

ANTHONY J. MARCHESE, Ph.D.

COLORADO STATE UNIVERSITY • FORT COLLINS, CO 80523 • (970) 491-2328

RESEARCH: Combustion, alternative fuels, diesel emissions, multi-phase reacting flows, microgravity research, chemical kinetics, rocket propulsion, product development.

EDUCATION: **Ph.D., Mechanical and Aerospace Engineering** Princeton University
Awarded: November 1996 Princeton, NJ
Thesis Topic: *Microgravity Droplet Combustion*

M.A., Mechanical and Aerospace Engineering Princeton University
Awarded: April 1994 Princeton, NJ

M.S., Mechanical Engineering Rensselaer Polytechnic Institute
Awarded: May 1992 Hartford, CT
GPA: 4.00 / 4.00

B.S., Mechanical Engineering Rensselaer Polytechnic Institute
Awarded, Magna cum Laude: December 1989 Troy, NY
GPA: 3.81 / 4.00

EMPLOYMENT: **Associate Professor** December 2007 to Present
Colorado State University, Dept. of Mechanical Engineering Fort Collins, CO

Department Chair January 2007 to December 2007
Associate Professor August 2000 – December 2007
Assistant Professor September 1996 - August 2000
Rowan University, Dept. of Mechanical Engineering Glassboro, NJ

Project Director January 2004 – July 2007
South Jersey Technology Park at Rowan University Glassboro, NJ

Visiting Faculty Fellow September 2003- August 2004
Princeton University Princeton, NJ

Graduate Research Assistant September 1992 - August 1996
Princeton University Princeton, NJ

Assistant Research Engineer December 1989 - September 1994
United Technologies Research Center East Hartford, CT

Student Trainee Research Engineer June 1987 - September 1989
NASA Lewis Research Center Cleveland, OH

EXPERIENCE: **Project Director** January 2004 – July 2007
South Jersey Technology Park at Rowan University Glassboro, NJ

Oversaw development of the first phase of Rowan University's 188-acre, 1.5 million SF research park.

Managed all day-to-day operations and approved all expenditures of SJTP, Inc., a non-profit 501(c)3 corporation.

Developed and implemented the strategic, financial and real estate plans of the SJTP.

Raised \$7.3 Million in funds from the DRBA, NJCST, NJDCA, U.S. HUD and U.S. SBA a variety of state and federal sources for construction and tenant improvements.

Directed the programmatic development, architectural design, financing and construction of the 45,000 SF Samuel H. Jones Innovation Center, a \$15 million LEED® certified wet-laboratory/office building.

E-Mail: marchese@colostate.edu

Web site: <http://www.engr.colostate.edu/~marchese>

Chair, Associate Professor, Assistant Professor ***September 1996 – Present***
Rowan University, Department of Mechanical Engineering ***Glassboro, NJ***

Hired in 1996 as the first junior faculty member in the Department of Mechanical Engineering at the newly created College of Engineering at Rowan University. Granted early promotion and tenure in May 2000.

Obtained funding for 30 proposals from NASA, NSF, NJDOT, NJDEP, NCIIA, U.S. Navy and private industry for a total of \$3,200,000 in external funding.

Developed the mechanical engineering thermal sciences curriculum and thermodynamics/engine laboratory.

Initiated the Rowan Undergraduate Venture Capital Fund for rapid development of original student inventions within the multidisciplinary Engineering Clinic sequence. Raised over \$120,000 to date, which has been distributed directly to undergraduate student teams.

Visiting Faculty Fellow ***September 2003 – August 2004***
Princeton University ***Princeton, NJ***

On sabbatical from Rowan University, performed chemical kinetic studies on biodiesel fuels in the Combustion and Fuels Laboratory at Princeton University.

NASA/ASEE Summer Faculty Fellow ***June 1998 - August 1998***
National Aeronautics and Space Administration ***Cleveland, OH***

For the summer of 1998 I received a NASA Summer Faculty Fellowship to determine the effects of multi-step kinetics on flame propagation through layered premixed gas systems. The effort included developing reduced methanol kinetic mechanisms and modifying a two-dimensional liquid pool burning model to include detailed chemistry and transport.

Graduate Research Assistant ***September 1992 - August 1996***
Princeton University ***Princeton, NJ***

Refined a numerical model to study the transient, spherically symmetric, combustion of pure and multicomponent alkane and alcohol droplets.

Performed microgravity droplet combustion experiments using the NASA Lewis 2.2 Second Drop Tower. Developed new data analysis and numerical modeling technique to determine flame structure from measured OH radical chemiluminescence.

Generated matrix of test conditions for NASA space-based FSDC and DCE droplet combustion experiments launched aboard the space shuttle in November 1995, April 1997 and July 1997, respectively.

Developed a new chemical reaction mechanism for oxidation and pyrolysis of higher n-alkanes. Performed chemical kinetic experiments using a variable pressure flow reactor to test the new mechanism.

Assistant Research Engineer ***December 1989 - September 1994***
United Technologies Research Center ***East Hartford, CT***

Performed numerical, analytical, and experimental studies to identify the thermal, structural and fluid dynamic effects of variable speed and high discharge temperature on the operation of positive displacement compressors.

Specified, oversaw installation, and developed software for a UNIX-based, high speed data system featuring a Concurrent 6700 computer.

Developed instrumentation and real-time data analysis techniques utilizing thermocouples, heat flux gages, high-response pressure transducers, accelerometers, proximity probes, mass flow meters and acoustic emission sensors.

Developed 4 inventions (2 patents issued to date) describing innovative lubrication, thermal management, and dynamic stabilizing concepts for positive displacement compressors.

Student Trainee Research Engineer ***June 1987- September 1989***
National Aeronautics and Space Administration ***Cleveland, OH***

Completed four full-semester, cooperative education assignments (52 weeks, total) in various branches of the Space Propulsion Technology Division at NASA Lewis Research Center. Received offer for career position as research engineer.

Developed calibration system and compressible flow analysis software to simplify control valve selection for the Rocket Engine Test Facility at NASA Lewis Research Center. Designed innovative propellant feed system for aluminum/RP-1 metallized gel propellant rocket engine testing.

Determined the thermodynamic performance of chemical rocket propellants derived from the lunar soil and Martian soil/atmosphere. Assessed the current technology for in-situ production of such propellants in support of a lunar base and/or manned Mars mission.

