



MICHIGAN GREEN CHEMISTRY EDUCATION NEWSLETTER

JUNE 2009

2009 MI Green Chemistry Education Networking Conference

On Friday May 8, the first Michigan Green Chemistry Education Networking Conference was held at Grand Valley State University. With financial support from the Michigan Department of Environmental Quality, this conference was designed to establish a network of educators who utilize or are interested in implementing green chemistry in their classrooms. The goals of organizing the annual one-day symposium are to build awareness and communication among educators in K-12 and higher education institutions and develop long-term plans to implement green chemistry curricula into classrooms and laboratories. In the end, the hope is to better prepare the future MI workforce and to promote and protect the state's economic, social, and environmental needs.



Over 70 educators, legislators, and industrial chemists from across the state of MI attended the conference, which was held at the GVSU Alumni House. Opening remarks were given by the GVSU Chemistry Department Chair Todd Carlson and faculty member Dalila Kovacs. The morning session consisted of several talks from educators who have established green chemistry and pollution prevention courses recently. Jim Krikke of Grand Valley State presented his experiences teaching a new general education Pollution Prevention and Green Processes course. This course was designed to introduce freshman to the primary sources of pollution and how green chemistry and green engineering may be used to limit these sources. Jennifer Aurdandt and Montserrat Rabago-Smith of Kettering University discussed the implementation of a green chemistry course to their department curriculum and the assessment the course outcomes and student feedback. The third speaker of the morning, James Jackson of Michigan State University, presented his development of a green chemistry freshman seminar course.



The conference was excited to host the featured speakers, John Warner and Amy Cannon. John is an internationally recognized leader in the implementation of green chemistry practices in both the industrial and academic sectors. He started the first Green Chemistry Ph.D. program at



the University of Massachusetts-Boston and founded the Center for Green Chemistry at University of Massachusetts-Lowell. He is also editor of *Green Chemistry Letters and Reviews*, associate editor of the journal *Organic Preparations and Procedures International*, and co-author of the book *Green Chemistry: Theory and Practice*. Currently, John is the President of both the Warner-Babcock Institute for Green Chemistry and Beyond Benign.

Amy Cannon holds the world's first Ph.D. in Green Chemistry from the University of Massachusetts where her research involved the environmentally benign synthesis of photoactive materials. Along with John, she co-founded Beyond Benign, a non-profit organization that specializes in K-12 curriculum, community outreach, and workforce training in green chemistry. John gave an inspiring presentation on how his life has led him to the importance of implementing green chemistry throughout industry and academics. Amy followed his talk with information on how Beyond Benign has been working to achieve this goal.



After lunch, attendees of the conference were invited to a session on implementing green chemistry into high school chemistry curricula. Doug Mandrick of Portage Public Schools demonstrated several green chemistry labs based on those he learned from a Beyond Benign program in Colorado.

Following the success of this year's event, organizers plan to hold the conference again next Spring. Events next year will likely include panel discussions, small group networking, and additional laboratory demonstrations.

Green Chemistry Activity

Jennifer Aurandt (jaurandt@kettering.edu) and Montserrat Rabago-Smith (mrabagos@kettering.edu) - Kettering University:

Jennifer and Montserrat have been actively developing green chemistry curricula at Kettering University, including a green industrial chemistry course aimed at engineering majors and another with an industrial ecology focus:

Green Industrial Organic Chemistry Course for Engineers:

Promoting environmentally responsible engineers and scientists necessitates the integration of green chemistry into the undergraduate engineering curriculum. In response to this need Kettering has developed a pollution prevention (P2), Green Chemistry, and Green Engineering course designed for undergraduate engineering students that have taken general chemistry. Instead of the option of adding an additional course to a packed curriculum, they have modified a course that is required of all Mechanical and Industrial Engineering students at Kettering University - Chem 145: Industrial Organic Chemistry. The course would be a lab/lecture hybrid course entitled: "Green Industrial Organic Chemistry". This course would meet all of the learning objectives for the traditional organic chemistry course for engineers while using the 12 principles of Green Chemistry and Green Engineering as the spine of the course. The pedagogy includes the engagement of students in interactive dialog, internet research on the web, networking opportunities with industry, government, and academic professionals that are knowledgeable and well experienced in the field of P2, the twelve principles of Green Chemistry and the principles of Green Engineering. In addition, laboratory exercises will be conducted in order to facilitate the learning of organic chemistry. The students' understanding of the learning objectives of organic chemistry will be assessed and compared to other sections taught without the incorporation of the green principles. Students' understanding of the green chemistry will also be assessed through both formative and summative assessment tools. The class will be assessed through peer review by the chemistry and engineering faculty. Development of this course is supported by Michigan Pollution Prevention Retired Engineers Technical Assistance Program (RETAP) Internship Program, administered by the Department of Environmental Quality, Environmental Science and Services Division.

