design in shear, tension, and torsion. We will be analyzing the microstructure of the printed insert as compared to the insert made through traditional manufacturing methods to see any correlation to the mechanical properties the inserts have exhibited. Additionally, we will be performing fracture analysis on the inserts once they have undergone mechanical testing to observe the points of failure in the insert. Based upon our results from mechanical testing, we will give our final recommendations to Sikorsky regarding the feasibility of additive manufacturing for producing small parts for aircrafts. Included in our recommendations will be a cost model to convey the cost of mass production through additive manufacturing versus traditional manufacturing methods.

Team 3: A Predictive Model for Specification and Control of Advanced Electron Beam Welding

Sponsored by: PTR-Precision Technologies, Inc
Sponsor Advisor: John Rugh, Gary LaFlamme



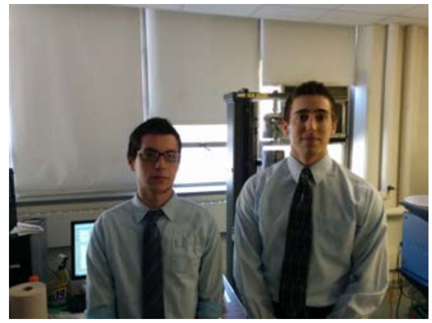
Daniel Cunningham

PTR
PRECISION TECHNOLOGIES, INC.

My Capstone design project, sponsored by PTR-Precision Technologies, deals with electron beam welding, a process that uses a high-energy electron beam to transfer energy into a material. Electron beam welding is known for producing precise welds with small heat affected zones and is often used to manufacture or repair high-value components, such as turbine blades for jet engines. My project deals specifically with electron beam welding of nickel-based superalloys. These materials often crack during the welding process, hurting the mechanical properties of the component. The goal of the project is to reduce or eliminate cracking in these welds by optimizing the power of the welding beam and by using pre- and post-weld heat treatments. PTR has advanced technology that allows for extremely high-frequency deflection of the electron beam, essentially allowing them to weld simultaneously with multiple beams of different power and shape. In my project, this process will be modeled using a finite element method in COMSOL Multiphysics. Up to three electron beams (for welding, pre-heating, and post-heating) of different powers and geometries will be used in the model. The model has been developed to calculate the temperature profile and residual thermal stress within the material throughout the welding process. After running simulations of the model for various beam powers and patterns, several sets of optimal parameters will be chosen based on the predicted temperature and stress profiles. These parameters will be used to weld physical pieces of material. The heat affected zone of these welds will be examined with optical and scanning electron microscopy. The welds will be evaluated based on the degree of cracking, using metrics such as total number of cracks and average crack length, and compared to a control material welded with a single electron beam and no pre- or post-heating. The resulting data will be analyzed for patterns between input parameters and the degree of cracking in the weld. The end goal of the project is to be able to use the predictive model to determine the optimal welding parameters to minimize cracking in the welding of a component made of a nickel-based superalloy.

Team 4: Additive Metal Processing for the Production of Stainless Steel Surgical Tools