Performed detailed trajectory analyses for Earth-to-Mars ion-propelled cargo missions.

CONSULTING: ***Princeton University / NASA*** ***September 1996 - September 1998***
Princeton, NJ; Huntsville, AL

Served as a member of the science support team for the Droplet Combustion Experiment (DCE) which flew aboard the first Microgravity Science Laboratory mission (MSL-1) on Space Shuttle Columbia flights STS-83 and STS-94 in April and July 1997.

Generated and communicated the science requirements from the Payload Operations Control Center at Marshall Space Flight Center to astronauts as they executed the experiment aboard Columbia during the STS-83 and STS-94 missions.

Kimble Glass ***October 1997 - October 1998***
Vineland, NJ

Performed an experimental and modeling study to determine the operating characteristics of annealing furnaces used in specialty glass manufacturing for the pharmaceutical industry.

CVM Corporation ***August 1999***
Wilmington, DE

Performed analytical calculations for development of a Petroleum Hydrotreating Catalyst Plant, which was under development for installation in Kuwait.

L3 Communications ***November 2001-Present***
Camden, NJ

Develop and deliver short courses including Rapid Product Development, Electronic Packaging and Propulsion for engineering trainee program at L3 Communications in Camden, NJ.

National Collegiate Inventors and Innovators Alliance ***January 2006-Present***
Amherst, MA

Develop and deliver workshops on engineering entrepreneurship for the Kern Engineering Entrepreneurship Network (KEEN) grant program.

TEACHING EXPERIENCE:

Convection Heat Transfer

Spring 2008

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| Thermodynamics I | Fall 2001, Fall 2002 |
| Design for X | Spring 2001, Spring 2005 |
| Gas Dynamics | Fall 2000, Spring 2003, Spring 2006 |
| Rocket Propulsion | Spring 2000, Spring 2001, Fall 2005, Fall 2007 |
| Combustion | Fall 1999, Fall 2004, Fall 2006, Fall 2008 |
| Fluid Mechanics II | Spring 1999 |
| Junior/Senior Engineering Clinic | Fall 1998 to Present |
| Sophomore Engineering Clinic Coordinator | Fall 1998 to Spring 2001 |
| Freshman Engineering Clinic II | Spring 1997, Spring 1998, Spring 2003 |
| Solid Mechanics | Fall 1997, Fall 1998, Fall 2001, Fall 2002 |
| Freshman Engineering Clinic I | Fall 1996 |
| Thermodynamics, Ordinary Differential Equations | Spring 1993, Fall 1995 |
| Refrigeration Systems | Summer 1991 |

TEACHING INTERESTS

In addition to the above courses, I am interested in developing and teaching graduate level courses in Non-Equilibrium Gas Dynamics, Conduction Heat Transfer and Radiation Heat Transfer; and undergraduate courses in Thermodynamics, Heat Transfer, Fluid Mechanics and Product Design and Development.

PROFESSIONAL MEMBERSHIP

Tau Beta Pi National Engineering Honor Society
 Pi Tau Sigma National Mechanical Engineering Honor Society
 Sigma Xi, The Scientific Research Society
 The Combustion Institute
 American Institute of Aeronautics and Astronautics (AIAA)
 American Society of Mechanical Engineers (ASME)
 Society of Automotive Engineering (SAE)
 American Society of Engineering Education (ASEE)
 National Space Society (NSS)
 Association of University Research Parks (AURP)

SERVICE TO THE PROFESSION

Reviewer for the *ALAA Journal*
 Reviewer for the *ALAA Journal of Propulsion and Power*
 Reviewer for the journal *Combustion Science and Technology*
 Reviewer for the journal *Environmental Science and Technology*
 Reviewer for the *Journal of Physics D: Applied Physics*
 Reviewer for the journal *Combustion and Flame*
 Reviewer for the journal *Combustion Theory and Modeling*
 Reviewer for the journal *Proceedings of the Royal Society of London*
 Reviewer for the journal *Measurement Science and Technology*
 Reviewer for the journal *ASME Journal of Heat Transfer*
 Reviewer for the *International Journal of Engineering Education*
 Reviewer for the *ASEE Journal of Engineering Education*
 Reviewer for the Thirty-Second Symposium (International) on Combustion
 Reviewer for the Thirty-First Symposium (International) on Combustion
 Reviewer for the Thirtieth Symposium (International) on Combustion
 Reviewer for the Twenty-Ninth Symposium (International) on Combustion
 Reviewer for the Twenty-Eighth Symposium (International) on Combustion
 Reviewer for proceedings of the ASEE Annual Meeting, 2001-present
 Reviewer for proceedings of the NCIIA Annual Meeting, 2003-present

Program Review Committee, National Collegiate Inventors and Innovator's Alliance, Oct. 2001
 Peer review panelist for U.S. Civilian Research and Development Foundation (CRDF) Grants, 2003
 Program Review Committee for Hewlett Foundation ESWI Grant Program, Nov. 2002
 Program Review Committee for Kern Family Foundation Engineering Entrepreneurship, 2004-2005
 Peer review panelist for NSERC Chair in Design Engineering, Ryerson University, December 2008
 Peer review panelist for NSF Combustion and Plasma Systems, December 2005, March 2007
 Peer review panelist for EPA/NSF Pollution Prevention in Fluid and Thermal Systems, May 1997
 Peer review panelist for NASA Microgravity Combustion Science Proposals, May 2002
 Peer review panelist for NASA Microgravity Combustion Science Proposals, May 2000
 Peer review panelist for NASA EPSCoR Microgravity Science Proposals, October 2000
 Peer review panelist for NASA EPSCoR Microgravity Science Proposals, January 2001
 Peer review panelist for NCIIA Advanced E-Team Grant Proposals, June 2001, January 2009
 Session Chair, 6th Joint Meeting of the Combustion Institute, May 2009.
 Session Chair, SAE Powertrain and Fluids Meeting, October 2006, October 2007
 Session Chair, Thirty-Second Symposium (International) on Combustion, August 2008
 Session Chair, Spring Meeting, Combustion Institute, Western States Section, March 2008
 Session Chair, Fall Meeting, Combustion Institute, Eastern States Section, November 2005
 Session Chair, 4th Joint Meeting of the U.S. Sections of the Combustion Institute, March 2005
 Session Chair, FIE Annual Conference, October 2006, November 2003
 Session Chair, ASEE Annual Conference, Education Research Methods Division, June 2001
 Session Chair, ASEE Annual Conference, Entrepreneurship Division, 2001, 2004, 2006, 2007
 Session Chair, Twenty-Seventh Symposium (International) on Combustion, August 1998
 Session Chair, Fall Meeting, Combustion Institute, Eastern States Section, October 1997
 F.I.R.S.T. Robot Competition, (Camden High School/Rowan team) 1998, 1999, 2000, 2001, 2002
 ASME Leadership Development Intern, Council on Education, 1999
 Member of Combustion and Fuels Committee, SAE, 2006-present
 Chair, ASEE Entrepreneurship Division, 2000-2001
 Chair, ASEE Entrepreneurship Division, 2006-2007

