Mechanical and Aerospace Engineering at West Virginia University

2006-2007 Annual Report

www.mae.wvu.edu

TABLE OF CONTENTS

Greg Babe, President and CEO of Bayer Material Science LLC, being inducted into the Academy of Distinguished Alumni of MAE

The mission of the College of Engineering and Mineral Resources is to prepare students to practice their profession and to contribute to the well being of society through academic study, research, extension and service.

MESSAGE FROM THE CHAIR

Fulfilling our Mision

Among the 50 states, West Virginia bests only Louisiana, Arkansas and Mississippi in median income. With an industrial-age manufacturing sector besieged by global competition and coal-based energy industry ominously threatened by soon-to-be government-mandated CO2 emissions, one might wonder why we are training more and more mechanical (and aerospace) engineers.

Evolving from the land-grant mandate of 1862, our clear mission today is to lead the economic development of the state, and this is our approach.

First, there is the *local* economic development impact of sponsored research and tuition-generating instruction. We are in the business of exporting value-added knowledge. We neither pollute nor utilize natural resources. Our revenue comes from research contracts and tuition. Our toil translates into local economic development in the form of high salaries for highly technical staff, including faculty, post-docs, graduate students, engineering scientist and more. Our department is increasingly successful in these efforts.

For example, this year we topped $10,000,000 in research expenditures, derived largely from industrial and federal funding. These monies are spent mainly on salaries that contribute directly to the local economy. Second, to effect *broad*, state-wide, economic development one must catalyze the creation of new, high-value added industry. Our proposition is that by creating a surplus of highly trained engineers and engineering scientists, many of whom wish to live in this wonderful state, we satisfy a prerequisite need for the creation and relocation of high-value added industry to the state.

As one savvy economic development official put it, “To lure a company into the state, it is easier and quicker for us to build a road than to train the workforce they need,” especially a highly technical cadre of engineers that may take four to eight years to train.

Ever Barbero, Ph.D.

For us to lure the best students into our department we have no choice but to become competitive at the national and international level. The lightning rod that guides our efforts is *reputation*, and we pursue it relentlessly. Not just reputation for reputation’s sake but rather as a metric that is a reliable indicator of excellence in all academic and scientific endeavors.

Reputation is hard to quantify but the public recognizes it when it sees it. This year marks the first time that Mechanical Engineering at West Virginia University has been ranked among the top 100 best ME programs in the nation by *US News and World Report*. While we are proud of the progress we have made, we are not really satisfied with the actual ranking. After all, who wants to be 82nd best? In our hearts, we want to be in the first or second tier, among the top 50.

Our recipe for achieving this goal, and our commitment to it, should be evident from the improving performance indicators listed on the back cover of our annual report. There you can see that the number of Ph.D. graduates, publications and a host of other indicators have been rising steadily.

To continue our quest, we need your help. Yes, everyone who cares, like you, can help Mechanical and Aerospace Engineering at West Virginia University in some way. Let us find that way together.

NEW FACULTY MEMBER – HAILIN LI

EDUCATION

Ph.D. (2004), University of Calgary, Canada

M. Sc. (1994), State Key Engine lab, Tianjin University, Tianjin, China

B. Sc. (1991), Harbin Engineering University, Harbin, China

WORK EXPERIENCE

Assistant Research Officer (2004-2007), National Research Council Canada

Research Engineer (1994-2000), China Automotive Technology and Research Center

Visiting Scholar (1999), Ford Motor, MI, USA

FUNDED RESEARCH PROJECTS

"Lean burn technologies for internal combustion engine", PERD/AFTER Program, Canada

"Advanced fuels for HCCI engine", CCT&II Program, Canada

Dr. Hailin Li joined West Virginia University as an Assistant Professor in August 2007. Before joining WVU, Hailin was assistant research officer at the National Research Council Canada. He received his Ph.D from University of Calgary in 2004. He also worked as research engineer in China Automotive Technology and Research Center before moving to North America in 2000. Hailin has been married to Li Jin since 1996. They have a lovely daughter, Cathy, who enjoys a happy and diverse life moving from China, to Canada and now to the United States.

Hailin's expertise is in the area of combustion and exhaust emissions of I.C. engines, advanced combustion, and alternative fuels. In the past decades Dr. Li has conducted research projects and built his expertise in cutting-edge technologies to reduce exhaust emissions and improve fuel economy of I.C. engines. These projects include the national NGV program in China, as well as the advanced lean combustion concepts and clean fuel projects in the PERD/AFTER and CCT&II programs funded by the Government of Canada.

Dr. Li has been very active in research associated with I.C. engines, combustion, and exhaust emissions. These have resulted in journal and conference publications, editorial work reviewing manuscripts and proposals, hosting and organizing professional meetings and conferences. He is member of several professional societies including SAE, ASME, and Combustion Institute.

MOST RECENT PUBLICATIONS

Li, H.L., Karim, G.A. and Sohrabi, A., 2007, "The lean mixture operational limits of a S.I. engine when operated on fuel mixtures", in press, Transaction of ASME, Journal of Engineering for Gas Turbines and Power.

Li, H.L. and Karim, G.A. 2007, "Modeling the performance of a turbo-charged S.I. natural gas engine with cooled EGR", in press, Transaction of ASME, Journal of Engineering for Gas Turbines and Power.

Li, H.L., Guo, H.S., Neill, W.S., Chippior, W., and J. D Taylor, 2006, "An experimental and modeling study of HCCI combustion using n-heptane", in press, Transaction of ASME, Journal of Engineering for Gas Turbines and Power

Li, H.L. and Karim, G.A., 2006, "An experimental investigation on the knock and combustion characteristics of CH4, CO, H2 and their binary mixtures", Proc Instn. Mech. Engrs., Journal of Power and Energy, Vol. 220, Issue 5, pp. 459~471, 2006

STUDENT PROJECTS – CHALLENGE X

Challenge X is a four year competition sponsored by the U.S. Department of Energy, General Motors, and other partner companies. Seventeen universities from across the United States and Canada were selected to participate in Challenge X based on student designed proposals. The selected universities are given an opportunity to participate in hands-on research and development with alternative-fueled engines, advanced vehicle management controllers, and emissions-control technologies.

A 2005 Chevrolet Equinox was donated to each participating university. The goal of each university was to design a vehicle system that would result in a reduction in emissions and energy consumption while maintaining user acceptability, performance, and safety.

West Virginia University's design was a "through-the-road" hybrid design which consisted of a 1.9 liter diesel engine, 115 ultra-capacitors, and several electric motors. WVU's design also included distributed controller architecture, sub frame modifications, and a State of Charge (SOC) control strategy optimized for regenerative braking. Also, a pressurized urea injection system was designed and employed to reduce vehicle emissions.

Students designed components of the vehicle and performed finite element analysis using software such as Unigraphics, Solid Works, Pro-Engineer, and ANSYS. Matlab/Simulink was employed to model and simulate ultra-capacitor activity.

WVU placed 9th this year at the 2007 competition which was held at the GM proving grounds in Milford, Michigan. The goal of the 2007 competition was to demonstrate a 99% buyoff ready vehicle with a refined design. The 2006 competition was held at the GM proving grounds in Mesa, Arizona with the goal of having the vehicle 65 % buyoff ready. WVU earned 9th place in the 2006 competition. WVU placed 13th at the design competition in 2005 which took place in Auburn Hills, Michigan. The 2005 competition was judged on design, simulation and hardware selection.

Points at the competitions are distributed based on fuel economy, user acceptability, vehicle emissions, a road agility course, trailer tow, and both written and oral reports based on design aspects. Next year's Challenge X schedule consists of several public relations events, one of which will be displaying WVU's Equinox at Disney's Epcot Center. The 2008 team will be given the task of making the vehicle customer ready and developing a market strategy.

This year, General Motors extended employment opportunities to two of WVU's Challenge X members, proving the Challenge X program is not only a great learning experience, but also connects students with potential employers. Next year, the WVU team plans to optimize the urea injection system to further reduce vehicle emissions, and focus on further optimization of the hybrid system.

For more information please visit their website: http://www2.cemr.wvu.edu/~challengex

STUDENT PROJECTS WITH INDUSTRY

Projects with Industry is a program in which senior mechanical and aerospace engineering students form teams and work with a West Virginia based industry. The students gain experience with energy and environmental aspects of engineering while solving production, energy conservation, or other general industrial problems. Throughout the semester, students visit industrial sites to gather information and make presentations on their progress and final designs.

This year, three students worked with the S.J. Morse Company in Capon Bridge, West Virginia to reduce the humidity in their facility. The S.J. Morse Company produces wood veneer products and the current level of humidity was causing products to become warped. WVU's team determined that the humidity could be reduced and worker comfort could be increased by installing an air conditioning system in the current plant. The students also designed a heating system for a new facility the company plans on building. This system will be fueled by wood waste produced during the wood veneer manufacturing process, reducing both energy and disposal costs for the company. Grushaund Allen, John Ruth, and Eric Saffell worked together on the S.J. Morse Company project. These students also collaborated on a project with Pyrotek, Inc. in Bridgeport, WV.

Pyrotek, Inc. manufactures steel rollers for annealing furnaces, which are used in the metal industry. It is important to obtain the maximum quantity of heat transfer from the rollers to maximize the life of the furnace. The goal of this project was to develop a heat transfer model of the water cooled rollers that simulated insulation and coolant flow so that the roller design could be optimized. Students created a model using Matlab software and a series of iteratively analyzed heat transfer equations.

During the summer of 2007, Emily Meissner, Sean Moran, Shawn Fike, Joe Dubusky, Mohammed Zaifullah, Amr Younes, Robert Wilson, Jason Hatcher, and Patrick Betoney collaborated on projects with Allevard Springs USA, Inc, located in Prichard, WV. Allevard manufactures coil springs and suspension components for major auto companies such as Ford and Mercedes. The projects included designing a quench tank for torsion bars, designing an automatic tool gage for quality control, improving a rubber molding process, designing a deburring station, and designing a masking system for the powder coating of torsion bars.

Projects with Industry is supported by the West Virginia Development Office's Energy Efficiency Program. Any company interested in working with a student team, may contact the course instructors, Drs. Ken Means and Larry Banta at 304-293-3111 ext. 2308 and ext. 2334, respectively.

STUDENT PROJECTS – DESIGN BUILD FLY

The West Virginia University Department of Mechanical and Aerospace Engineering has formed teams to compete in the Design/Build/Fly (DBF) competition for the past eleven years. DBF is an international Unmanned Aerial Vehicle (UAV) competition sponsored by the American Institute of Aeronautics and Astronautics (AIAA), Cessna Aircraft, and Raytheon Missile Systems. This year, fifty teams from United States, Israel, Scotland, and Turkey competed.

