

## **Undergraduate Research in Pollution Prevention and Sustainability**

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### **Abstract**

Rowan University has been hosting an NSF REU Site which focuses on Pollution Prevention and Sustainability since 2004. The site has been established for three consecutive summers. The initiative is based on current global initiatives to integrate sustainability into the science and engineering curriculum. Students need to be exposed to enriching experiences that require them to have concerns for human conditions and the environment that are conservative and protective. The REU site allows eleven undergraduates to participate in pollution prevention and sustainability research activities at Rowan University for eight weeks during the summer. Engineering and science faculty participate in mentoring activities along with Rowan undergraduate and graduate students. Social building skills such as community outreach seminars, workshops, social picnics, field trips and communication strengthening exercises are also an integral part of this REU experience. Environmental ethics, diversity and community impact of engineering activities are the topics of mini workshops. All these topics have tremendous relevance to pollution prevention and sustainability but can be absent from a traditional engineering curriculum. It is anticipated that the undergraduate research experience promotes interest in pursuing graduate school and strengthens leadership skills and self esteem.

### **Introduction**

Many engineering programs worldwide are integrating pollution prevention, green engineering and sustainability modules in their traditional curriculum. The College of Engineering at Rowan University is taking numerous innovative measures to integrate environmental education for all of their engineering students. Faculty from all disciplines have taken personal initiatives to integrate environmental education in core engineering classes<sup>1-4</sup>. The College of Engineering along with the College of Liberal Arts and Sciences recently received funding to host a NSF funded Research Experiences for Undergraduates (REU) site in Pollution Prevention and Sustainability.

The sustainability theme strengthens our REU site many ways. It has encouraged collaborative efforts between our College of Engineering and the College of Liberal Arts and Sciences. It also

allows the students to perceive the multidisciplinary nature of pollution prevention research and sustainability concepts. Overall the program generates an appreciation for the need of engineering design and scientific inquiry to address sustainability for protection of the environment and future generations.

## Objectives

The REU objectives as outlined in our NSF proposal are as follows:

- *Generating* excitement among the undergraduate students by providing them with the opportunity to work on engineering issues of national and international significance,
- *Providing* undergraduate students with the opportunity to work on fundamental research projects that have significant impacts on human health and the environment,
- *Increasing* the participation in research of women, underrepresented minorities, and persons with disabilities,
- *Mentoring* undergraduate students by providing leadership roles by faculty and students,
- *Exposing* a broad and interdisciplinary group of undergraduate students to the scientific method used in creation, investigation, and documentation of a research project,
- *Encouraging* undergraduates (especially those from underrepresented groups) to pursue advanced degrees,
- *Sharing* research with communities outside the university (e.g., industry, pre-college groups which include minorities) through presentations during recruiting efforts and engineering open houses, and
- *Serving* as a model for other undergraduate institutions in integrating research and quality education.

Faculty from all our engineering disciplines (Chemical, Civil, Electrical and Mechanical) along with faculty from Biology, Chemistry and Sociology are participating in the REU program. The program funds eleven science and engineering students to reside on campus for eight weeks and work with faculty mentors on research. All research projects promote the REU theme of pollution prevention and sustainability. Faculty are actively involved in mentoring activities for students during and after the duration of the REU project. Rowan undergraduate research assistants and graduate students also work closely with the REU participants. The Rowan students are also a valuable component of our mentoring efforts. The research projects offered in the Fall of 2004 are indicated in Table 1.

**Table 1: REU Projects for 2004**

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<b>REU Project Titles</b>
Arsenic Removal in Drinking Water
BugPower: Fueling our Future with Microorganisms
Metal Removal from Industrial Wastewater
Developing "Green" Controlled Release Systems for Drug Delivery
Use of Jute in Strengthening Asphalt Mixtures
Stormwater Management in Chestnut Branch Watershed
Environmentally Conscious Disassembly of End-of-Life Computers
Chemical Kinetic Model Development and Flow Reactor Studies of Biodiesel Fuel Blends
Long-Life Smart Structures for Laser Data Transmission
Invertebrates as Bio-indicators of the Water Quality of the Maurice River
Design of Detoxifying Systems for Organo-nitriles Mediated by Cyanogenic Enzymes

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### **Project Details**

A total of eleven Rowan University professors from science and engineering are involved in the REU research projects as mentors, while three other faculty from Sociology, Biology and Civil Engineering are involved in the Environmental Ethics, Diversity and Community Impact workshops. Students are exposed to environmental ethics as it relates to their science and engineering curriculum via lectures and videos. The diversity workshop helps students understand the importance of working in a multidisciplinary diverse team and the importance of gender bias in science and engineering. Finally the students are taught to think about the social impacts of science and engineering projects on communities. Specifically the students are exposed to environmental justice cases.