SERVICE TO THE UNIVERSITY

Administrator and Director, South Jersey Technology Park at Rowan University, 2002-2007
 Intellectual Property Task Force, 2005-2007
 Campus Master Plan Steering Committee, 2004-2007
 Middle States Accreditation Steering Committee, 2003- 2004
 Chair, College of Engineering Clinic Committee, 2001-2002
 College of Engineering Promotion Committee, 2003, 2006-present
 College of Engineering Sophomore Clinic Coordinator, 1998-2000
 College of Engineering Planning Committee, 2000-present
 Rowan University Senate, 1999-2001
 ASME faculty advisor, 1996-1998
 Learning Outcomes Assessment Committee member, 1996-1998
 Intercollegiate Athletics Committee member, 1998-2000
 Advisory Panel, Faculty Center for Excellence in Teaching and Learning, 1996-2001
 Advisory Panel, Center for the Study of Student Life and Development, 2000-2002
 Curriculum Chair, Department of Mechanical Engineering, 1997-1998
 College of Engineering Computer Resources Committee (CRC), 1997-1999

SEARCH COMMITTEES

Mechanical Engineering Faculty, 1 Position, 2004
 Mechanical Engineering Faculty, 1 Position, 2000

Mechanical Engineering Faculty, 1 Position, 1999
Mechanical Engineering Faculty, 2 Positions, 1998
Mechanical Engineering Faculty, 2 Positions, 1997
Mechanical Engineering Faculty, 1 Position, 1996
Electrical and Computer Engineering Faculty, 1 Position, 2002
Electrical and Computer Engineering Faculty, 2 Positions, 2000
Electrical and Computer Engineering Faculty, 2 Positions, 1997
Electrical and Computer Engineering Faculty, 2 Positions, 1996
Mechanical Engineering Technician, 1 Position, 1997
Mechanical Engineering Technician, 1 Position, 2007
Process Engineering Technician, 1 Position, 1999
Director of Faculty Center for Teaching Excellence, 2000
College of Engineering Dean, 2000
Rhorer Chair for Entrepreneurial Studies, 2006
Vice President for University Advancement, 2006

AWARDS AND HONORS

ASEE 2004 Kauffman Award for Technology Entrepreneurship, 2004
CASE Professor of the Year, Rowan University Nominee, 2002
NASA Institute for Advanced Concepts, Phase I Fellow, 2002.
Carnegie Scholar, Carnegie Academy for the Scholarship of Teaching and Learning, 2001-2002
ASME Leadership Development Initiative Fellowship, Council on Education, 1999
NASA/ASEE Summer Faculty Fellow, 1998
NASA/ASEE Summer Faculty Fellow, 1999
Honored as the first-ever "Person of the Week" by the Rowan Alumni Association, 1997
Winner of Luigi Crocco Prize for Outstanding Teaching Assistant, 1993

WORKSHOPS ATTENDED AND CONTINUING EDUCATION

Babson-Olin Symposium for Engineering Entrepreneurship Educators (SyE³) Pilot Program, June 21-25, 2005.
Mini-Conference on Energy STEM Innovations. NSF Coalition. University of Wisconsin, Madison, WI. May 28-29, 2003.
Entrepreneurship Boot Camp. Rowan University Center for Innovation and Entrepreneurship. Glassboro, NJ. April 2002
Carnegie Academy for the Scholarship of Teaching and Learning, The Carnegie Foundation for the Advancement of Teaching, Menlo Park, CA, 2001, 2002
Roundtable on Entrepreneurship in Engineering Education, Stanford, CA, October 2005.
Roundtable on Entrepreneurship in Engineering Education, Stanford, CA, October 27-29, 2004.
Roundtable on Entrepreneurship in Engineering Education, Stanford, CA, October 5-6, 2000.
1999 Summer Academy, *American Association for Higher Education*, Snowmass Village, CO, July 14-18, 1999
New Century Scholars Workshop, *National Science Foundation*, Stanford, CA, August 1-5, 1999

MEDIA APPEARANCES:

Channel 10, WCAU, Philadelphia. August 2002. Interviewed in a segment describing an experiment built by Rowan Engineering students, which flew aboard NASA's KC135 reduced gravity aircraft.

Channel 6, WPVI, Philadelphia. April 2001. Interviewed in a segment describing the development of the Engineering College at Rowan and describing an experiment built by Rowan Engineering students, which flew aboard NASA's KC135 reduced gravity aircraft.

Channel 17, WPHL, Philadelphia. Sept. 1999. Appeared in a segment describing an experiment built by Rowan Engineering students, which flew aboard NASA's KC135 reduced gravity aircraft.

Channel 17, WPHL, Philadelphia. April 1 1997. Interviewed in a long segment on the evening news on Channel 17, WPHL, Philadelphia. The interview explained my research and discussed its relevance to the fire aboard the Russian Space Station, Mir.

NJN, New Jersey's Public Television Station. July 1997. Interviewed in a long segment on the evening news for NJN, New Jersey's public television station prior to the STS-94 Space Shuttle mission.

My experimental work has been featured in various newspaper articles in numerous newspapers (The Star Ledger (4), Gloucester County Times (4), Atlantic City Press (3), Mount Olive Chronicle(4), Courier Post, Philadelphia Inquirer and the Coloradoan

The Rowan Undergraduate Venture Capital Fund has been featured in dozens of articles in newspapers such as the Philadelphia Inquirer, Star Ledger, Atlantic City Press, Courier Post, Gloucester County Times, etc. and in national publications such the ASME *Mechanical Engineering* magazine.