Sponsored by: Covidien
Sponsor Advisor: Dr. William Powers



Scott Suvall, Daniel Violette

Covidien is interested in gaining a general understanding of Direct Metal Laser Sintering (DMLS) as a possible means of production for their complex stainless steel parts that are used in surgical equipment. More specifically, they are interested in investigating the properties of 17-4 PH stainless steel, which is a mechanically strong, corrosion resistant steel that experiences age hardening at elevated temperatures due to copper particle precipitation. The objective of this project is to demonstrate the capability of additive manufacturing technology by investigating if DMLS-produced 17-4 PH Stainless Steel maintains similar mechanical properties when compared to 17-4 PH bar stock, while maintaining acceptable levels of surface roughness and dimensional accuracy. Stainless steel DMLS tensile test specimens built to ASTM standards by Linear Mold & Engineering will be exposed to a heat treatment and mechanically tested at UConn to meet this objective. 17-4 PH bar stock tensile samples will also be provided by Covidien and tested as a control. Variables in the DMLS production process will be modified in order to determine their resulting effects on microstructure and mechanical properties, including orientation of parts on the build plate, steel powder age, and steel powder size. These variables could have a dramatic impact on porosity, ultimate tensile strength, yield strength, elongation, and hardness, among other mechanical properties. The tensile samples will be built with both retired and active powder, 20 mm and 40 mm layer sizes, and build orientations ranging from 0° to 90° on the build plate. All samples are tested following a solution treatment at 2000°F followed by age hardening at 900°F for an hour (which corresponds to the ASTM H900 treatment). The development of this technology could have profound impacts on production and manufacturing around the world. Today, many companies and organizations including Connecticut industries such as United Technologies Corporation and Covidien are interested in the possibilities of additive manufacturing. By developing additive manufacturing and DMLS, companies are seeking to reduce production time and cost for components with complex geometries that are traditionally hard to machine. This senior design project will offer useful insight into the current state of DMLS additive manufacturing technology for use in production and manufacturing environments.

Team 5: Improved Repair of Sikorsky Firewalls by Laser Welding Methods

Sponsored by: Sikorsky Aircraft Corporation and Sikorsky Innovations, Inc; KTI
Sponsor Advisor: Dr. Michael Urban

Joshua Leveillee, Derek Baxter

Sikorsky
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Repair methods for aircraft are critically important to both commercial and military applications. Sikorsky has taken an interest in using laser-welding methods to repair helicopter firewalls, the metallic wall surrounding the engine, to replace rivet repair methods. By doing so, the repair method will create a continuity between the firewall material and repair patch. The current rivet repair method creates stress concentrators. Past senior Capstone groups have thoroughly investigated the static strength and microstructure of lap welds for said repairs. It was found that the highest allowable voltage without resulting in laser punch through (melting through the patch material) is ideal to use for achieving high static strength. This high voltage results in a martensitic phase, which is predicted to be weak in fatigue. This year, Sikorsky wishes to determine the fatigue characteristics of the replicated welded firewall materials. Firewall material is cut into half test gauges in preparation for welding. Samples are cleaned with acetone and Kroll's Etchant (HF) to ensure an ideal welding surface. Three different joining conditions and baseline materials samples will be compared in fatigue. One set of samples will be welded to the ideal voltage, the next set will be welded and heat-treated, and the final set will be joined by rivet to replicate the original repair method. Baseline firewall material will also be analyzed for fatigue properties. A comprehensive set of stress-cyclic life curves will be developed for each of the three selected test groups and baseline material. The aim is to compare the fatigue behaviors and deduce advantages or disadvantages to replacing the rivet repair method with laser welding methods. Our criteria for success are creating a welding repair method that can be performed on sight in the field and is superior in strength and fatigue durability to the current riveting method. This project will aid in the continuous pursuit of life-long learning and enforce the ethical responsibly to the engineering discipline.

Team 6: Process and Chemistry to Produce UV Stable Colored Cable Insulation

Sponsored by: Rockbestos-Suprenant Cable Corporation, Inc.
Sponsor Advisor: Daniel Masakowski, Ivan Stannard

Rafael Patel

Electrical cables used in outdoor environments are subjected to harsh UV radiation from the sun. To survive outdoors, cables must be resistant to UV radiation in order to avoid degradation. Over a cable's lifetime, UV degradation can easily lead to complete failure, and eventually compromise the conductive core. Electrical cables are composed of an inner conductor core, polymer insulation, and an outer protector called the cable jacket. The jacket adds both color and UV protection to the cable. Polyolefins, the base polymers used in the jacket, are not susceptible to UV degradation in pure form, but post processing the presence of carbonyl and other groups, which absorb ultraviolet radiation and subsequently initiate chain cleavage, eventually lead to complete degradation of the polymer over time. Since the polymer is not by itself resistant to UV radiation, additives called UV-stabilizers are mixed in to the polymer blend to provide this property. Currently, carbon black is the most common additive used to prevent photodegradation, however, carbon black does not allow for the manufacture of colored cables. RSCC has sponsored this project with the goal of finding a UV-stabilizing additive that maintains acceptable UV resistance, while also allowing for color addition. The processing of the jacket involves electron irradiation; this step crosslinks the base polymer to give it physical durability. While there are of course pigments and additives that allow for colored cables (in addition to black), there are as of yet no successful combinations that are not degraded by irradiation, or that do not inhibit the crosslinking of the base polymer during irradiation. In this project, a white cable jacket with a new UV-stabilizer has been provided by the company. The goal is to verify the viability of the additive in this jacket for outdoor use. This includes both physical and chemical analysis of the cable to fully understand the role the new additive plays in the weathering of the jacket, and how degradation develops during its lifetime. The crosslinking process will also be examined in this project by altering the level of irradiation across samples. Using this variation, the differing effects on the UV-stabilizer can be analyzed.