The objective of the 2007 competition was to design an aircraft that could be squad-deployed for over-the-hill reconnaissance and air sampling. The competition awarded points for completion of both air and ground tasks. The time required for assembly of the aircraft and preparation for mission deployment, and the time required to reconfigure the aircraft between missions were to be minimized.

WVU students formed two design teams which competed in the DBF competition. Aircraft WVU Gold was designed and constructed by Matthew Muscavitch, Dan Schulman, Pat Smith, Daniel Sutton, Josh Barnett, Will Vogel, and Tristan Wolfe. Joe Allen, Curtis Groves, Steven Hard, Ryan Malone, Nathan Music, Jon Nagurney, Zach Napolillo, and Pat Wildfire designed and constructed WVU Blue. WVU Gold was designed as a biplane with inverted V-tail and pusher propeller aircraft, and placed 15th in the competition.WVU Blue was designed as a V-tailed tractor monoplane aircraft, and placed 16th overall WVU Blue was the fastest aircraft at the competition, completing two laps of the course in 75 seconds, which was 24 seconds faster than all competitors.

The 2008 competition will be held in April at the Cessna facilities in Wichita, Kansas, and many students from the 2007 WVU teams will return to compete in the 2008 competition. The mission for 2008 will simulate a small short-takeoff passenger aircraft capable of carrying both passengers and cargo. Dr. John Loth has been the course instructor for ten years; he is assisted by graduate student Shanti Hamburg. Funding for the project is provided by WVU's Mechanical and Aerospace Engineering Department and the NASA WV Space Grant Consortium.

STUDENT PROJECTS - BAJA VEHICLE DESIGN

The Mini Baja all-terrain vehicle competition is sponsored by the Society of Automotive Engineers (SAE). Teams of college students are given the task of designing and fabricating a competitive all-terrain vehicle. Each team must use a standard ten-horsepower Briggs and Stratton engine and follow strict safety guidelines in the design of the vehicle. The goal of the team is to optimize the design based on safety, durability, cost, and weight.

Each competition consists of dynamic events, static events, a technical report, and a cost report. Dynamic events include land and water maneuverability, acceleration, mud bog, power-pulling, and suspension and traction tests. Static events include design judging and technical inspection. The final component of the competition is a four hour endurance race in which drivers encounter rough terrain and deep water.

This year the students formed two teams and designed two separate Baja cars to compete in two competitions. The first competition was hosted by the University of Central Florida in mid-April and required the vehicle to be amphibious. WVU performed very well, placing 9th overall out of 59 entries from colleges across North America. WVU's team placed an impressive 5th in the acceleration event, 8th in the power-pull, and 8th in the endurance race. The water-based team was comprised of Neil Blackman, Garrett Campbell, Caleb Crosby, Dean Hecht, Megan Hubbell, Brad Humbert, Nagi Lam, Rob Rohrssen, Dan Schulman, Josh Sill, John-Michael Storton, Gregory Thomas, Ben Truschel, and Jay Wargo.

The second team built a land-based vehicle for the competition hosted by the Rochester Institute of Technology, held in June. The team designed and assembled their own manual transmission, and fabricated hub assemblies for a custom five-link aluminum suspension. The land-based team was comprised of Shane Bobo, Chad Crosbie, Bryan Dickson, Brandon Gatsche, Thomas Harris, Matt Holsopple, Jason Keller, Tyler Kuhn, Jonathan Kweder, Joe Lepito, Luke Mulhollem, Craig Neff, Chris Shifflett, George Shoukry, Chris Shreve, Scott Yarbrough, and Seiar Zia.

As participants in Mini Baja, students gain valuable design, fabrication and testing experience. Students use software packages such as Pro-Engineer and Ansys to create 3-dimensional models of vehicle components and perform finite element analysis to examine potential areas of stress induced failure.

For more information please contact Dr. Ken Means at Ken.Means@mail.wvu.edu

STUDENT PROJECTS – MICROGRAVITY RESEARCH TEAM

This year, the West Virginia University Microgravity Research Team (MRT) submitted a proposal to perform a circular hydraulic jump in microgravity. WVU was one of thirty-five teams invited to participate out of more than 70 collegiate proposal submissions to the NASA Reduced Gravity Student Flight Opportunities Program (RGSFOP) from across the country. This was the seventh year of the program at WVU and the sixth WVU team to fly an experiment in microgravity.

The class was separated into two groups: Flyers and Ground Crew. The Flyers were WVU MAE undergraduate students Jackie Grimes, Mehran Mohebbi, Jonathan Painter, and Kyle Phillips. WVU MAE undergraduate students Kevin McCrea, Emily Calandrelli, Alan Talbott, and Nicholas Weston were members of the Ground Crew.

The team's goal was to design an experimental apparatus which would be capable of studying the phenomenon known as the circular hydraulic jump under conditions of reduced gravity. The circular hydraulic jump phenomenon can be simply understood by examining the behavior of water when washing dishes. The sink dispenses a stream of water which contacts a dish or plate; the stream of water then spreads out radially in a thin layer and experiences an abrupt increase in depth as it flows outward from center of the stream. The abrupt increase in depth can be explained as the hydraulic jump.

This year, the team spent their spring break in Houston at NASA's Johnson Space Center, where the team got to test their experiment aboard NASA's C-9 "Weightless Wonder" research aircraft. The "Weightless Wonder" is capable of producing weightless periods in 25 second durations. After retuning to Morgantown, the team analyzed the data which was taken during the flight and concluded on their scientific findings. The students submitted their results to the NASA RGSFOP, and presented their findings at the Canadian Congress on Applied Mechanics.

The WVU Microgravity Research Team is supported by the WVU Mechanical and Aerospace Engineering Department and the NASA West Virginia Space Grant Consortium. The project advisors are professors Dr. John Kuhlman and Dr. Donald Gray.

For more information, please visit the project course website: http://www2.cemr.wvu.edu/~wwwzerog/

EDITORIAL AND PROFESSIONAL SERVICE

Editorial Boards

Ever Barbero, International Journal of Aerospace Engineering

Ever Barbero, Journal of Natural Disasters, Accidents and Civil Infrastructure, ASCE

Darran Cairns, Guest Editor, Journal for the Society of Information Display

Donald Lyons, International Journal of Agile Manufacturing, ISAM

Donald Lyons, International Journal for Advanced Manufacturing Systems, ISPE

James Smith, Journal of Engines, SAE International

James Smith, International Journal of Computers and their Applications

Professional Service

Richard "Dick" Bajura, Member of the Board, Pittsburgh Coal Conference

Richard "Dick" Bajura, Member, ASME Energy Committee

Richard "Dick" Bajura, Member, ASME Climate Change Task Force

Nigel Clark, Organizer, 14th. Asia-Pacific Automotive Conference (SAE)

Donald Lyons, Chair, Board of Directors, International Society of Agile Manufacturing

Donald Lyons, Chair, Board of Directors, International Society for Productivity Enhancement

James Smith, Member of the Board of Directors, Member of the Engineering Meetings Board, and Member of the Technical Standards Board of SAE International

SAE Fellows

SAE recognizes its most accomplished members with the grade of Fellow, the highest membership grade available.

Nigel Clark, Professor and Berry Chair

The SAE Fellow Committee made their selection based on Nigel's outstanding accomplishments in quantifying real-world emissions from heavy-duty vehicles and his work in the development of transportable heavy-duty chassis dynamometers.

ASME Fellows

ASME recognizes its most accomplished members with the grade of Fellow, the highest membership grade available. MAE is fortunate to have four faculty who have been recognized by ASME for this prestigious honor.

Ever Barbero, Professor and Chair

Richard "Dick" Bajura, Professor and Director of the National Research Center for Coal and Energy

Ismail Celik, Professor

John Kuhlman, Professor

SAMPE Fellows

The Society for the Advancement of Material and Process (SAMPE) recognizes its most accomplished members with the grade of Fellow for their distinguished contributions in the fields of materials and process engineering – the technology by which materials are developed or selected and manufacturing processes are chosen that will convert materials into products that meet design, performance, cost effectiveness, and other criteria.

Ever Barbero, Professor and Chair

FACULTY AWARDS

MAE Academy of Distinguished Alumni Award

Larry E. Banta received the Academy of Distinguished Alumni Award in 2007 for his dedication to undergraduate teaching. The MAE Department is lucky to have an outstanding roster of distinguished alumni in its Academy of Mechanical Engineering and Mechanics and in its Academy of Aerospace Engineering. The two academies jointly sponsor a teaching award to recognize the most notable teachers. The Promotion and Tenure Committee of the Department nominates a candidate every year.

George W. Weaver Award

Russell Dean received the 2007 George W. Weaver award in recognition of his excellent teaching of courses in engineering mechanics. Engineering mechanics includes the subjects of statics, dynamics and mechanics of materials, which are covered in three courses that form the foundation of several engineering disciplines.

Donald T. Worrel Award

Ken Means received the 2007 Donald T. Worrel Award in recognition of his exemplary dedication to the department and excellence in performing MAE's mission of teaching, research, and service. This award was established in memory of an esteemed former faculty member in the MAE department. The award is granted based on recommendations by the Promotion and Tenure Committee.

CEMR Faculty Awards

John M. Kuhlman was named as an Outstanding Teacher for 2006-2007. Students seeking a way to recognize their professors originally created the Outstanding Teacher Award to honor those teachers who had made significant contributions to their lives and education. The College continues this tradition by recognizing faculty that make major contributions to the teaching mission and provide outstanding classroom experiences to their students.