A number of social activities are also planned for the REU duration. These activities allow the students to strengthen their social and team building skills. Activities include a picnic, trips to the Jersey Shore, New York City and Philadelphia Museum. Students are also required to watch movies that expose them to global environmental topics. Movies in 2004 included: The Whale Rider, Rabbit Proof Fence, Osama, Home and Abroad, The Bhopal Express, Mr. and Mrs. Ayer, Erin Brokovich and a Civil Action.

The REU helps the participant to strengthen their communication skills via oral and poster presentations and technical writing of reports. A formal closing ceremony is held to close the REU site. Students attend a profession poster display ceremony and showcase their work to the Rowan University community, their parents and relatives. Before their departure students are informed about information pertinent to attending graduate school and obtaining fellowships and research/teaching assistantships. Students are encouraged to participate in national and international conferences to compete and present their REU research work<sup>5-7</sup>. Assessment of the

workshop is also conducted via participant surveys. Surveys are conducted at the start and the end of the REU. Surveys are also sent to the participants every year after their departure to gauge their performance in school and enthusiasm for graduate school. Current survey results for 2004 indicate that 80% of the graduating students in May 2004 are applying to graduate school.

An informative website has been established for rapid information dissemination. The url is <http://www.rowan.edu/colleges/engineering/clinics/reu0406/>

## Conclusions

The REU program promotes mentoring of undergraduate students in research activities that encourage them to pursue graduate school. Our REU program allows students from various science and engineering backgrounds to understand the value of sustainability and environmental protection for future generations. Participants are provided with an enriching experience that not only encourages them to apply to graduate school but also provides an opportunity to strengthen their self esteem, teamwork and leadership skills.

## Acknowledgement

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## Biography

**Dr. Kauser Jahan** is an Associate Professor of Civil and Environmental Engineering at Rowan University, Glassboro, New Jersey. She completed her Ph.D. studies in the Department of Civil and Environmental Engineering at the University of Minnesota, Minneapolis in 1993. Dr. Jahan is a registered Professional Civil Engineer in Nevada and is actively involved in environmental engineering education and outreach for women in engineering. Her research interests include biodegradation of petroleum compounds and surfactant enhanced remediation of slightly soluble organic compounds.

**Dr. Mariano Savelski** is an Associate professor in the Department of Chemical Engineering. He joined Rowan in September 1999 and has a Ph.D from the University of Oklahoma, Norman. He has seven years of industrial experience in the design for pollution prevention and food technology areas. As a university professor, Dr. Savelski has six years of experience teaching undergraduate students in chemical engineering. As project co-director, Dr. Savelski assists Dr. Jahan with student recruitment and selection, field trips, seminars, and the ethics workshops, in addition to leading one of the REU projects. He is also responsible for the implementing the ethics workshops component of this REU.

**Dr. Stephanie Farrell** is an Associate Professor in the Department of Chemical Engineering. She has been involved with several pre-engineering programs for high school students and college freshmen. Through these programs, she has focused on informing students about engineering careers and stimulating their enthusiasm for engineering education. Outside the classroom she has worked extensively to encourage the participation of underrepresented groups in engineering by participating in programs such as The Alliance for Minority Participation, University Research Experiences for Undergraduates and Exploring Career Options in Engineering and Science.

**Dr. Joseph Orlins** is an Associate Professor in the Department of Civil and Environmental Engineering. He has over 17 years' experience in academic and professional engineering practice. Dr. Orlins' major research interests are environmental fluid mechanics, fish passage at hydraulic structures, and remediation of contaminated sediments. Current research predominantly focuses on the fluid mechanics associated with interfacial mass transfer and mass transport in environmental systems.

**Dr. Yusuf Mehta** is an Assistant Professor of Civil and Environmental Engineering. He has extensive experience in pavement materials characterization. Dr. Mehta has been involved with several projects with the Departments of Transportation in various states (Florida, New Jersey, Rhode Island, Wisconsin).