Team 7: Computational Design of Predictive Models for Dislocation Evolution in Metallic Materials

Sponsored by: Prof. Avinash Dongare

Sponsor Advisor: Dr. Ramakrishna R. Valisetty, Dr. Raju Namburu, US Army Research Center, Dr. David Furrer, Pratt & Whitney, Dr. Dmitri Novikov, UTRC

Karoon Mackenchery

The current research in the design of materials focuses on the applicability in extreme environments. These materials will require enhanced performance and minimal degradation at extremes of mechanical stress, strain, and temperature. For example, materials used for armor need to have high strengths and toughness, as well as enhanced failure resistance. There is a need to process materials with optimal properties under these extreme environments. If these challenges are not met, the combination of harsh environments will cause the materials to degrade and fail earlier than the limits defined by the structure-property relationships of the materials. In order to design materials with optimized properties for various applications, a number of factors (microstructure, chemistry, deformation behavior, degradation behavior, etc.) must be considered to understand the intrinsic limits of the materials performance. For metallic systems the mechanical behavior is determined by the evolution of dislocations. The evolution of dislocations is determined by several factors, such as the microstructure of the system, loading conditions, temperatures, pressures, etc. The quantitative contributions of these factors, however, are still unknown. Knowledge of how these variations affect dislocations at the atomic scale is important in the design of metallic systems to be used under extreme conditions.

Team 8: Develop Design Rules for Diffusion Brazing in Superalloy Joints

Sponsored by: Pratt & Whitney
Sponsor Advisor: Edward Szela, Dr. Agnieszka Wusatowska-Sarnek

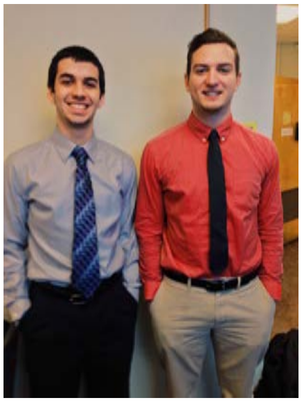
Alexander Reardon

Pratt & Whitney
A United Technologies Company

Pratt & Whitney is currently investigating the viability of manufacturing mid-turbine frames composed of the nickel-based superalloy MAR-M-247 as a means of increasing their product performance. Due to the complex geometry of the mid-turbine frame, processing the part as one complete casting has proven to be difficult. Instead, individual segments of the mid-turbine frame are cast individually and joined in a later processing step. Due to the high operating temperatures and pressures of the mid-turbine frame and the thermo mechanical properties of MAR-M-247, conventional materials joining techniques such as welding, diffusion bonding, and conventional brazing have proven to be insufficient in joining the individually cast segments to form the finished mid-turbine frame. Pratt & Whitney has opted to join the individually cast segments through a materials joining technique called diffusion brazing, or transient liquid phase bonding (TLPB). One of the greatest advantages diffusion brazing offers over other more-conventional materials joining techniques is that it can produce joints whose microstructure is nearly identical to that of the base alloy resulting in uniform composition and thermo mechanical properties across the joint. However, TLPB joints may exhibit some level of inhomogeneity due to athermal solidification or crack formation. Diffusion brazing can be used to join advanced material systems, and often involves complex interactions between components, establishing the need for further analysis of the diffusion brazing process in MAR-M-247. This project aims to investigate the effects of various process parameters on diffusion brazing of MAR-M-247 samples. Additionally, an optimized heat treatment will be designed which can produce crack-free, isothermally solidified TLPB joints in MAR-M-247 given a set of initial parameters. In an effort to streamline testing and reduce experimental costs, microstructural data acquired from this research project will be sent to Pratt & Whitney to validate their currently existing diffusion brazing predictive model. Should Pratt & Whitney possess a computer model which can predict the microstructure of a TLPB joint without the need to conduct expensive heat treatments and waste resources, they will have an economically competitive advantage over their competitors in processing MAR-M-247 mid-turbine frames.