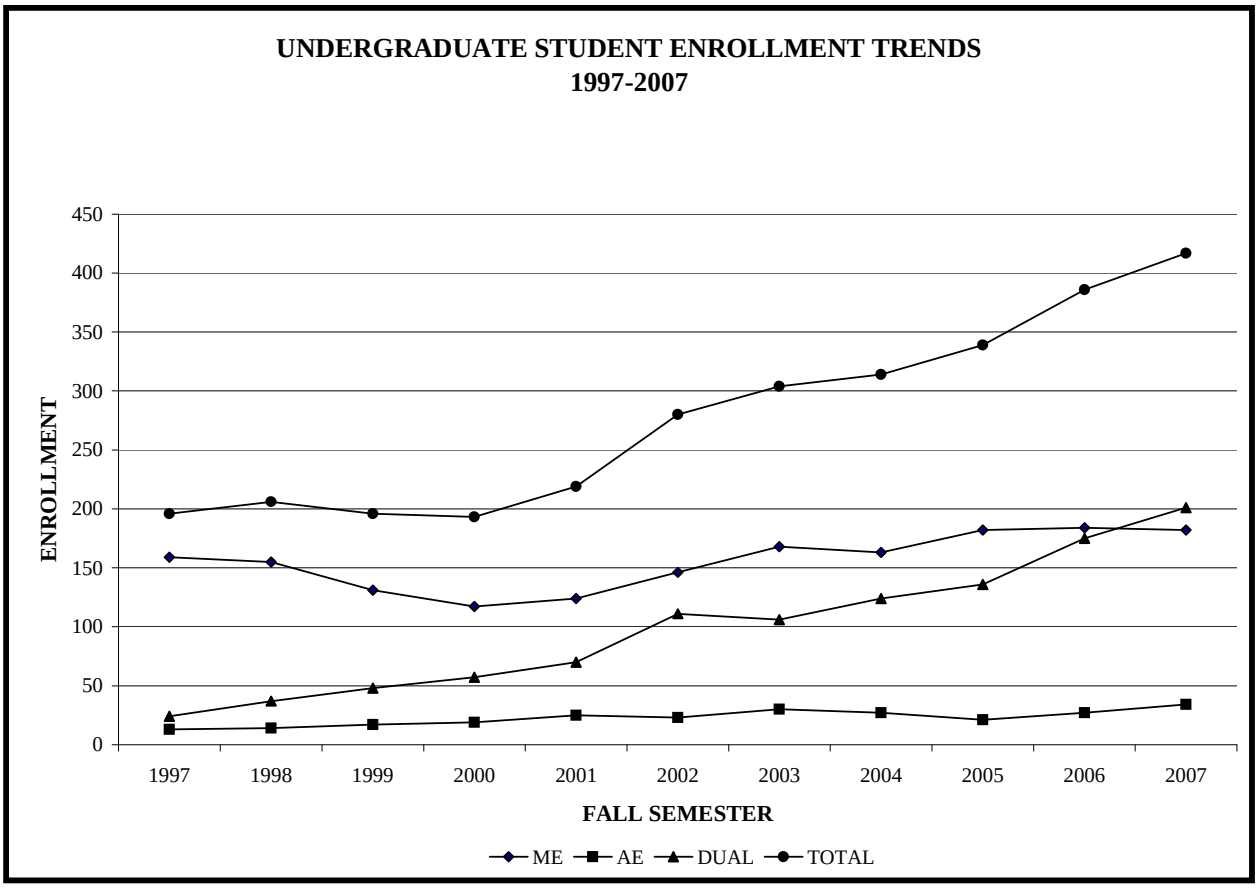
Ismail Celik, **Nigel Clark**, and **Marcello Napolitano** were named Outstanding Researchers for 2006-2007. The recipients are chosen by a committee of their peers based on their research activities and their mentoring of graduate students for this year as well as the continuity of quality research over a several-year period.

Larry Banta was named Outstanding Advisor of the Year for 2006-2007. The college recognizes the importance of student advising in the success of our students. The Outstanding Advisors Award recognizes excellence in student advising as well as continuous improvement in undergraduate advising in the College.

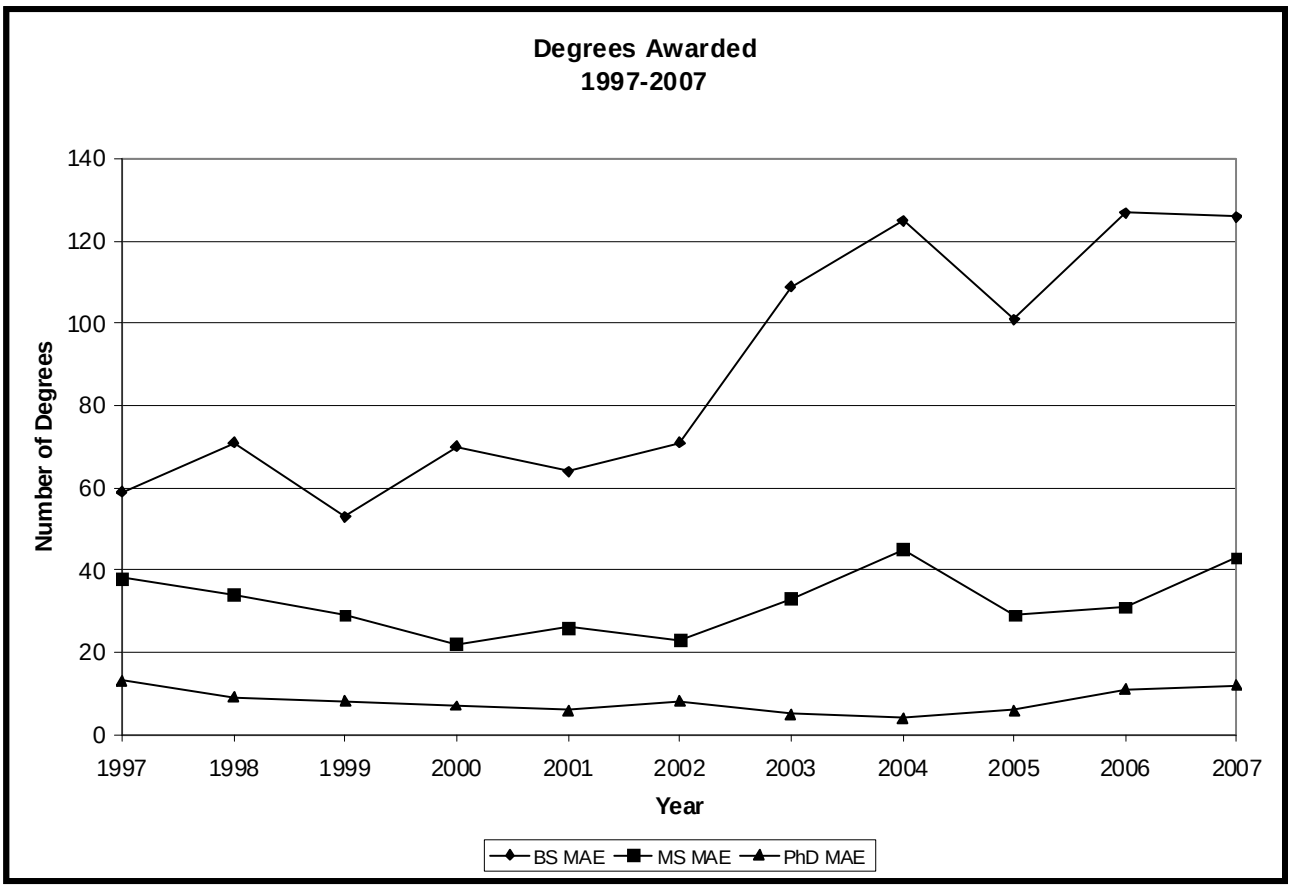
ENROLLMENT/GRADUATION TRENDS

Enrollment in the Mechanical and Aerospace Engineering Department has continued to grow over the past year. The data displayed in this article includes sophomores, juniors, and seniors that have declared a major. Freshmen and undeclared sophomores remain at the college level until they are eligible to declare a major. Over the past five years, undergraduate enrollment has grown by 37 percent. This growth is driven by our highly motivated students that choose to undertake the challenging dual AE-ME curriculum. Forty-eight percent of students in the mechanical and aerospace engineering department pursue the dual degree. Only slight variations in enrollment have been experienced by the single majors of mechanical engineering and aerospace engineering. Dual majors are not double counted in the data, so the enrollment figures shown represent actual number of students, currently 417.

Recent efforts in the graduate program have been made to raise the standards and increase the number of doctoral students, while strengthening the aerospace program. Over the past five years, Ph.D. enrollment has increased from 34 students in 2002 to 69 students in 2007. We are very proud of our doctoral student population, who has earned some outstanding honors. For example, we have three Fullbright Fellows working in diverse areas such as Bioengineering, Material Science, and



ENROLLMENT/GRADUATION TRENDS



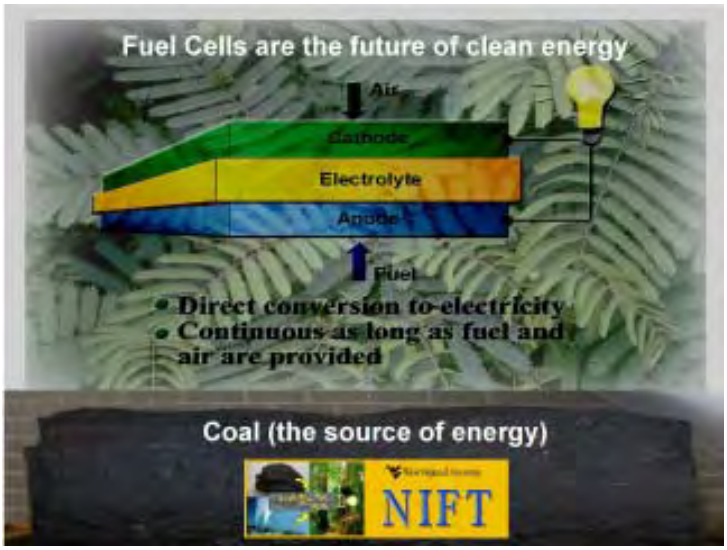
Engines and Emissions. Due to an increase in standards, the Masters Students enrollment has decreased from 97 in 2002 to 76 in 2007.

In 2006-2007 no other department in our college awarded more BS degrees than the Mechanical and Aerospace Engineering Department. The number of undergraduate degrees awarded has increased from 71 in 2002 to 126 in 2007. Due to the increase in undergraduate enrollment, the number of degrees awarded is expected to increase.

Over the past five years, our graduate program has experienced an increase in the number of MS degrees awarded from 23 in 2002 to 43 in 2007. The number of doctorate degrees awarded has also increased in the last five years, from 8 in 2002 to 12 in 2007. Due to the increase in standards at the Masters level, our department predicts that the number of MS degrees awarded will level off. The undergraduate and doctorate programs are expected to experience continued growth in enrollment and degrees awarded.

FEATURED RESEARCH PROGRAM:

Increasing worldwide energy demands, along with dwindling conventional fuel reserves and growing environmental pollution, call for new generation energy technologies that can provide sustainable and affordable electric power with minimal impact on the environment.