**Dr. William Riddell** is an Assistant Professor of Civil and Environmental Engineering. He has worked with the NASA Langley Research Center and the Volpe National Transportation Systems Center. Dr. Riddell's research interests include structural mechanics and materials science.

**Dr. Gina Tang** is an Assistant Professor of Electrical & Computer Engineering at Rowan University. She worked as a research assistant at the Multi-lifecycle Engineering Center at New Jersey Institute of Technology. Since then she has been actively conducting research on modeling and scheduling computer-integrated manufacturing/demanufacturing systems. Her work has led to over 20 articles in journals, conference proceedings and book chapters within the last three years.

**Dr. Anthony Marchese** is an Associate Professor of Mechanical Engineering and holds a Ph.D. in Mechanical and Aerospace Engineering from Princeton University. His research areas include chemically reacting flows, chemical kinetics, microgravity experiments, rocket propulsion, fire safety, environmental issues and refrigeration. He is currently funded by NASA Microgravity Combustion Science to study microgravity flame spread and by NJDOT to study diesel emission reduction strategies for school buses and heavy-duty diesel vehicles. In 2001, he was named a Carnegie Scholar by the Carnegie Foundation for the Advancement of Teaching.

**Dr. Paris R. von Lockette** is an Assistant Professor in Mechanical Engineering at Rowan University. He received his Ph.D. from University of Michigan at Ann Arbor. Dr. von Lockette's primary work focuses on uncovering the

relationships between the microstructure of elastomers and polymers and their microscopic behavior. Dr. von Lockette's forte is the construction of computational simulations of the gelation (network formation) process in macromolecular materials. He also constructs constitutive and optical models to predict material behavior.

**Dr. Beena Sukumaran** is an Associate Professor of Civil and Environmental Engineering at Rowan University, Glassboro, New Jersey. She obtained her Ph.D. from Purdue University in the School of Civil Engineering with particular emphasis in Geotechnical Engineering. Her research interests include evaluating the performance of suction caissons in different soil conditions, effect of inherent particle characteristics on liquefaction potential, pavement analysis, fuzzy set applications in geotechnical engineering and use of the discrete element method to investigate the interaction forces acting on particles.

**Dr. Patricia Mosto**, Chair and Professor of the Biology Department, Rowan University, has been involved in the area of environmental ethics for the last 20 years. She teaches courses such as The History of the Environmental Movement, Environmental Sciences, Natural Resources, Environmental Toxicology and Environmental Microbiology. She was also the Chair of the committee that planned the newly approved Bachelor of Arts in Environmental Studies at Rowan University. She has been a lecturer on Environmental Ethics for organizations such as The Sierra Club, The Nature Conservancy, and The Academy of Natural Sciences.

**Dr. Catherine Yang** Professor in the Department of Chemistry and Biochemistry, has extensive expertise both in environmental and biomedical research areas. She is the director of an NIH sponsored Antitumor project and oversees two other national funded biochemical projects at Rowan University. In the past few years, more than forty undergraduate and graduate students have gained valuable experience by participating in these projects. She received the Cottrell College Award from Research Corporation for her endeavors in involving undergraduate students in cutting edge research.

**Dr. Courtney Richmond** is an Assistant Professor in the Department of Biological Sciences at Rowan University. She mentored an REU student in the past, during a postdoctoral research position in southern Maryland, at the Academy of Natural Sciences Estuarine Research Center. Dr. Richmond has worked on several NSF-funded projects, including a current collaboration with Dr. Nancy Marcus of Florida State University, on the effects of hypoxia on the dominant copepod found in planktonic communities worldwide, *Acartia tonsa*. Dr. Richmond's interests are focused on the impacts of both natural and anthropogenic stressors on coastal organisms.

**Dr. Demond Miller**, Director of the Liberal Arts and Sciences Institute, holds academic rank as an Associate Professor of Sociology at Rowan University (Glassboro, New Jersey). He has worked as a Principal Investigator/Co-Principal Investigator on grants involving, environmental communication, community empowerment, community satisfaction and substance abuse. His primary areas of specialization are environmental sociology and media, communication analysis with concentrations in quantitative/qualitative research methods, community development, and social/environmental impact assessment. Dr. Miller is also active in the Society for Applied Sociology and in the Harvey Flack Mentoring Program at Rowan University.