My student's work in microgravity boiling heat transfer has been featured in the Philadelphia Inquirer, Gloucester County Times and the Courier Post.

PERSONAL INTERESTS:

Baseball, soccer, golf, hiking, roller blading, mountain biking, drawing/painting, guitar.

INVENTIONS

U.S. Pat. # 5,366,352; *Thermostatic Compressor Suction Inlet Duct Valve*, with R. L. DeBlois and D. G. Cutts; Awarded: November 22, 1994.

U.S. Pat. # 5,256,044; *Scroll Compressor with Improved Axial Compliance*, with J. J. Nieter, and R. L. DeBlois; Awarded: October 26, 1993.

U.S. Patent Disclosure; *Cook Stove Assembly*, with M. Defoort, B. Willson and D. Lionberg. Filed: April 10, 2009.

TECHNICAL SESSIONS , WORKSHOPS AND CONFERENCES ORGANIZED

Organizer and Session Chair, "Alternative Fuels", 2009 SAE Powertrain & Fluid Systems, November 2009, San Antonio, TX

Organizer, "Compression Ignition Performance with Alternative Fuels", 2009 International SAE Powertrain & Fluid Systems, October 2009, Florence, Italy.

Organizer, 2nd National Capstone Design Conference, Boulder, CO, Summer 2010

Organizer and Session Chair, "Alternative Fuels", 2008 SAE Powertrain & Fluid Systems, October 2008, Chicago, IL

Organizer and Session Chair, "Alternative Fuels", 2007 SAE Powertrain & Fluid Systems, October 2007, Chicago, IL.

Organizer and Panelist, "Toward a Common Standard Rubric for Evaluating Capstone Design Projects", 1st National Capstone Design Conference, Boulder CO, June 2007.

Organizer and Session Chair, "Diesel Emissions: Emissions Measurement", 2006 SAE Powertrain & Fluid Systems, October 16 – 19, 2006 Toronto, Ontario, Canada

- Panelist, “From E team funding to Venture Capital: Creating Bridging Alternatives for Technology Commercialization”, National Collegiate Inventors and Innovators Alliance, Tenth Annual Meeting, Portland, OR, March 2006.
- Panelist, “Commercialization of Undergraduate Intellectual Property: A Comparison to the Research University Model”, National Collegiate Inventors and Innovators Alliance, Tenth Annual Meeting, Portland, OR, March 2006.
- Workshop Organizer and Leader, “Innovative Entrepreneurship Programs”, Roundtable On Entrepreneurship Education for Scientists and Engineers, Stanford University, Stanford, CA, October 2005.
- Panelist, “Commercialization of University Intellectual Property: Variations in Approaches of Research (Doctoral), Comprehensive (Masters) and Liberal Arts Institutions”, National Collegiate Inventors and Innovators Alliance, Ninth Annual Meeting, San Diego, CA, March 2005.
- Panelist, “Understanding Student Empowerment and Promoting Student Learning through the Scholarship of Teaching and Learning”, Association of American Colleges and Universities, Philadelphia, PA, November 2004.
- Panelist, “Best Practices in Engineering Entrepreneurship Education”, Roundtable On Entrepreneurship Education for Scientists and Engineers, Stanford University, Stanford, CA, October 2004.
- Panelist, "Challenges in Diversity - Gender, Class and Ethnicity: Strategies for Teaching & Learning. The Professions", Carnegie Fellows' Notre Dame Diversity Conference, South Bend, IN, November 2002.
- Organizer and Session Chair, "Reinventing the Design Curriculum", National Collegiate Inventors and Innovators Alliance, Fourth Annual Meeting, Washington, DC, March 2000.
- Organizer and Session Chair, "Crossing Interdisciplinary Boundaries: Impediments and Enablers to Faculty Collaboration and Integration", Eighth AAHE Conference on Faculty Roles and Rewards, New Orleans, LA, February 2000.
- Panelist, "Innovation in Engineering Education: What Makes Innovation Possible and Sustainable", Frontiers in Education Conference, Kansas City, MO, October 2000.

GRADUATE STUDENTS SUPERVISED

Graduate Advisor – PhD

Timothy Vaughn, Ph.D., 2011, Colorado State University, Expected.

David McKenna, Ph.D., 2011, Colorado State University, Expected.

Graduate Advisor – Master’s

Fred Hovermann, “Development of a New Apparatus to Measure Flame Spread through a Free-Stratified Fuel/Air Mixture”, MS, 2003.

Jason Hearne, “School Bus Idling and Mobile Diesel Emissions: Effect of Fuel Type and Development of a Mobile Test Cycle”, MS, 2004.

Andrew Toback, “Diesel Emission Reduction Strategies for School Buses and Heavy Duty Diesel Vehicles: Exhaust After Treatment”, MS, 2005.

Sarina Colligan, “Emissions Measurements and Life Cycle Analysis of Biodiesel and ULSD for Recycling and Trash Vehicles”, MS, 2005.

Marcos Villa-Gonzalez, “Two-dimensional Propagating Edge Flames, MS, 2005.

Matthew Hammill, “Ignition Delay of Oxygenated Fuel Droplets: Development of a 1 Second Drop Tower and 1-g Results”, MS, 2005.

Timothy Vaughn, “Ignition Delay of Biodiesel and Biodiesel Surrogate Fuel Droplets”, MS, 2006.

Mark Wessel, "Microgravity Ignition Delay of Bio-Ester Fuel Droplets", MS, 2007.
David McKenna, "Mobile Emissions Measurements from Biodiesel Blends in Diesel Locomotives", MS, 2008, Expected.
Bethany Fisher, MS, 2009, Colorado State University, Expected.