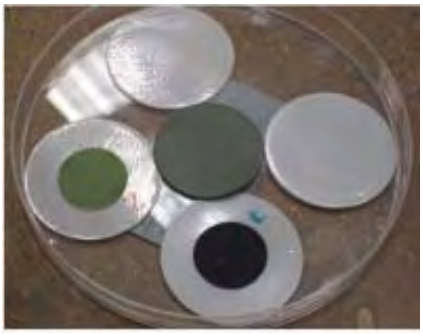


Coal will continue to be a fuel of choice; it is expected to supply 40% of the global electricity demand and at least half of the U.S. electricity demand into the foreseeable future. Fuel cells offer the promise of increasing the net efficiency of central electric generation plants from the present level of 30% to 35% for coal combustion systems, to levels approaching 60% to 70% in advanced gasification systems using fuel cell, gas turbine, and steam turbine generation cycles. Researchers in the Department of Mechanical and Aerospace Engineering (MAE) are actively involved in projects aimed at developing the science and technology for such systems.

The National Institute for Fuel Cell Technology (NIFT), under the leadership of Dr. Ismail Celik, is a new center established with the help of U.S. Department of Energy and the West Virginia Experimental Program to Stimulate Competitive Researach (EPSCoR). NIFT brings together researchers from MAE and other departments of the university, to conduct collaborative multi-disciplinary research on fuel cells.

NIFT supports the DOE's SECA (Solid state Energy Conversion Alliance) program mission of successful commercialization of high-temperature fuel cells and the West Virginia state strategic energy plan. NIFT aims to gain national and international recognition for research in coal-based fuel-cell technology and to help develop the emerging fuel cell industry in the state of West Virginia. NIFT researchers come from a wide range of backgrounds, including material science, chemistry and quantum mechanics which makes it possible to address the problems from multiple perspectives.

Fuel Cells and Coal Syngas



Button cells manufactured in-house

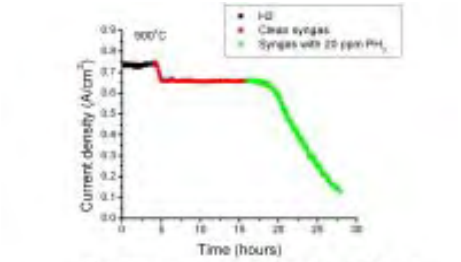
High-temperature fuel cells such as solid oxide fuel cells can operate on fuels derived from coal. With fuel cells coal-based power generation could be made more efficient and clean. Synthesized gas, or syngas, is obtained from gasification of coal and is composed mainly of hydrogen and carbon monoxide. In addition syngas also contains the usual coal contaminants such as sulfur and trace amounts of a wide range of metals. Assessing the effect of these trace elements on the performance of the SOFCs and exploring remedies for the poisonous contaminants is the aim of a new project undertaken by NIFT. This project is funded jointly by DOE, WV state and WVU Research Corporation with close collaboration of National Energy Technology Laboratory (NETL).

MAKING FUEL CELLS WORK WITH COAL GAS

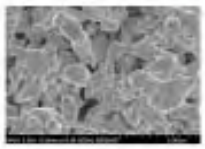
The project is divided into four sub-projects, including anode materials and characterization, sub-micro scale modeling, multi scale continuum modeling, and cell and system level testing.

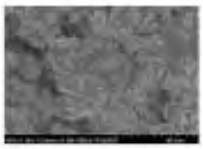
Anode Materials and Characterization

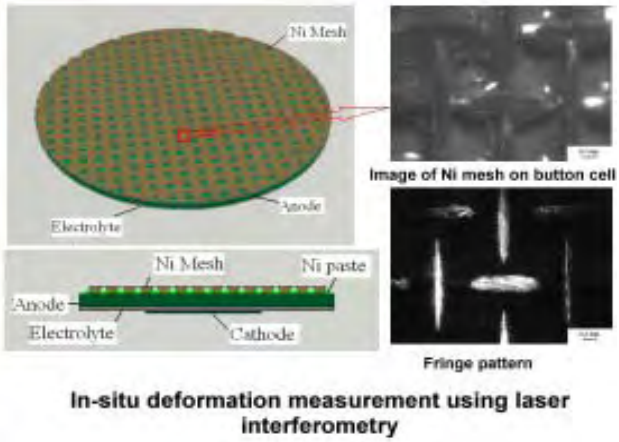
Novel materials are proposed for anode component of the fuel cell which is exposed to coal syngas. Cells are being manufactured in-house for testing. Nanotechnology is being applied to the manufacturing process to produce desired anode microstructure for optimum performance. Both electrolyte supported and anode supported cells were manufactured and tested. The performance of cells manufactured at NIFT is on par with that of commercial cells. An investigation of the effect of



Cell performance degradation due to PH_3


Anode surface after running with clean syngas


Anode surface after impurity test



In-situ deformation measurement using laser interferometry

phosphine (PH_3) contamination showed that the cell performance degraded significantly within few hours. Scanning Electron Microscope (SEM) analysis on the cell showed that the anode microstructure was coarsened after phosphine exposure. To assess the structural degradation of the cells under operating conditions a test set up is designed for in-situ measurement of the cell deformation using laser interferometry. The feasibility of the testing method was demonstrated at room temperature.

Multi-Scale Computer Modeling

The goal of this project is to develop a comprehensive virtual simulation framework for testing of solid oxide fuel cells based on different modeling approaches: (1) quantum mechanical approximations at atomistic levels, (2) molecular dynamics simulations based on classical Newtonian mechanics, and (3) continuum modeling. Atomistic simulations were performed for interactions of contaminants such as phosphine, hydrogen sulfide(H_2S) and arsine(AsH_3) with nickel matrix. These simulations shed light on the properties and features of chemical bonding, charge transfer, and Ni surface electronic states. This knowledge helps researchers understand the mechanism of contaminant-nickel interaction. Similar simulations at molecular level provide input data for continuum level modeling.

Multi-Scale Continuum Modeling

An in-house simulation code, DREAM SOFC, was developed to simulate the button cells being tested in the lab at macro scales. Another model is also under development for simulation of the Electrochemical Impedance Spectrum (EIS) to study

Continued on Page 19

STUDENT PROJECTS – BALLOON SATELLITES

This was the fifth year that the "Balloon Satellites" course has been offered at West Virginia University. Using a helium-filled weather balloon, students design, build, launch, track, and recover small payloads. When launched, the payloads transcend the stratosphere and are tracked and recovered via GPS. The instructors set weight, size, and cost constraints which impact the design of the instrumentation packages. In Spring 2007, three missions were successfully completed during the flight: balloon thermal wake temperature measurements, gyro-stabilization of a payload, and live in-air video feed to ground.

Ten students who participated in the balloon satellite course this year formed three teams. Team one, The Floating Four, measured the temperature distribution of the "thermal wake" of the balloon. Thermal wake is caused by solar heating of the balloon during daylight hours. As the balloon rises, a heated wake is left behind, where temperature measurements are hotter than the undisturbed air temperature. Team one consisted of Jeffrey Ford, Chad Panther, Kyle Phillips, and James Wittenschlaeger. Team two, Beta Iota Gamma, selected the missions of gyroscopically stabilizing the payload, testing a cut down system, and working on an internal heating system. Frederick Beamer, Phil Evans, Benjamin Gracie, and Shawn Hefner worked together as team two. John Brewer and Aaron Graves comprised team three. Known as The Local Access Boys, they proposed to attempt to broadcast live video feed to a ground station and record solar cell signal to determine payload spin rate.

The course is taught by professors Drs. John Kuhlman and Mike Palmer, and is open to any student with at least a sophomore standing. The funding for the course has been provided by the NASA West Virginia Space Grant Consortium and the WVU Mechanical and Aerospace Engineering Department.

For the next academic year, this course will be offered as two separate courses: a beginning 1-credit course consisting of relatively simple projects that will be specified by the course instructors, and a second follow-up 2-credit course where student teams will propose their own mission and hardware. This will result in students earning three credit hours for an approved technical elective.

For more information, please visit the course website: http://www2.cemr.wvu.edu/~satellite.balloon/

STUDENT PROJECTS - INDUSTRIAL OUTREACH IN MEXICO

INDUSTRIAL OUTREACH PROGRAM IN MEXICO: ELEVEN YEARS DELIVERING RESULTS…

What is the likelihood that engineers have to travel abroad as part of the job? What are the chances that engineers have to deal/or negotiate with professionals from different countries, with different cultures and languages? How many job opportunities are there in engineering that require some sort of international experience? More than ever!

WVU's engineering students have the opportunity of gaining international and professional experience through the ***Industrial Outreach Program in Mexico***, which provides an ideal environment for students to immerse themselves in a different culture while using and honing engineering skills in practical industrial projects abroad. In this program, students learn the dynamics of teamwork to achieve a common goal despite language and cultural differences. In the process, students learn about themselves as individuals and gain a new perspective on the role of their profession in a global society.

Led by Dr. Victor H. Mucino, WVU's Industrial Outreach Program in Mexico has established a successful and unique model in the USA and Mexico to integrate "hands-on" engineering practice with an international bilingual and bicultural immersion in professional settings. During six weeks, students tackle meaningful problems working alongside with engineers from industry and faculty advisors from various institutions. At the end of the program, a professional quality report and presentation is offered to industrial managers, in which students practice their foreign language communication skills as well as their engineering prowess.

One of the main reasons for the success of this program is the network of people, industries, families, universities and local government officials developed after eleven years of continued activity. This summer nine WVU students teamed up with 12 Mexican students and faculty advisors from three Mexican universities (Monterrey Tech, University of Queretaro and the Tech. Institute of Queretaro). WVU's Jackie Grimes and Kelby Napolillo worked with Luis Juardo and Mary Carmen Vazques at ConduMex working on aeolian vibrations of cables; Candice Elliott and Richard Mulcahy teamed up with Aldo Jurado and Luis Ramirez to analyze the design of bolted joints in tractors for Case New Holland; Collin Boyd teamed up with Mariano Moreno, Carlos Espejel and Juan Carlos Sanchez to study reliability of appliances for GE Appliances (MABE); Daniel Ledeboer teamed up with Eward Ruiz and Antonio Monterubio to developing software for design of gear systems for CIATEQ; Steven Martin and Kemberly Griffith teamed up with Jorge Ramirez and Aaron Marin to design aluminum tubing cutting processes for VRK Automotive and Graham Jones teamed up with Eduardo Banda to develop design protocols for installations for GE Aircraft Engines.