Team 9: Laser Based Additive Processing of Ultra-hard Coatings on Stainless Steels

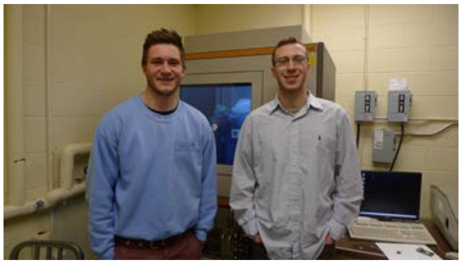
Sponsored by: RBC Bearings, Inc.
Sponsor Advisor: Dr. John Cowles, Wayne Samuelson


Nathan Martin, Anthony Manni

Plain bearings used in high performance applications must have sufficient structural integrity to withstand any tensile, compressive, shear or torsional stresses the part may encounter. Additionally, the surface of the bearing must be wear resistant in order to prolong the life of the part. However, most structural materials have relatively high rates of wear. In order to achieve this combination of strength and wear properties, hard coatings can be applied to the bearings to make them more wear resistant. Typical coating techniques include both thermal spraying and weld overlay coatings. Thermal spraying does not affect the strength of the underlying material, but generally has high porosity and lacks a metallurgical bond with the substrate material. Weld overlay coatings generally have lower porosity and a strong bond with the substrate material, but also compromise its strength. Currently, coatings are being formed using a nitriding process which produces a hard metal nitride layer. While this nitride layer yields favorable wear properties and do not affect the overall strength of the part, it tends to be extremely thin and brittle. This, combined with occasional issues with the process of nitriding, often leads to the scrapping of parts. A relatively new process which shows promise is laser cladding. In laser cladding, a feed material, usually in the form of a powder, is sprayed toward the surface of the material. A laser then rapidly heats and melts the metal particles, which then contact the substrate and rapidly re-solidify. This process combines the advantages of both thermal spraying and weld overlay coatings; laser cladded coatings exhibit low porosity and a metallurgical bond while leaving the strength of the underlying metal intact. Additionally, the exact nature of the coating can be tuned by varying various input parameters. In this project, the feasibility of using laser cladding to create wear resistant coatings is explored. Using stainless steel substrates and a proprietary powder provided by the nanosteel company, a series of coatings were made using varying input parameters in order to find the range of parameters which will produce optimal coatings. The goal of this project is to produce laser cladded coatings free of porosity and cracks, which form a strong bond to the substrate and contain sufficient wear properties.

Team 10: Additive Manufacturing of Tooling to Repair Complex Shape Fiber Composites

Sponsored by: Sikorsky Aircraft Corporation and Sikorsky Innovations, Inc.
Sponsor Advisor: Dr. Michael Urban, Paul Inguanti