Graduate Committee

Peter Jansson, "Hydro Catalysis: A New Energy Paradigm", MS, 1997
Jeremy T. Neyhart, "Automated segmentation of radiodense tissue in digitized mammograms", MS, 2002
Brian K. Fitzpatrick, "Theory, Construction and Instrumentation of a Thermoacoustic Prime Mover, MS, 2002.
Brian Kuritz, "Application of Experimental Design in the Steady State Particulate Exposure Levels in a 1992 International School Bus, MS, 2003.
David Martinez, "Measurement of Particulate Matter inside the Passenger Compartment of a School Bus", MS, 2007, Expected.
Ahmet Yozgatligil, "Burning and Sooting Behavior of Ethanol Droplet Combustion under Microgravity Conditions", Ph.D., 2005, Drexel University.
Kenneth Kroenlein, Ph.D, 2007, Princeton University
Michael Foster, Ph.D., 2007, Drexel University.
Bradley Urban, Ph.D, 2008, Princeton University
Dan Lionberg, M.S. Candidate, CSU
Marty Malenshek, M.S., 2008, CSU
Liaw Batan, Ph.D. Candidate, Life Cycle Assessment of Production Systems of Microalgae Biodiesel, CSU
Steve Brown, Ph.D. Candidate, Atmospheric Sciences, CSU
Syndi Nettles-Anderson, Ph.D Candidate, CSU
Brett Wilson, M.S. Candidate, CSU

Undergraduate Research Students

Alexander Stanton, West Virginia University, '09, *C2B2 REU*
Bryant Ladson, Morehouse College, '09, *CSU AGEP Program*
Kabel Skelton, '10, *CSU, Engines and Energy Conversion Laboratory*

JOURNAL PUBLICATIONS AND BOOK CHAPTERS

1. Nayagam, V., Marchese, A. J. and Sacksteder, K.R (2008). Inverse Scale Modeling in Droplet Combustion. *Progress in Scale Modeling*. Koço Saito, Editor. Springer
2. Marchese, A. J., Abraham, J., Greene, C., Kizenwether, L. and Ochs, J. (2008). Toward a Common Standard Rubric for Evaluating Capstone Design Projects. *Advances in Engineering Education*, Submitted.
3. Kadlowec, J., Bhatia, K., Chandrupatla T.R., Chen, J. C., Constans, E., Hartman, H., Marchese, A. J., von Lockette, P. and Zhang, H. (2007). Design Integrated into the Mechanical Engineering Curriculum: Assessment of the Engineering Clinics. *Journal of Mechanical Design*, July 2007, Volume 129, Issue 7, pp. 682-691.
4. Villa-Gonzales, M., Marchese, A. J., Easton, J. W. and Miller, F. J. (2007) Experimental Measurements of Two-Dimensional, Planar, Propagating Edge Flames. *Proc. Combust Inst.* **31**, 939-946.
5. Gail, S., Thomson, M., Sarathy, S. M., Syed, S. A., Dagaut, P., Dievart, P., Marchese, A. J. and Dryer, F. L. (2007). A Wide Range Kinetic Modeling Study of Methyl Butanoate. *Proc. Combust Inst.* **31**, 305-311.
6. Toback, A., Ginn, J., Hearne, J., Marchese, A.J., Hesketh, R. P. (2005). Life Cycle Analysis of Heavy Duty Diesel Vehicle Idling Alternatives. *SAE 2004 Transactions, Vol.113-4, Journal of Fuels and Lubricants, ISBN Number 0-7680-1553-7, July 2005, pages 426-435.*
7. Toback, A., Hearne, J., Kuritz, B., Marchese, A.J., Hesketh, R. P. (2005). The Effect of Ambient Temperature and Humidity on Idling Emissions from Diesel School Buses. *SAE 2004 Transactions, Vol.113-4, Journal of Fuels and Lubricants, ISBN Number: 0-7680-1553-7, July 2005, pages 530-539.*
8. Pekula, N., Kuritz, B., Hearne, J., Marchese, A.J., Hesketh, R. P. (2004). The Effect of Ambient Temperature and Humidity on Idling Emissions from Heavy Duty Diesel Trucks. *SAE 2003 Transactions, Vol.112, Journal of Fuels and Lubricants, ISBN Number: 0-7680-1451-4, September 2004, pages 148-158.*
9. Marchese, A. J. Ramachandran, R.P., Hesketh, R.P. and Schmalzel, J.L. (2003). The Competitive Assessment Laboratory: Introducing Engineering Design via Consumer Product Benchmarking. *IEEE Transactions on Education.* **46**, pp. 197-205.
10. Miller, F.J., Easton, J. W., Marchese, A.J. and Ross, H.D. (2002). Gravitational Effects on Flame Spread Through Non-Homogeneous Gas Layers. *Proc. Combust Inst.* **29**, pp. 2561-2567.
11. Ramachandran, R. P. and Marchese, A. J. (2002). Integration of Multidisciplinary Design And Technical Communication: An Inexorable Link. *International Journal of Engineering Education.* **Vol 18, No. 1**, pp. 32-38.
12. Marchese, A. J., Schmalzel, J. L., Mandayam, S. A. and Chen, J. C. (2001) A Venture Capital Fund for Undergraduate Engineering Students at Rowan University. *Journal of Engineering Education.* **Vol. 90, No. 4**, pp. 589-596.
13. Marchese, A. J., Dryer, F. L. and Nayagam, V. (1999). Numerical Modeling of Isolated N-Alkane Droplet Flames: Initial Comparisons with Ground and Space-Based Microgravity Experiments. *Combust. Flame*, **116**, pp. 432-459.
14. Newell, J. A., Marchese, A. J., Ramachandran, R. P., Sukumaran, B. and Harvey, R. (1999). Multidisciplinary Design and Communication: A Pedagogical Vision. *International Journal of Engineering Education.* **Vol 15, No. 5**, pp. 376-382.
15. Marchese, A. J. and Dryer, F. L. (1998). Radiative Effects in Space-Based Methanol/Water Droplet Combustion Experiments. *Proc. Combust Inst.* **27**, pp. 1200-1208.
16. Nayagam, V., Haggard, J. B., Colantonio, R. O., Marchese, A.J., Dryer, F.L., Zhang, B. L. and Williams, F. A. (1998). N-Heptane Droplet Combustion in Oxygen-Helium Mixtures at Atmospheric Pressure. *AIAA Journal.* **Vol. 36, No. 8**, pp. 1369-1378.