GRADUATES 2006-2007

Bachelor of Science
In Aerospace Engineering
Jason Michael Absten
Theodore R. Adams
Adeolu Kareem Awofisayo
Joseph Orlando Bellotte
Bruce A. Bennett
John Harold Brewer, III
Kenneth Scott Durbin
Alexander Westley Gray
Shanti Hamburg
Nicholas Jaye Hansford
John Eric Harman
Scott Jared Henson
Jeremy Clay Hill
Meagan Lynne Hubbell
Stanley John Kaminski
Mark Thomas Kozlowski
Jonathan Kweder
Kirk Andrew LaBarbara
Robert Matthew Lease
Jacob Samuel Lemanski
Joseph S. Lepito
Joseph Anthony Loiero, Jr.
Michael Jared Lyons
James Michael Maley
Patrick Quay McDonald
Benjamin Cecil Middlebrooks
Tiffany Dawn Newcomb
Chad Colby Panther
Kyle Garret Phillips
Jaclyn Marie Porter
John B. Redrow
Brian Allen Rittenhouse
Arthur William Scherich III
Andrew David Seymour
Christopher A. Shifflett
Jeremy Scott Sigley
Stephen Craig Silver
Maurice Smith, Jr.
James William Spencer
Jared Michael Tannenbaum
Stephen Allan Willilams, Jr.
Frank Joseph Wineland
Steven Anthony Zasadny

Bachelor of Science
In Mechanical Engineering
Jason Michael Absten
Theodore R. Adams
Daniel Robert Adamson, Jr.
Seth Michael Avery
Adam Scott Bailey
Rifaat Roshdy Bassaly, Jr.
Bruce A. Bennett
Shane Allan Bobo
Andrew Simon Bonelli-Padow
Lindsay Amber Boyd
John Harold Brewer III
Peter Jackson Burke
Garrett Jordan Campbell
Daniel John Cook
Chad Edward Crosbie
Andres Felipe Cuesta
Bryan Scott Dickson
Jennifer Lynn Dodd
Jeremy David Frame
Graham Mark Fuller
Brandon Phillip Gatsche
Joan Manuel Gil
Brett E. Gleasman
Alexander Westley Gray
Brian Donald Hainkel
Shanti Hamburg
Jerome Robert Haney
John Wesley Hardin
John Eric Harman
Ryan Harvey
Scott Jared Henson
Matthew James Holsopple
Meagan Lynne Hubbell
Nathaniel Ryan Hudak
Colin David Hultengren
John Martin Kay
Jonathan Kweder
Alan Michael Kyes
Nagi A. Lam
Jacob Samuel Lemanski
Daniel Brooks Lenhart
Joseph S. Lepito
Samuel William Logan
Joseph Anthony Loiero, Jr.
Michael Jared Lyons
James Michael Maley
Patrick Quay McDonald
David Michael Messner
Christian Matthew Montagliani
Luke Garrison Mulhollem
Caleb Sean Murphy
Erik Jonathan Myers
Craig David Neff
Tiffany Dawn Newcomb
Chad Colby Panther
Kyle Garret Phillips
James Matthew Pierce
Jaclyn Marie Porter
Matthew Joseph Radosevich
Brian Allen Rittenhouse
Robert Joseph Rohrssen
David Brian Rutherford
Arthur William Scherich III
Eric Alexander Saffell
Andrew D. Schmidt
Andrew David Seymour
Joshua Brent Shelton
Christopher A. Shifflett
George Fouad Shoukry
Christopher Russell Shreve
Matthew Ryan Sickles
Jeremy Scott Sigley
Joshua Joe Sill
Christopher Michael Sioma
Jared Michael Tannenbaum
Gregory Shane Thomas
Robert Ray Tincher
Edward Joseph Wargo III
Stephen Allan Williams, Jr.
Frank Joseph Wineland
Scott Ryan Yarbrough
Steven Anthony Zasadny

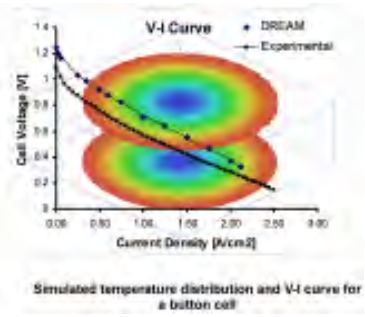
Master of Science
In Aerospace Engineering
Shannon Lynnette Glaspell
Paul Joseph Kreitzer
Steven L Rowan
Larry Wayne Rowe II
Justin Lee Smith
Eric Vincent Taylor
Kuntal A. Vora

GRADUATES 2006-2007

Master of Science
In Mechanical Engineering
James Anthony Altobello
Robin Wendell Ames
Siva Kumar Boyapati
Amit Valmick Desai
Thomas Henry Evans
Michael Andrew Fasouletos
Praveen Garakahalli.
Mahesh Govindareddy
Henry Zebede Graham IV
Christopher Douglas Griffin
Chandima Surangie Jayasinghe
Dave Shivanka Jayasinghe
Russell Troy King
Andrew Douglas Lowery
Seth Daniel Lucey
Thomas Gibson McConnell
James Joshua Maybury
Nathaniel C. Moles
Heath Anson Morris
Jordan M. Musser
Dony Cherian Oommen
Saritha Reddy Potula
Vishnu V. Rachamalla
Dhananjay Rao Hejamadi
Varakala Shashidhar Reddy
John Michael Sakacsi
Bruce Michael Schlicker
Steven Michael Seachman
Vimala Shekar
Tyler-Blair Adams Sheppard
Petr Sindler
Corey Michael Strimer
Robert Ray Tincher
Aseem A. Tiwari
Deepika Vadlamani
Santosh amarnat Varthakavi
Karthikeyan C. Venkatasubramaniam
Sandeep Vennam
Rajesh Vijayaraghavan
Ashwin Vishwanathan
Jeremy Scott Watts
Kenneth Arthur Williams
Bryan Michael Wimer
Zachary Fred Witzgall
Andrew James Zimmerman

Doctor of Philosophy
Mark A. Bright
Ahmed M. El-Sherbeeny
Cem Ersahin
Baiyun Gong
Srikanth Gururajan
Kevin John Ford
Mohan Krishnamurthy
Dustin Langdon McIntyre
Jose Alejandro Posada Montoya
Julio Noriega-Motta
S. Raju Pakalapati
Glen Andrew Wilt
Jing Xu

Continued from Page 15



Simulated temperature distribution and V-I curve for a button cell

behavior of an SOFC anode. Work is also under progress to model the thermal stresses and long term structural degradation of the SOFCs operating on syngas.

Cell and System Level Testing

Cells manufactured in-house as well as commercial are being tested using various techniques. Some of the experimental methods used are: cyclic voltammetry, Electrochemical Impedance Spectroscopy (EIS), and current interrupt methods for electrochemical characterization and infrared spectroscopy, Scanning Electron Microscopy (SEM), and x-ray diffraction for physical and chemical testing. Electrochemical methods reveal the origins of various losses occurring in the SOFCs whereas the chemical and physical tests provide insight into the possible mechanisms of the poisonous effects of trace metals. This knowledge would help in devising new materials and techniques for better cells. Experimental results are being used to validate the numerical models.

Researchers Dr. Ismail Celik, MAE *(Director, Technical Manager)*, Dr. Richard Bajura, MAE, NRCCE *(Administrative Manager)*, Dr. Harry Finklea, CHEM, Dr. Bruce Kang, MAE, Dr. Xingbo Liu, MAE, Dr. Andrei Smirnov, MAE, Dr. Nick Wu, MAE, Dr. John Zondlo CHE, Dr. Oktay Demircan, CHEM, Dr. Ning Ma, PHYS, Dr. S. R. Pakalapati, MAE, Dr. Chunchuan Xu CHE

Graduate Students Francisco Blancas, F. Nihan Cayan, Rolando Chavez, Jose Escobar, Gulfam Iqbal, Mingyang Gong, Huang Guo, Mingjia Zhi

RESEARCH AWARDS 2006-2007

Booz/Allen/Hamilton Inc. and Subsidiary Corporations, Emissions and Fuel Efficiency of a Diesel-Fueled Step Van, Clark, Wayne, Thompson, Gautam, Lyons, $13,562

BP America, Inc., Biodiesel Blend Emissions Effects, Clark, Wayne, Gautam, Thompson, Krishnamurthy, Lyons, $45,597

Coordinating Research Council, Inc., Sixteen Hour Cycle Development, $12,834

Dinex Exhausts Inc., Verification of Exhaust After treatment System for Transport Refrigeration Units by the CARB Procedure, Wayne, Shade, Clark, Gautam, Lyons, Thompson, $196,968

Eagle Glass Specialties, Inc., Characterization of Laser-Speckle for Nano and Micro Structured Glass Surfaces and Correlation to Surface Topography, Cairns, $10,000

Emissions Control System, Analysis of Regulated and Unregulated Exhaust Emissions from Oxidation Catalyst Equipped Transit Buses, Gautam, Krishnamurthy, Wayne, Clark, Thompson, Shade, Lyons, $132,573

ESW America, Inc., Verification of ESW America's Particulate Reactor for California ARB Using a Chassis Dynamometer, Shade, Wayne, Krishnamurthy, Clark, Gautam, Thompson, Nix, Lyons, $40,000

ESW America, Inc., Verification of ESW America's Particulate Reactor for California ARB Using a Chassis Dynamometer Phase II, Shade, Wayne, Krishnamurthy, Clark, Gautam, Thompson, Nix, Lyons, $12,000

Greater Vancouver Transportation Authority TransLink, Translink Bust Technology Demonstration Test Program Review by West Virginia, Clark, Wayne, $14,504

IMTS, Development of Novel CFD Tools for Bioengineering Applications, Celik, $79,998

International Truck and Engine Corporation, Effects of Tracer on Diesel Engine PM Emissions, Clark, Krishnamurthy, Wayne, Gautam, Lyons, $18,947

Interstate Diesel, Inc., Fuel Injector on Emissions from Railroad Locomotives, Wayne, Thompson, Gautam, Lyons, Clark, $41,895

National Institute for Occupational Safety and Health (NIOSH), Surfactant Collection System for Nano-Oartucykate Exhaust Products from Heavy-Duty Diesel Engines: Development and Performance Testing, Gautam, Carder, $240,000

National Science Foundation, Further Analysis of Near-Surface Tornado Intensification, Lewellen, $112,000

Oilkleen International, Inc., Characterization of the Improvement in Emissions and Fuel Economy Performance Using Oilkleen's Fuel Handling System, Krishnamurthy, Clark, Thompson, Gautam, Lyons, Wayne, Shade, $15,000

ORYXE, Third CARB Investigation for an Additized Diesel Fuel, Thompson, Clark, Gautam, Lyons, Wayne, $91,909

ORYXE, Selection of a CARB Reference and Candidate Fuel, Thompson, Clark, Gautam, Lyons, Wayne, $39,967

ORYXE, ORYXE Energy CARB Cost Reduction Certification Program, Thompson, Clark, Gautam, Lyons, Wayne, $109,404

ORYXE, Selection of a Bio-Derived Diesel Fuel Blend for the Texas Market, Thompson, Clark, Gautam, Lyons, Wayne, $81,459

ORYXE, Selection of Candidate Diesel Fuels for California and Texas Markets, Thompson, Clark, Gautam, Lyons, Wayne, $70,157

ORYXE, Evaluation of an Additized ULS Bio-Diesel Candidate Fuel Following the Official TCEQ Alternative Fuel Formulation Procedure, Thompson, Clark, Gautam, Lyons, Wayne, $74,705

ORYXE, Selection of a Bio-Derived Diesel Candidate Fuel for a TCEQ Evaluation, Thompson, Clark, Gautam, Lyons, Wayne, $57,777

ORYXE, Evaluation of CARB Reference and Candidate Fuels for SOF Determination, Thompson, Clark, Gautam, Lyons, Wayne, $100,620.