Luke Wiles, Marc Chalé

Sikorsky
A United Technologies Company

Blemishes, dings, tears and cracks occur throughout an aircraft's life. Therefore, an effective system is needed to repair the surface flaws. Current repair technologies are labor intensive and susceptible to defects. The goal of this project is to design a system which more accurately repairs damaged surfaces, reduces the possibility of human error, reduces long term repair costs, decreases repair time, and allows for environmental sustainability as well as human safety. In order to complete the goal, the team will design a nonmetallic tooling to repair aircraft panels by selecting material systems, choosing an additive manufacturing fabrication process and by optimizing geometry. The tooling will be used to cure patches for damaged surfaces up to 12 inches by 12 inches in area. The patches will fit onto the damage surface with a dimensional tolerance of .010 inches. The entire repair process will be compatible for use in the field or aboard large naval vessels. The mold will be recycled or reused. The team working on this project is composed of a mechanical engineering component and a material science and engineering component. The two components have collaborated to design an overall solution for the project. This paper outlines the progress made by the material science and engineering component. Five primary steps were established as the solution to the project. The steps are a) image the damaged panel surface, b) develop a computer assisted design (CAD) for a mold, c) use additive manufacturing to print the mold, d) cure an epoxy patch on the mold, e) apply the patch to the damaged surface, and f. recycle the mold. A comprehensive material search was performed to select viable materials for each aspect of the design. The most critical material for the solution was the mold material. A list of viable mold materials was compiled. Each material on the list was quantitatively ranked based on its properties. 2 high performance thermoplastics were selected for laboratory testing. Poly ether ether ketone (PEEK) and poly ether ketone ketone (PEKK) as well as a carbon filled PEEK will be investigated for performance as a mold for composite panel repair patch. Future work will involve laboratory analysis of these polymers.

Team 11: Tribology of S-Monel – Influence of Alloy Processing History & Material Properties

Sponsored by: UTC Aerospace Systems
Sponsor Advisor: Kevin Rankin, David Grulke

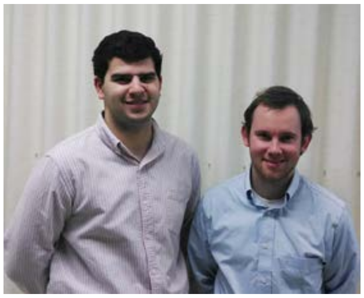
Steven Onorato

UTC Aerospace Systems

A seal ring used in a butterfly valve is experiencing more wear than expected when is closes and slides along the interior of the valve housing. The material that composes this seal ring is Silicon Monel, which is a precipitation hardened nickel copper alloy containing between 3.5 and 5% silicon with small amounts of iron and manganese exhibiting a very favorable combination of hardness and ductility. One possible cause identified in the investigation of this valve was a lower hardness value of the seal ring. The objectives for this project are therefore to identify the cause of the lower hardness value of the S-Monel seal ring, to investigate the effect of each heat treatment parameter on hardness and wear, study the relationship between hardness and wear, and attempt to identify a heat treatment that increases hardness to a range of 34-41 on the HRC scale, and also increases the wear resistance of the S-Monel to levels higher than baseline samples.
The success of this project will be measured by the strength of the relationship between wear and hardness when plotted against each other, as well as the identification of the significance of each heat treatment parameter, and whether the hardness and wear resistance of the S-Monel can be improved to acceptable levels. A fractional factorial experiment will be designed around three heat treatments found in literature search and then analyzed by Analysis of Variance (ANOVA). The material properties that will be investigated are hardness, mass loss upon wear testing by means of a pin on disk wear test, and microstructural features such as dendrite spacing and grain size. When all the data is collected and analyzed the material properties will be plotted against each other and relationships and trends will be identified and the most favorable heat treatment conditions will be found. This project is limited by time and the conditions of the wear testing as the actual seal ring operates under much more extreme and dynamic conditions.

Team 12: Modify Design and Manufacturing for ESP Cable Systems in Extreme Environments

Sponsored by: Marmon Utility – Kerite Pump Cable
Sponsor Advisor: Michael Norton, Mohamed Alameh