17. Marchese, A. J. and Dryer, F. L. (1997). The Effect of Non-Luminous Thermal Radiation in Microgravity Droplet Combustion. *Combust. Sci. and Tech.*, **124**, 1-6, pp. 371-402.
18. Held, T. J., Marchese, A. J., and Dryer, F. L. (1997). A Semi-Empirical Reaction Mechanism for N-Heptane Oxidation and Pyrolysis, *Combust. Sci. and Tech.*, **123**, pp. 107-146.
19. Marchese, A. J., Dryer, F. L., Colantonio, R. O., and Nayagam, V. (1996). Microgravity Combustion of Methanol and Methanol/Water Droplets: Drop Tower Experiments and Model Predictions. *Proc. Combust Inst.* **26**, pp. 1209-1218.
20. Marchese, A. J., Dryer, F. L., Nayagam, V., and Colantonio, R. O. (1996). Hydroxyl Radical Chemiluminescence Imaging and the Structure of Microgravity Droplet Flames, *Proc. Combust Inst.* **26**, pp. 1219-1227.
21. Marchese, A. J., and Dryer, F. L. (1996). The Effect of Liquid Mass Transport on the Combustion and Extinction of Bi-Component Droplets of Methanol and Water, *Combust. Flame.* **105**, p. 104.
22. Sukumaran, B., Mehta, Y., Bryant, T., D'Intino, R., Marchese, J., Everett J. and Gephardt, Z. (2007). Generating Entrepreneurship Opportunities for the Developing World through the Engineering Curriculum. *World Transaction in Engineering and Technology Education*, Vol. 6, No. 1, pp. 37-40.

CONFERENCE PROCEEDINGS AND TECHNICAL PRESENTATIONS

Research

1. Vaughn, T., Marchese, A. J., Kroenlein, K. and Dryer, F. L. (2010). Ignition of Fatty Acid Methyl Ester Fuel Droplets in Microgravity: Experiments and Detailed Numerical Modeling. *ALAA Aerospace Sciences Meeting*, Orlando, FL, 2010.
2. McKenna, D. S., Marchese, A. J. and Volckens, J. (2009). Investigation of Health Effects of Algae-Derived Biofuel Exhaust Emissions. *NSF IGERT Poster Session, Washington, DC*.
3. Marchese, A. J. (2009). Algae Derived Biofuels for the Transportation Sector. Panel Member: Greenhouse Gas Emissions from Advanced Diesel Technologies- What to Expect Now and in the Future. *2009 Transportation Planning, Land Use and Air Quality Conference*. Denver, CO, July 28-29, 2009.
4. McKenna, D., Fitzpatrick, Hesketh, R. P., Bhatia, K.K., Marchese, A. J. (2009). Exhaust Emissions from 2-stroke Diesel Locomotive Engines Operating on Soy Methyl Ester Biodiesel Blends. *SAE Powertrain, Fuels and Lubricants Meeting, San Antonio, TX, November 2009*.
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- 114.Hesketh, R. P., Jahan, K., Marchese, A. J. (1997) Integrating Hands-on Education to Freshman Engineers at Rowan College. *1997 ASEE Zone 1 Spring Meeting*. West Point, NY, April, 1997.

Integrating Writing and Engineering Design

- 115.Harvey, R., Hutto, D., Hollar, K., Consans, E., Pietrucha, B. and Marchese, A. J. (2002). Writing as a Design Practice: A Preliminary Assessment. *ASEE Annual Meeting*, Montreal, Canada
- 116.Johnson, F. S., Hutto, D., Dahm, K., Marchese, A. J., Sun, C., Constans, E., Hollar, K. and von Lockette, P. (2001). An Investigation into Interdisciplinary Team Teaching in Writing and Engineering: A Multi-Year Study. *ASEE Annual Meeting*, Albuquerque, NM.
- 117.Johnson, F. S., Hutto, D. and Marchese, A. J. (2001). Engineering Education in New Contexts: Creating and Improving A Multidisciplinary Learning Environment. *Writing Across the Curriculum Conference*, Indianapolis, IN, May 2001.
- 118.Marchese, A. J., Mosto, P. and Johnson, F. (2000). Crossing Interdisciplinary Boundaries: Impediments and Enablers to Faculty Collaboration and Integration. *Eighth AAHE Conference on Faculty Roles and Rewards*, New Orleans, LA, February 2000.
- 119.Ramachandran, R. P., Marchese, A. J., Newell, J. A. (2000). A Pedagogical Concept of Integrating Multidisciplinary Design and Technical Communication. *ASEE Annual Meeting*, St. Louis, MO.
- 120.Harvey, R., Johnson, F., Marchese, A. J., Newell, J. A., Ramachandran, R. P., and Sukumaran, B. (1999). Improving the Engineering and Writing Interface: An Assessment of a Team-Taught Integrated Course. *ASEE Annual Meeting*, St. Louis, MO.
- 121.Harvey, R., Johnson, F., Marchese, A. J., Newell, J. A., Ramachandran, R. P., and Sukumaran, B. (1999). Teaching Quality: An Integrated TQM Approach to Technical Communication and Engineering Design. *ASEE Zone Meeting, Monmouth University, Spring 1999*.

Diversity Issues

- 122.Gale, R., Marchese, A. J. and Rome, D. (2004) "Understanding Student Empowerment in the Professions, Promoting Student Learning through the Scholarship of Teaching and Learning", *Association of American Colleges and Universities, Philadelphia, PA, November 2004*.
- 123.Marchese, A. J. (2003). Creating a High Quality and Inclusive Public Undergraduate Engineering Program: Bridging the Gap Between Institutional Mission and Institutional Culture. *Workshop on Racism and Diversity in Community*. University of Illinois at Urbana-Champaign. January 24-25, 2003
- 124.Marchese, A. J. (2002). Creating an Inclusive Undergraduate Engineering Program. *Challenges in Diversity - Gender, Class and Ethnicity: Strategies for Teaching & Learning*. November 2002. Notre Dame, IN.
- 125.Marchese, A. J. (2002). Strategies for Enhancing Learning in Students of Color at Predominantly White Undergraduate Engineering Programs. *American Association for Higher Education. Annual Meeting*. March 2002, Chicago, IL.

TRADE JOURNAL ARTICLES

- 126.Marchese, A. J., Mandayam, S. and Schmalzel, J. L. (1998). Thermodynamics of Coffee Makers. *Hewlett Packard Engineering Educator*, Vol. 2, No. 1., p. 8.
- 127.Schmalzel, J., Marchese, A. J., and Hesketh, R. P. (1998). What's Brewing in the Engineering Clinic? *Hewlett Packard Engineering Educator*, Vol. 2, No. 1., p. 6.