Research and Development, Developing Novel Coating Solutions, LLC (RDS), Kang, Barbero, Liu, $37,000

Research and Development, Developing Novel Coating Solutions, LLC (RDS), Kang, Barbero, Liu, $16,823

Research and Development, Developing Novel Coating Solutions, LLC (RDS), Kang, Barbero, Liu, $20,000

Research and Development, Degradation of Metallic Interconnects in Coal Based SOFC, Barbero, Wu, Liu, $79,882

RESEARCH AWARDS 2006-2007

Research and Development, Degradation of Metallic Interconnects in Coal Based SOFC, Barbero, Wu, Liu, $6,497

Research and Development Solutions (RDS), LLC, Assessment of Turbo-Chemistry Models for Prediction of Fuel Composition Effects on GTC Emissions, Celik, $129,469

Research and Development Solutions (RDS) LLC, Defining the Future Needs for Lubricant Formulations for Hydrogen-Fueled Heavy-Duty Engines: Enabling Technology Development, Gautam, Thompson, Clark, Carder, Wayne, Lyons, $45,000

Research and Development Solutions, LLC, Development of Advanced Controls for Hyper System: Budget Revision 1, Banta, $57,900

Research and Development Solutions, LLC (RDS), Long Term Reliability Investigation on TBC, Chen, Kang, $31,272

Research and Development Solutions, LLC (RDS), Collaboratory for Multiphase Flow Research, Turton, Johnson, Kang, Clarke, Kuhlman, $1,125,000

South Coast Air Quality Management, Characterization of Nox Emissions from Late Model Year Heavy-Duty Vehicles, Gautam, Clark, Thompson, Wayne, Lyons, Krishnamurthy, $240,000

South Coast Air Quality Management, Characterization of Exhaust Emissions from Natural Gas-Fueled Refuse Haulers, Clark, $180,000

Tenoroc LLC, Bloom Centrifuge for Internal Combustion Engine Use, Thompson, Smith, $97,764

Tenoroc LLC, Bloom Centrifuge for Internal Combustion Engine Use, Thompson, Smith, $7,047

Tenoroc LLC, Bloom Centrifuge for Internal Combustion Engine Use, Thompson, Smith, $29,957

Transit Resource Center, Analysis of Tailpipe Emissions from Westchester County Transit Buses, Wayne, Thompson, Gautam, Lyons, Clark, $217,256

US Army, Flexible, Network Centric Small Unit Lethality, Napolitano, Gautam, $98,000

US Department of Energy, Direct Utilization of Coal Syngas in High Temperature Fuel Cells, Celik, Kang, Condlo, Finklea, Smirnov, Ma, Cooper, Wu, Liu, $700,000

US Dept. of Energy, Integrated Control of Next Generation Power System, Chouldry, Lai, Noore, Reynolds, Saymanski, Schoder, Sneckenberger, $770,000

US DHHS/CDC/NIOSH, Enclosing Hood Effectiveness, Celik, Guffey, $121,662

US DHHS/CDC/NIOSH, Experimental and Theoretical Study of Early Detection and Isolation of Influenza, Celik, $115,369

US DOT, Federal Transit Administration, Transit Vehicle Exhaust Emissions Evaluation - Phase V, Wayne, Thompson, Gautam, Lyons, Clark, $1,349,964

US DOT, Federal Transit Administration, Hybrid Bus Emissions and Certification Working Group, Wayne, Lyons, Clark, Gautam, Thompson, $300,000

Virginia Polytechnic Institute and State University, Warm Air Drying of Fine Particles (CAST Round III), Kang, Saus, Johnson, $100,322

WV Department of Highways, Development of Reinforced LMC and MSC for Crack Resistant Bridge Deck Overlays, Shoukry, Riad, Cairns, William, $240,697

WV Department of Highways, Monitoring the Structural Performance and Bridge Deck Crack Growth - Star City, Riad, William, Prucz, Shoukry, $282,609

WV Department of Highways, Bridge Deck Crack Reduction Through Uniform Setting and Curing Procedures, Riad, $192,248

WV Development Office, Industry Energy Efficiency Program, Means, $150,000

WV Development Office, Glass Industry Assistance Project, Banta, $90,000

WV Higher Education Policy Commission/WV EPSCoR, WV EPSCoR Cost Share on Direct Utilization of Coal Syngas in High Temperature Fuel Cells, Bajura, $250,000

PUBLICATIONS 2006

Agrawal, B., Upadhyay, P. C., Banta, L. and Lyons, D. "Transient Temperature Distribution in Composites with Layers of Functionally Graded Materials, *Journal of Reinforced Plastics and Composites*, Vol. 25, May 2006 pp. 513-542.

Alleman, T.L., Barnitt, R., Eudy, L., Miyasato, M., Oshinuga, A., Corocan, T., Chatterjee, S., Jacobs, T., Cherrillo, R.A., Clark, N.N., and Wayne, W.S., "Final Operability and Chassis Emissions Results From a Fleet of Class 6 Trucks Operating on Gas-To-Liquid Fuel and Catalyzed Diesel Particle Filters," Transactions of the SAE, *Journal of Fuels & Lubricants*, 2005 (printed in 2006) pp. 1450-1464.

Angle, G., Smith, J., and Huebsch, W., "Experimental and Computational Investigation into the Use of the Coanda Effect On the Bell A821201 Airfoil," Application of Circulation Control Technologies, *Progress in Astronautics and Aeronautics Series*, Vol. 214, published by AIAA, 2006, Chapter 9, pp. 275-289.

Barbero, E. J. and Ford, K. J. (2006) Determination of Ageing Shift Factor Rates for Field-Processed Polymers, *SAMPE J. of Advanced Materials*, 38(2) April, 7-13.

Barbero, E. J., Lonetti, P. and Sikkil, K. Finite Element Continuum Damage Modeling of Plain Weave Reinforced Composites, *Composites Part B*, 37 (2006) 137-147 (March).

Barbero, E. J.; Trovillion, J.; Mayugo, J.A.; Sikkil, K.K. Finite element modeling of plain weave fabrics from photomicrograph measurements, *Composite Structures*, v 73, n 1 (May) 2006, p 41-52.

Beare, R. , MacVean, M., Holtslag, A., Cuxart, J., Esau, I., Golaz, J-C., Jimenez, M., Khairoutdinov, M., Kosovic, B., Lewellen, D., Lund, T., Lundquist, J., McCabe, A., Moene, A., Noh, Y., Raasch, S., and Sullivan, P. "An intercomparison of large-eddy simulations of the stable boundary layer", *Boundary-Layer Meteorology*, 118:247—272, 2006.

Bond, R. E., Morris, G. J., and Loth, J. L., "Ground Effect Characteristics and Centerline Pressure Distributions for a Hypersonic Configuration", *Journal of Aircraft*, Vol. 43, No. 6, Jan-Feb, 2006, p. 58-63.

Celik, I., Klein, M., Freitag, M., Janicka, J. (2006)"Assessment Measures for URANS/DES/LES: An Overview with Applications", *Journal of Turbulence*, 7(48):1-27.

Chen, K., Banta, L. and Jiang, G., "Saddle-Point Based Separation of Touched Objects in 2-D Image", *Journal of Electronics* (China), Vol 23 No 3, May 2006, pp 450-456.

Cuxart, J., A. Holtslag, R. Beare, E. Bazile, A. Beljaars, A. Cheng, L. Conangla, M. Ek, F. Freedman, R. Hamdi, A. Kerstein, H. Kitagawa, G. Lenderink, D. Lewellen, J. Mailhot, T. Mauritsen, V. Perov, G. Schayes, G-J. Steeneveld, G. Svensson, P. Taylor, W. Weng, S. Wunsch and K-M. Xu." Single-column model intercomparison for a stably stratified atmospheric boundary layer." *Boundary-Layer Meteorology*, 118:273—303, 2006.

El-Sherbeeny, A. M., Odom, J. V. and Smith, J. E., "Ocular Manifestations Due to Systemic Exposure to Mercury", *Journal of Toxicology: Cutaneous and Ocular Toxicology*, Volume 25, Number 3, pp 173-183, Informa Healthcare, London, England, September 2006.

El-Sherbeeny, A. M., Odom, J. V. and Smith, J. E., "Spatial Density Distribution as a Basis for Image Compensation", *Journal of Modern Optics*, Special Issue: Developments in Vision Enhancement Technology and their Evaluation, Volume 53, Number 9, 15 June 2006, pp: 1241-1244, Taylor and Francis.

El-Sherbeeny, A. M., Odom, J. V., Della-Giustina, D. and Smith, J. E., "Eye Biomarkers as Early Indicators of Occupational Toxicity: Blood Toxins, Heavy Metals, and Neurotoxins", *Professional Safety Journal of the American Society of Safety Engineers*, Volume 51, Number 8, pp 26-32, August 2006.

Feng, C. and Kang, B. "A transparent Indenter Measurement Method for Mechanical Property Evaluation," *Experimental Mechanics*, vol. 1, 1-14, (2006).

Gu, Y., Seanor, B., Campa, G., Napolitano, M. R., Rowe, L., Gururajan, S., Wan, S. "Design And Flight Testing Evaluation Of Formation Control Laws", *IEEE Transactions on Control Systems Technology*, Vol.14, No 6, pp 1105-1112, November 2006.

Guiler, R.W. and Huebsch, W.W., "Development and Testing of a Wing Morphing Mechanism for the Control of a Swept Wing Tailless Aircraft," 2005 SAE Transactions, *Journal of Aerospace*, 2006, pp. 1296-1305.

Huebsch, W.W., "Dynamic Roughness for Aerodynamic Flow Control," *AIAA Journal of Aircraft*, Vol. 43(2), 2006, pp. 353-362.