Alejandro Lluberes, Parker Wells

In response to several failures observed in Marmon-Utility Kerite's electrical submersible pump (ESP) power cables, an investigation of the cause for failure was conducted. ESP systems are a form of artificial lift used in oil wells as deep as 10,000 feet. The cables used to power the motor that drives the pump, must withstand very high temperatures, high pressures, and highly corrosive chemicals and gases including hydrogen sulfide, carbon dioxide, and chlorine. Power cables typically consist of a copper conductor, a layer of electrical insulation, and a lead sheath extruded over this system to protect it from the harsh environment of the well. This project focuses on the corrosion effects of the well environment on the lead sheath. Of particular interest is to develop a relationship between the chemical composition of the lead sheath, the pressure of hydrogen sulfide in the well, and the effect of decompression on the lifetime of the cable. Decompression is a common failure mechanism in which diffusion of high pressure gas penetrates the lead sheath through micro cracks originating on the surface. An equilibrium state between the inside of the cable and well is established over a period of weeks or months. When the ESP system is suddenly removed from the well, which is common for maintenance issues, the pressure outside the cable decreases drastically resulting in the generation of a pressure gradient between the inside and outside of the cable. This gradient causes gas to rapidly escape the cable which then causes the insulation and lead sheath to swell. This swelling of the cable will eventually cause an electrical failure and subsequent shutdown of the system costing oil companies time and money. While decompression is often the ultimate cause for failure, our goal is to understand how corrosion may accelerate this process and propose either a manufacturing or design modification to enhance the lifetime of the cable.

Team 13: Design Characteristics for Alternate Anaerobic Adhesives

Sponsored by: UTC Aerospace Systems
Sponsor Advisor: Michael Folsom, David Grulke

Stephen Consoles, Jacob Wrubel

UTC Aerospace Systems

Anaerobic threadlockers and retaining compounds are used in a variety of applications in aerospace. To increase economic flexibility, comparable adhesives from leading manufacturers will be tested alongside the products currently used by UTC Aerospace Systems to verify their viability in various applications. Threadlocking adhesives will be tested on nut/bolt samples for breakaway and prevailing (at 180^o) torque strengths, while retaining compounds will be tested on pin/collar samples for shear strength. If possible, preeminent adhesives will be identified. The project will investigate the effects of short term high and low temperature exposure, as well as a long term heat treatment (1000 hours at 150^{o}C). Most samples will be assembled with plain-carbon steel parts, however some adhesives will be tested on cadmium plated nuts/bolts to explore the effect of the substrate material. This project will also study the importance of cure time and bond width, and will also perform failure analysis on key samples to provide insight to the failure mechanisms. A new test method will be developed to imitate real-life conditions via fatigue testing. This will involve the manufacturing of a custom fixture, and an unprecedented design of experiment.

Team 14: Tooling and Processing Optimization for Complex Geometry, Nonferrous Castings

Sponsored by: Sikorsky Aircraft Corporation and Sikorsky Innovations, Inc.

Sponsor Advisor: Paul Inguanti, Dr. Michael Urban, Alexander Weintraub

Nathan Lussier,
Sean Reynolds (missing from photo)

Sikorsky
A United Technologies Company

Sikorsky currently has complex aluminum and magnesium castings, which have had nearly 0% first pass yield in manufacturing due to various defects being found in each casting. In order to save time and money, Sikorsky is interested in using ProCAST, a finite element method software, to predict defects before a casting is ever produced. The goal of this project is to determine the usefulness of ProCAST, by creating a casting that is good, or mostly defect free, and one that is bad, which will contain may defects. The castings were designed to promote the defects that were of the greatest interest to Sikorsky. Once the model of this casting was designed, a pattern board will be created to build the mold. The castings will be made of Aluminum 357, which is an aluminum-silicon alloy utilized in Sikorsky aluminum castings. The castings will be made using the sand casting process, in which a mold is created by packing sand around one half of a pattern, which is the positive of the casting. The pattern is removed, leaving a negative for the liquid aluminum to fill. Both a good and bad casting will be made, using the same pattern, by changing the foundry parameters, such as superheat, chills, and other process variables, to create or remove the defects. Thermocouples will also be placed inside the mold, to track the liquid front, and temperature of the casting, which will later be compared to ProCAST's results. Once the castings are made, they will be sectioned and evaluated to determine where the defects are located. The process parameters will be entered into ProCAST, and the program parameters will be optimized to create the result seen in the castings. The goal of this project is to determine ProCAST's ability to accurately predict defects. If ProCAST is found to be capable of accurately predicting the defects of interest, it will save Sikorsky time and money, while also helping make parts of more consistent quality. Castings could be modeled before they were sent out to be cast, avoiding the cost for castings that would later be scrapped or re-processed. ProCAST would then be a valuable tool to the engineering team at Sikorsky.