128. Johnson, F. S, Marchese, A. J. and Mosto, P. (2000). Crossing Interdisciplinary Boundaries: Impediments to and Enablers of Faculty Collaboration and Integration. *The Department Chair*, Anker Publishing Company.

INVITED SEMINARS

1. Marchese, A. J. (2009). "Algae Based Biofuels for the Transportation Sector", Clean Energy Supercluster, Expo 2009, May 2009, Colorado State University.
2. Marchese, A. J. (2009). Pollutant Emissions Reduction in Biofuel Powered Systems. Front Range Student Ecology Symposium, February 25, 2009.
3. Marchese, A. J. (2008). Creating an Entrepreneurial Culture in an Engineering Curriculum. *Worcester Polytechnic Institute*, Worcester, MA, October 25, 2008.
4. Marchese, A. J. (2008). Engaging the Entrepreneurial Mindset in an Engineering Curriculum. *Ohio Northern University*, Ada, OH. May 19, 2008.
5. Marchese, A. J. (2007). Biodiesel Locomotive Emissions Testing Using a Mobile Emissions Analyzer SEMTECH Users Conference, Sensors, Inc., Detroit, MI., October 2007.
6. Marchese, A. J. (2007). A Solution to the Biodiesel NO_x Problem. *Colorado State University*, April, 2007.
7. Marchese, A. J. (2007). Fundamental and Practical Research toward Solution to the Biodiesel NO_x Problem. *West Virginia University*, March, 2007.
8. Marchese, A. J. (2006). Biodiesel Research at Rowan University. *New Jersey Technology Council, Green Homes, Green Vehicles, Green Buildings Conference*. May 2006.
9. Marchese, A. J. (2005). The Biodiesel NO_x Problem. *University of Colorado at Colorado Springs. Colorado Institute for Technology Transfer and Implementation*, November 2005.
10. Marchese, A. J. (2005). Exhaust Emissions from Biodiesel Powered School Buses. *NJ Biofuels Workshop*, Rutgers EcoComplex, June 2005.
11. Marchese, A. J. (2003). Flame Spread through Free Stratified Mixtures. *Drexel/ KAIST and Seoul National University Mini-Combustion and Plasma Workshop*, Drexel University, August 2003.
12. Marchese, A. J. (2003). Microwave Resonant Transfer Plasma Propulsion. *Mechanical Engineering Department Seminar Series. Drexel University*. April 2003.
13. Marchese, A. J. (2003). Flame Propagation through Free Stratified Fuel/Air Mixtures. *Aerospace and Mechanical Engineering 2002/2003 Colloquium*. University of Notre Dame. February 2003.
14. Marchese, A. J. (2001). Microgravity Droplet Combustion: Experiments and Detailed Numerical Modeling. *Invited Lecture: University of Vermont*. University of Vermont. July 2001.
15. Marchese, A. J. and Gabler, H.C. (2000). Energy, Emissions and Fire Safety Research at Rowan University. *Invited Poster Presentation, New Jersey Department of Transportation*, Trenton, NJ, October 2000.
16. Marchese, A. J. (1997) Microgravity Droplet Combustion. *Invited Lecture: University of Delaware Fluid, Particulate and Environmental Seminar Series*, Oct. 1997.

OTHER

1. Marchese, A. J. Combustion of Single and Multicomponent Liquid Droplets: Detailed Kinetic Modeling and Microgravity Experiments. *Ph.D. Dissertation, Department of Mechanical and Aerospace Engineering, Princeton University, 1996.*
2. Marchese, A. J. Thermodynamics of Scroll Compressors. *Master's Project. Rensselaer Polytechnic Institute at Hartford, 1992.*

PROPOSAL AND GRANT ACTIVITY

Funded (\$3,784,000)

“Microgravity Ignition of Algae- Derived Biofuel Droplets”, NASA Space Grant Consortium Seed Grant, \$8,500. Awarded.

“Engine Performance and Emissions Testing of Hydrogen Generator – Phase I Diesel Engine Tests”, GENR8, LLC, \$12,000. 2009. Awarded.

“Technology Entrepreneurship for a Globally Sustainable Future”, NCIIA Course and Program Grant, \$31,000. 2009-2010. Awarded.

“The Effect of Chemical Structure on Pollutant Formation Kinetics in Algae-Derived Biofuel Combustion”, NSF, \$325,000. Awarded.

“Effect of Chemical Structure on NO_x and PM Emissions from Algae-Based Biodiesel FAME”, 2008-2009, Sustainable Biofuels Development Center, \$75,000. Awarded.

“Combustion Chemistry and Pollutant Emissions from Algae-Derived SVO, FAME and HTRD”, Clean Energy Supercluster RFA, 2008-2009, \$35,000. Awarded.

“Chemical Kinetic and Engine Modeling of a High Altitude, 2-Stroke, Direct Injection C₃H₈-N₂O Internal Combustion Engine”, Busek Company (DARPA SBIR Subcontract), 2008, \$15,000. Awarded.

“A Rapid Compression Machine for Chemical Kinetic Studies of Emissions from Bio-Derived Fuels”, NSF MRI, \$451,000. 2008-2009, Awarded.

“Performance Evaluation of Fuel Additives on a John Deere 6.8 L Diesel Engine, EnCana Corporation, (Co-PI, with Dan Olsen), 2008, \$99,943. Awarded.

“Evaluation of Biodiesel Blends in NJ TRANSIT Diesel Locomotives”, NJDEP, NJ TRANSIT, 2007-2008, \$150,000. Awarded.

“Evaluation of Biodiesel Blends in Home Heating Oil”, NJDEP, \$100,000. 2007-2008, Awarded.

“Evaluation of Biodiesel Blends in Airport Ground Support Equipment”, NJDEP, 2007-2008, \$85,000. Awarded

“Resonant Transfer Plasma Calorimetry Studies”, BlackLight Power Corporation, \$75,000. Awarded.

“In-Cabin Particulate Matter Quantification and Reduction Strategies”, NJDEP, \$220,000. (Co-PI, with Robert Hesketh). Awarded.

“Development of a 1-Second Drop Tower for Microgravity Combustion and Fluid Mechanics Research”, Principal Investigator. *NSF MRI*. 2004-2006. \$190,000. Awarded.

Chemical Kinetic Development and Flow Reactor Studies of Biodiesel Fuel Blends”, NJDOT, 2003, \$75,000. Awarded.