PUBLICATIONS 2006

Ikonomov, P., Ghantasala, M. Dwivedi, S. and Lyons, D., "Simulation of Forces for Virtual, Nanoassembly," *International Journal of Advanced Manufacturing Systems*, Vol. 9, Issue 2, 2006.

Jaca, R., Sosa, E. M. and Godoy, L. A. (2006). "Límites inferiores de cargas de pandeo para tanques de pared delgada con techo cónico". *Mecánica Computacional*, vol. XXV, pp. 585-604.

Johnson, E., Regester, J., and Kang, B., "Fluidized Bed Riser as a Dry Particle Separation System", *Minerals & Metallurgical Processes*, vol. 22, no.3, 130-134, August, (2005).

Kang, B. and Cisloiu, R., "Evaluation of Fracture Behavior of Iron Aluminides," *Theorectical and Applied Fracture Mechanics*, vol.45, no. 11, 25-40, (2006).

Kang, B. S.-J., Yao, Z. and Barbero, E. J., "Post-Yielding Stress-Strain Determination Using Spherical Indentation," *Mechanics of Advanced Materials and Structures*, 13:129-138 (2006) (Jan).

Khan, A.S., Clark, N. N., Thompson, G. J., Wayne W. S., Gautam, M., Lyons, D. W. and Hawelti, D., "Idle Emissions from Heavy-Duty Diesel Vehicles: Review and Recent Data," *Journal of the Air & Waste Management Assoc*., Vol 56, October 2006, pp. 1404-1419

Kinsey, J.S., Mitchell, W.A., Squier, W.C., Linna, K., King, F.G., Logan, R., Dong, Y., Thompson, G.J. and Clark, N.N., "Evaluation of methods for the determination of diesel-generated fine particulate matter: Physical characterization results," *Journal of Aerosol Science*, Vol. 37 (2006) pp. 63-87

Liu, X., Wu, N. Q. Wunsch, B. H., Barsotti, R. J., and Stellacci, F., Shape-Controlled Growth of Micron-Sized Gold Crystals by a Slow Reduction Method, *Small*, 2 (2006), 1046-1050.

Liu, X., Xu, J., Deem, N., Chang, K-M, Barbero, E. J., Cao, W-D, Kennedy, R. L., Carneiro, T., "Effect of Thermal-Mechanical Treatment on the Fatigue Crack Propagation Behavior of Newly Developed ALLVAC 718PLUS Alloy," *Superalloys 718-625-706 and Derivatives*, E. A. Loria Ed., TMS (2006).

Loth, J., Book Chapter 1,"Advantages of Combining BLC Suction with Circulation Control High-Lift Generation", *Applications of Circulation Control Technology*, Edited by Ronald Roslin (ONR) and Gregory Jones (NASA); AIAA Series: Progress in Astronautics and Aeronautics, Vol 214, June 2006, ISBN: 1-56347-789-0

Loth, J.,U.S. Patent No.: 7,040,482, "Bearing Life Extender for Conveyor Type or Zinc-Pot Rollers," issued May 9, 2006, sole inventor.

Loth, J., U.S. Patent No.: 7,134,631, "Vorticity Cancellation at Trailing Edge for Induced Drag Elimination," issued November 14, 2006, sole inventor.

Loth, J. and Morris, G. .J., U.S. Patent No.: 6,994,057," Compression Ignition Engine by Air Injection from Air-only Cylinder to Adjacent Air-Fuel Cylinder" issued Feb. 7, 2006.

Ma, L. , Liu, X. & Chang, K-M., "Reply to comment on 'Identification of SAGBO-induced damage zone ahead of crack tip to characterize sustained loading crack growth in alloy 783'", *Scripta Materialia, 54 (January 2006) 309–311*

Ma, N., Cooper, B.R., and Kang, B., "Tight-binding Study of Thermal Expansions for Mo_3Si," *Journal of Applied Physics*, 99, 053514, 1-8, (2006).

Madireddy, M. R. and Clark, N. N., "Sequential Inversion Technique and Differential Coefficient Approach for Accurate Instantaneous Emission Measurement," *International Journal of Engine Research*, Vol. 7, 2006, pp. 437-446.

McCarthy, M. C., Eisinger, D. S., Hafner, H. R., Chinkin, L. R., Roberts, P. T., Black, K. N., Clark, N. N., McMurry, P. H. and Winer A. H., "Particulate Matter: A Strategic Vision for Transportation-Related Research," *Environmental Science & Technology*, Volume 40 Issue 8, September 2006, pp. 5593-5599

Morris, G., J. US Patent No. 7,034,703 "Ambient Condition Detector with Time-Delayed Function", issued April 25, 2006, sole inventor.

Nirmala, K., Upadhyay, P. C. , Prucz, J., and Lyons, D., "Thermo-elastic Stress in Composite Beams with Functionally Graded Layer," *Journal of Reinforced Plastics and Composites*, Vol. 25, Aug. 2006, pp. 1241-1254.

Ogretim, E. and Huebsch, W. W., "Aircraft Ice Accretion Prediction Based on Neural Networks," *AIAA Journal of Aircraft*, Vol. 43(1), 2006, pp. 233-240.

PUBLICATIONS 2006

Ogretim, E., Huebsch, W.W., Narramore, J., and Mullins, R, "Mechanisms for Downstream Ice Growth," 2005 *SAE Transactions, Journal of Aerospace*, 2006, pp. 1212-1219.

O'Hare, B., Angle, G.., Huebsch, W. W., and Smith, J., "Continued Computational Investigation into Circulation Control for the V-22 Osprey Download Reduction," 2005 *SAE Transactions, Journal of Aerospace*, 2006, pp. 824-830.

Perhinschi, M. G., Campa, G., Napolitano, M. R., Lando, M., Massotti, L., Fravolini, M. L., "Modeling and Simulation of Closed Loop Aircraft/Fault Tolerant Control System", International Journal of Modeling and Simulation, Vol. 26, No 1, 2006.

Perhinschi, M. G., Napolitano, M. R., Campa, G., Seanor, B., Burken J., Larson R., "An Adaptive Threshold Approach for the Design of an Actuator Failure Detection and Identification Scheme", *IEEE Transactions on Control Systems Technology*, Vol.14, No 3, pp. 519-525, May 2006.

Perhinschi M. G., Napolitano M.R., Campa G., Seanor B., Burken J., Larson R., "Design Of Safety Monitor Schemes For A Fault Tolerant Flight Control System", *IEEE Transactions on Aerospace and Electronic Systems*, Vol. 42, Issue2, pp. 562-571, April 2006.

Rafael M., Sanchez M., Mucino V. H., Cervantes J., Lozano A. "Impact of driving styles on exhaust emissions and fuel economy from a heavy-duty truck: laboratory tests" Int. J. of Heavy Vehicle Systems, Vol.13, No. ½, pp 56-73, 2006.

Shi, S., Celik, I., Smirnov, A., Yavuz, I. (2006) "Large-Eddy Simulation of Spatially Developing Turbulent Wake Flows", Journal of Ship Research, 50(3):208-221.

Shoukry, S.N., William, G.W., Riad, M., Mcbride, K.C. (2006). Dynamic Relaxation: A Technique for Detailed Thermo-Elastic Structural Analysis of Transportation Structures. International Journal of Computational Methods in Engineering Science and Mathematics, Vol. 7, No. 4, pp. 303-311.

Smirnov, A. V., Burt, A. C., and Celik, I., (2006) "Multi-Physics Simulation of Fuel Cells Using Multi-Component Modeling", Journal of Power Sources, 158:295-302.

Sosa , E. M., Godoy, L. A., and Croll, J. G. .A. (2006). "Computation of lower-bound elastic buckling loads using general-purpose finite element codes". *Computers and Structures*, vol. 84, pp. 1934–1945.

Strimer, C. M., Clark, N. N., Carder, D., and Gautam, M., "Impact of Vehicle Weight on Truck Behavior and Emissions, Using On-Board Measurement," Transactions of the SAE, Journal of Engines, 2005 (printed in 2006) pp. 1630-1642.

Toth-Nagy, C., Conley, J. J., Jarrett, R. P., and Clark, N.N., "Further Validation of Artificial Neural Network Based Emissions Simulation Models for Conventional and Hybrid Electric Vehicles," Journal of the Air & Waste Management Association, Volume 56, July 2006, pp. 898-910

Upadhyay, P. C., Yadav, S., Banta, L. and Lyons, D. "Stress Concentration in the Matrix with Degraded Fiber-Matrix Interface," Journal of Composite Materials, Vol. 40, No. 18, 2006

Wan, S. and Banta, L., "Parameter Incremental Learning Algorithm for Neural Networks", IEEE *Transactions on Neural Networks*, Vol 17, No 6, Nov 2006 pp 1424-1438.

Wowczuk, Z. S., Auld, J. and Smith, J. E. "Project OCULUS: Enhanced Visual Information Platform", *Journal of Modern Optics*, Special Issue: Developments in Vision Enhancement Technology and their Evaluation, Volume 53, Number 9, 15 June 2006, pp: 1229-1240, Taylor and Francis.

The Microgravity Research Team receives a $1,000 check from WVHTC in support of their experiment aboard NASA's Weightless Wonder.

STUDENT RECEIVES NASA AWARD

Mechanical and Aerospace Engineering Student Jason Gross received the Robert H. Goddard Research Award from NASA for his work on the James Webb Telescope. The Webb Telescope, designed to gather information about the history of our universe, will succeed the Hubble Telescope when launched in 2013.

During the summer, Jason and sixteen other college students from around the world attended the NASA Academy, which takes places at the Goddard Space Flight Center in Greenbelt, Maryland. Students who are selected to attend the Academy have the opportunity to collaborate on research projects with NASA scientists, participate in meetings with aerospace industry professionals, and tour NASA facilities around the nation.

Jason Gross is a native of Morgantown, West Virginia, and expresses great pride in representing West Virginia University. His accomplishments include being elected Student Body President and serving as Vice Chairman of the Board of Governors. As student body president, Jason led the student government association in writing a proposal to build a sidewalk on Willowdale Rd., which resulted in a $500,000 Federal Transportation Grant and the completion of the sidewalk this fall. Jason and the members of the student government also filled a vacant vendor location in the Mountainlair with a Quiznos Sub Shop, and have lobbied for the establishment of a WVU campus child daycare facility.

Jason was a member of the 2006 Microgravity Research Team and traveled to NASA's Johnson Space Center in Houston, Texas, to test an experiment in a reduced gravity environment. Jason is a member of several honoraries including Helvetia, Chimes, Mortar Board, Tau Beta Pi, and Sigma Gamma Tau.

After graduating in December 2007, Jason plans to attend graduate school at West Virginia University and pursue a doctorate in aerospace engineering. His career goal is to become a NASA engineer and one day a research professor.

DONORS

American Society For Engineering Education, Inc.
Boeing Company Gift Matching Program
Caterpillar Foundation
Corning, Inc. Foundation
Cummins Business Services
Dow Chemical Company Foundation
Exxon Mobil Foundation
General Electric Company
International Business Machines Corporation
Lockheed Martin Federal Systems
Morgan Stanley
Potlatch Foundation II
Science Applications International Corporation
Shell Oil Company Foundation
United Technologies
WVHTC Foundation

Mr. and Mrs. John T. Ach
Mr. Charles D. Albright
Mr. and Mrs. Larry J. Andrews
Mr. Ravi K. Bahl
Dr. and Mrs. Frank T. Baker
Dr. and Mrs. Jimmy P. Balsara
Dr. Larry Banta
Mr. Richard A. Barido
Mr. and Mrs. John C. Benner
Mr. Arthur M. Bree
Mr. Barry K. Britton
Mr. David R. Bungard
Mrs. Kendra L. Burch
Mr. and Mrs. Stephen R. Burke
Mr. John W. Byrd
Mr. John W. Campbell
Mr. William L. Carenbauer
Mr. and Mrs. William C. Cavage
Dr. and Mrs. Jack B. Chaddock
Mr. Michael D. Childs
Mr. and Mrs. Robert J. Cochenour
Mr. and Mrs. David R. Collier
Mr. and Mrs. Charles W. Collins
Mr. and Mrs. James E. Conklin
Mr. and Mrs. William Crise
Mr. Stephen K. Cronin
Mr. and Mrs. Donald R. Culp
Mrs. Gloria DePaolis
Mr. James H. Doak
Mr. and Mrs. James F. Edwards, Jr.
Mr. and Mrs. James C. Evans
Mr. Robert L. Evans
Mr. David L. Faber
Mr. Richard L. Falkenstein
Dr. and Mrs. Jerome P. Fanucci
Mrs. Marsha H. Fanucci
Mr. Thomas A. Ferris
Mr. and Mrs. Kevin D. Fields
Dr. and Mrs. William L. Fourney
Ms. Jingang Fu
Ms. Denise Gatsche
Mr. and Mrs. Harry G. Gibson
Mr. John L. Giuliani
Mr. Gus Glyptis
Mr. and Mrs. Matthew G. Goff
Mr. and Mrs. Robert A. Gore
Mr. Robert W. Gross
Mr. and Mrs. Bill Hackett
Mr. and Mrs. Charles F. Haller
Dr. and Mrs. William R. Hamel
Mr. and Mrs. James E. Hardy
Mr. and Mrs. Gregory S. Harness
Mr. and Mrs. John P. Harris, Jr.
Mr. and Mrs. Howard M. Hatala
Mr. Daniel M. Hodgkiss
Mr. and Mrs. Walter D. Hubbell
Mrs. Kaye I. Hutter
Mr. and Mrs. Charles E. Jamison II
Mr. Burl W. Jones
Mr. and Mrs. Ralph W. Judy, Jr.
Mr. Richard J. Kacik
Mr. Guosheng Kang
Mr. and Mrs. Robert I. Karr
Dr. James A. Keenan
Mr. and Mrs. Bob Keith
Mr. and Mrs. Russell L. King, Jr.
Mr. Thomas R. Kolankiewicz
Dr. and Ms. John M. Kuhlman
Mr. and Mrs. Fred W. Kuhn
Mr. John P. Kweder
Mr. Leonard Landau
Mr. Thomas E. Leach
Mr. and Mrs. Robert R. Lenhart
Dr. Barbara T. Leonard
Mr. and Mrs. Matthew J. Leroch III
Mr. Allen K. Lichvar
Mr. and Mrs. Keith L. Lilly
Mr. and Mrs. David R. Linger
Mrs. Beverly S. Long
Dr. and Mrs. Thomas R. Long
Mr. and Mrs. Donald C. Lycan
Mr. Frederick L. Marr
Mr. and Mrs. Carl D. Matheny
Mr. William D. McClung, Jr.
Mr. and Mrs. W. Scott Mease
Dr. and Mrs. Paul G. Migliore
Mr. and Mrs. M. Bruce Milam
Mr. C. Douglas Miller
Mr. Robert M. Miller
Mr. and Mrs. Thomas M. Miller
Mr. and Mrs. Mack T. Moore
Mr. Kevin K. Moyers
Mr. and Mrs. W. Scott Mullins
Mr. and Mrs. Jeffrey Newel
Mr. James C. Pack, Jr.
Mr. and Mrs. Charles B. Palmer
Mr. Jon J. Parrinello
Mr. and Mrs. Joseph D. Parriott
Mr. and Mrs. Terrence L. Parsons
Mr. John D. Pellegrin
Mr. and Mrs. Harold L. Phillippi
Mr. Trevor M. Poquette
Ms. Nancy J. Prowant
Mr. and Mrs. Alan S. Pyle
Dr. R. Ganesh Rajagopalan
Mr. and Mrs. Bruce C. Raymond,P.E.
Mr. and Mrs. Samuel E. Reckley
Mr. and Mrs. Mark F. Reeder
Mr. and Mrs. John A. Reynolds
Mr. and Mrs. Peter B. Rich
Mr. James V. Rizzo, Jr.
Mr. James H. Rodman, Jr.
Dr. Carlos E. Romero
Mr. and Mrs. Richard L. Rood
Mr. Phillip M. Sabree
Mr. Arthur K. Schuler
Mr. Stan T. Serpento
Mr. and Mrs. Steven P. Shaver
Dr. Frank M. Shipper
Mr. and Mrs. Morris M. Shor

DONORS

Mr. and Mrs. Frank J. Shuler
Mr. & Mrs. Robert D. Skelton
Dr. and Mrs. Ojars Skujins
Ms. Linda Slonksnes
Mr. James B. Smith
Mr. and Mrs. Jerry J. Smutney
Dr. and Mrs. John E. Sneckenberger
Mr. and Mrs. William K. South
Mr. Peter L. Spence
Mr. and Mrs. C. Robert Steele
Mr. and Mrs. Daniel E. Steerman
Dr. Alan D. Stemple
Dr. James B. Stenger
Mr. and Mrs. J. Robert Stockner
Mr. Adam J. Suchko
Mr. Jeff A. Summers
Mr. and Mrs. Adrian M. Sushko
Prof. W. David Teter
Dr. Terri L. Tramel
Mr. and Mrs. Joseph R. Turner
Mr. and Mrs. Roy M. Turner
Mr. and Mrs. Marvin L. Vest, Jr.
Mr. and Mrs. Robert W. Walter
Dr. and Mrs. Richard E. Walters
Mr. and Mrs. Gary W. Wamsley
Mr. Frederick J. Werner
Mr. and Mrs. Earl K. West
Mr. John L. White
Mr. and Mrs. F. David Wilkin
Mr. & Mrs. Jack S. Willey
Mr. George A. Williams
Mr. and Mrs. Stephen A. Williams, Sr.
Mr. and Mrs. Christopher J. Williamson
Ms. Yuwen Yao
Mr. Richard Yungwirth
Mr. and Mrs. David G. Zipf

THANK YOU FOR YOUR SUPPORT

We have made every effort to make this list complete and accurate, but please let us know if you spot an error, so that we may correct it.

ADVISORY COMMITTEE

Name	Position	Company
Mr. Robert J. Aquaro	Vice President	Mitsubishi Motors
Mr. John Benner	Division Leader, Weapon System Engr.	Los Alamos National Laboratory
Mr. Darius Brant	Manager Aerothermophysics	Lockheed Martin Corporation
Mr. Gregg Corley	Director of Engineering	ATK Tactical Systems Company
Mrs. Christine Cropp	Engineer	Arion Systems, Inc.
Mr. James G. Direnzi	Chief Engineers Office	General Electric Aircraft Engines
Dr. William L. Fourney	Professor & Chair	University of Maryland, Aerospace Eng.
Mr. Charles E. 'Chuck' Jamison	Hoechst Celanese Corp. (Retired)	Hoechst Celanese Corp.
Mr. Neil Jubeck	Naval Air Warfare Center (Retired)	Naval Air Warfare Center
Mr. Richard E. Kleine	Vice President, Off Highway Business	Cummins
Mr. Robb Lenhart	Senior Consultant	Concurrent Technologies Corp
Dr. Steve Lewellen	Research Professor of Mech. & Aero. Engr. (Retired)	West Virginia University
Mr. Aubra D. McKisic	Senior Director of Engineering	Trinity Tank Car, Inc.
Mr. Will Miller	Staff Engineer	Mack Trucks, Inc.
Dr. B. Robert Mullins Jr.	Manager, US101 Program Development	Bell Helicopter Textron Inc.
Mr. George K. Oss	President & CEO (Retired)	Versar Laboratories Inc.
Mr. Robert J. Pokorski	Asst V-President, Strategic Maintenance	Strategic Maintenance, TTX
Mr. John J. Richard	Exec. Asst. to Genl. Manager (Retired)	Westinghouse Electric Corporation
Dr. John Tomblin	Executive Director, NIAR	Wichita State University
Dr. Dick Walters	Professor Emeritus	West Virginia University

Department of Mechanical and Aerospace Engineering
College of Engineering and Mineral Resources
West Virginia University
Morgantown, WV 26506-6106

Nonprofit Organization

U.S. Postage
PAID

Morgantown, WV
Permit No. 34

PERFORMANCE SUMMARY

Fiscal Year	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
No. of Faculty	24	24	24	28	28
Research Awards	$10,259,843	$9,126,475	$6,470,348	$10,676,884	$9,013,481
Research Expenditures	$7,608,796	$7,901,476	$8,894,729	$9,313,003	$10,032,752
Journal Papers (Jan-Dec)	40	43	33	38	55
Undergrad Enrollment	314	339	386	401	417
MS Enrollment	119	124	104	89	73
Ph.D. Enrollment	34	46	56	55	66
Undergraduate Degrees	109	125	101	127	126
MS Degrees	33	45	29	31	43
Ph.D. Degrees	5	4	6	11	12
Undergrad Student Cr. Hrs.	7,180	7,983	8,817	10,036	9,900
Graduate Student Cr. Hrs.	2,723	2,722	2,767	2,827	2,315
Undergrad Course Cr. Hrs.	209	220	184	277	236
Graduate Course Cr. Hrs.	43	45	54	45	48

Circulation 600 copies, also available on CD by request, contact http://www.mae.cemr.wvu.edu/contact.php