“The BlackLight Rocket Engine”, Principal Investigator, NASA Institute for Advanced Concepts, 2002, \$75,000. Awarded.

- "Diesel Emission Reduction Strategies for School Buses and HDDV Trucks", Co-Principal Investigator (with Robert Hesketh). *NJDOT Dept. of Research and Technology*. 2002-2003. \$740,000. Awarded.
- "Development of an Apparatus to Measure Ignition Delay in Microgravity", Co-Principal Investigator (with John Chen). *NSF MRI*. 2001-2002. \$224,400. Awarded.
- "Gravitational Influences on Flame Propagation through Non-Uniform Gas Mixtures", Principal Investigator, *NASA Microgravity Combustion Science*, 2000-2003. \$98,000. Awarded.
- "Competitive Assessment Laboratory", Principal Investigator, *National Science Foundation*, 1998-2000. \$111,200. Awarded.
- "Rowan Undergraduate Venture Capital Fund", Principal Investigator, *Henry M. Rowan Family Foundation, Inc.*, 2003-2004. \$65,000. Awarded.
- "CreATE: Creative Audio Technology Environment at Rowan University", Principal Investigator, *National Science Foundation CCLI*, 2000-2002. \$50,000. Awarded.
- "Development of a Human-Powered Stairclimber ", Principal Investigator, *Private Donors: John and Helen Glass*, 1999. \$50,000. 1999-2003. Awarded.
- "The Technology Entrepreneurship Concentration: An Interdisciplinary Certificate Program for Undergraduate Engineering and Business Majors at Rowan University", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 2003-2005. \$32,000. Awarded.
- "A Venture Capital Fund to Encourage Rapid Product Development with Multidisciplinary E-Teams in the Junior Engineering Clinic II", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 2000-2002. \$30,000. Awarded.
- "Stairclimber Competitive Assessment and New Product Development", Principal Investigator, *Electric Mobility Corporation*, 1999-2000. \$20,000. Awarded.
- "A Venture Capital Fund to Encourage Rapid Product Development with Multidisciplinary E-Teams in the Junior Engineering Clinic II", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*. 1998-2000. \$11,000. Awarded.
- "The Helping Hand: Design of a Writing Assistive Device for Arthritic Impaired Patients", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 2005-2006. \$14,400. Awarded.
- "Enhanced Machine Head Design", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 2001-2002. \$10,800. Awarded.
- "Development of a Passively Cooled Jet Blast Deflector for Aircraft Carrier Launch Operations", *NAVY Air Warfare Center*, Principal Investigator, 2001. \$10,000. Awarded.
- NASA Summer Faculty Fellowship. Principal Investigator. 1999. \$10,000. Awarded.
- "Numerical Model Development of Flame Propagation through Non-Uniform Premixed Gas Systems", Principal Investigator, *NASA Glenn Research Center*, 1998-1999. \$10,000. Awarded.
- "A Venture Capital Fund to Encourage Rapid Product Development with Multidisciplinary E-Teams in the Junior Engineering Clinic I", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 1998-2000. \$10,000. Awarded.
- NASA Summer Faculty Fellowship. Principal Investigator. 1998. \$10,000. Awarded.
- "Ski Lift Footrest Retrofit", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 2002-2003. \$8,375. Awarded.

- "Enhancing Engineering Design Education through Integration with Technical Communication" *Carnegie Academy for the Scholarship of Teaching and Learning*, 2001-2002. \$6,000. Awarded.
- "Development of a Fire Resistant Cover for the NAVY ILARTS System", *NAVY Air Warfare Center*, Principal Investigator, 2000. \$5,000. Awarded.
- "Development of a Road Towable Equipment Trailer", Principal Investigator, *MacKissic Corporation*, 2000. \$5,000. Awarded. PI transferred to Jennifer Kadlowec.
- "Image Analysis System for Microgravity Combustion Research", Principal Investigator, *Rowan Foundation*, 1996-1997. \$5,000. Awarded.
- "Analysis Software for Microgravity Combustion Research", Principal Investigator, *Roman Foundation*, 1997-1998. \$2500. Awarded.
- "A Distributed Venture Capital Fund for Joint Product Development at Rowan University and Swarthmore College", Principal Investigator, *National Collegiate Inventors and Innovators Alliance/Lemelson Foundation*, 2002-2003. \$4,000. Awarded.
- "Developing Reliability Models of Control Systems for a Nuclear Power Facility", Co-Investigator (Peter Jansson, PI), *PSEG*, 2001. \$100,000.
- "Stereolithography: A Distributed Partnership", Co-Investigator, (T.R. Chandrupatla, PI) *National Science Foundation Instrumentation and Laboratory Improvement*, 1996. \$200,000. Awarded.
- "REU in Pollution Prevention and Sustainability", Co-Investigator, *NSF REU (DUE-0088437)*, 2004-2007. \$240,513. Awarded.
- "Hands on the Human Body", Co-Investigator, *NSF CCLI (DUE-0088437)*, 2000. \$162,300. Awarded.
- "Low Cost Automated Crash Notification System", Co-Investigator, (Clay Gabler, P.I.) *NJDOT Research Challenge Grant*, 1998. \$112,100. Awarded.
- "Project for an Advanced Electric Vehicle", Co-Investigator (Linda Head, PI), *NJDOT Research Challenge Grant*, 1998. \$41,095. Awarded.
- "Development of a Position Tracking System for a Handheld Scanner", Co-Investigator, (Shreekanth Mandayam, P.I.). *Physical Acoustics Corporation*, \$18,000. Awarded.
- "Curriculum Pathfinder: A Comprehensive Guide for Students in Engineering", Co-Investigator, (Jess Everett, P.I.). *Rowan Courseware Development Grant*, 1998. \$14,500. Awarded.

Pending

- "Opportunity at the Bottom of the Pyramid: A Faculty Development Program to Prepare the Global Engineer", NSF, Phil Weilerstein, PI, \$199,000.
- "Estimating the Toxicity of Diesel-Based Aerosols Using a Novel Lab-on-a-Chip Biosensor", NIH, \$963,000. Chuck Henry, PI.
- "Collaborative Research: Bio-Alcohol/FAME Blends with Tailored Low Temperature Chemistry for Enhanced Homogenous Charge Compression Ignition (HCCI) Engine Performance", NSF, \$230,000.