Green Chemistry in an Industrial Ecology Course:

The National Academy of Engineering released the Grand Challenges facing engineering in the next century. Environmental sustainability is related to at least 5 of the fourteen challenges. To address these challenges, a multi disciplinary team of six faculty members from engineering, business, and chemistry developed a course entitled, "Environmentally Conscious Design and Manufacturing". In this course there are six distinct modules agreed upon as necessary to meet the environmental challenge of re-designing common products sustainably. The course is based upon the Ford Partnership for Advanced Studies (PAS) pedagogy which emphasizes active learning through "hands-on activities". The original six modules include (1) Historical Social and Ethical Perspectives, (2) Life Cycle Analysis, (3) Material Selection, (4) Process Design, (5)

End of Life Options, and (6) Environmentally Responsible Management. In addition to these original modules Green Chemistry was added as a seventh module to add an important lab component to the course. Each module was designed to become a stand alone module able to be disseminated and used in any course.

In the Green Chemistry module students synthesized biodiesel and analyzed the products through chemical analysis and using it as fuel in a jet engine. The 12 principles of Green Chemistry were presented as foundational knowledge for comparing the life cycle of petroleum-based diesel to vegetable-based biodiesel. Students' learning was assessed quantitatively for each module along with qualitative comments using the Strengths, Improvements, and Insights (SII) format. From feedback gathered in the first course offering, the Green Chemistry module was enhanced to include the use of the student-made biodiesel in a laboratory jet engine housed in the Mechanical Engineering Department. In addition to the student assessment, the role of Green Chemistry in this course was assessed by an outside advisory team composed of engineers from industry and other educational institutions.

Future Plans:

Teaching: Jennifer seeks to design the lab associated with Industrial Organic Chemistry to be less polluting and used to apply the principle of Green chemistry. In the future she would also like to teach a mechanistic toxicology class to undergraduates at Kettering.

Research: Jennifer also hopes to use the principles of Green chemistry in her research with the conversion of the wastewater treatment plant into a biofuel facility. The project is in the beginning phases.

Clinton Boyd (cboyd@sustainableresearchgroup.com) – Sustainable Research Group:

Clinton and SRG develop chemical assessment tools for human health and ecosystem impacts of chemicals over entire life cycles of materials and products. They offer services and assistance in the areas of green research, marketing, and real estate development.

Tracey Easthope (tracey@ecocenter.org) – Ecology Center:

Tracey is currently the Environmental Health director for the Ecology Center, a nonprofit organization in Ann Arbor that works at the local, state, and national levels for clean communities, a healthy environmental, and sustainability. This is accomplished through grassroots organizing, advocacy, education, and demonstration projects.

Clifford Harris (charris@albion.edu) - Albion College:

Clifford is active in research using ionic liquids as reusable green solvents for novel oxidation reactions. He also teaches both organic chemistry and advanced synthesis courses at Albion College.

James Jackson (jackson@chemistry.msu.edu) - Michigan State University:

James is active teaching organic chemistry with a green chemistry component, as well as implementing a first-year green chemistry seminar course at MSU. His research is centrally focused on green processing and other areas of green chemistry.

Jim Krikke (krikkeji@gvsu.edu) - Grand Valley State University:

Jim has recently taught the new CHM 180 course: Pollution Prevention, Green Chemistry, and Green Engineering at GVSU last winter semester. Students explored the primary sources of pollution and how green chemistry and green engineering may be used to limit these sources *via* pollution prevention schemes. Research projects, presentations, and debates on various environmental topics were used to allow students to personally reflect on these issues. External speakers from various environmental backgrounds were invited to relate their expertise. In addition, several off-campus trips to industrial and municipal facilities were used to highlight both waste treatment and prevention techniques.

Dalila Kovacs (kovacsd@gvsu.edu) - Grand Valley State University:

Dalila's research has focused on using heterogeneous catalytic processes as alternative green pathways from biomass-based resources. Her group studies competing pathways from sugar polyols to polymer building blocks, cyclic polyols as transfer hydrogenation donors on metal catalysts, and cellulose conversion. The latter project involves the investigation of yet another possible route to convert cellulose directly to ethanol, sorbitol, and mixed alcohols, avoiding the glucose stage and utilizing metal catalysts, easy to be separated and reuse in repeated catalytic cycles.

Dalila has also been active developing courses at GVSU that center on the core principles of green chemistry & engineering. These include:

CHM 180: Pollution Prevention, Green Chemistry & Green Engineering. This special topics class addresses green chemistry and green engineering and is geared toward the freshman level.

CHM 311: Green Chemistry and Industrial Processes. Focuses on green chemistry principles and their industrial applications, global perspectives on green chemistry performed in industrial settings with no negative environmental consequences, and increased benefits to humans and the earth.

She has also worked on developing the Introduction to Environmental Studies and Sustainability course, part of the new Environmental studies minor at GVSU and is proposing a Green chemistry certification program to be offered at GVSU, currently under the university curricular revision. For more information, visit <http://148.61.114.203/greenchem/index.html>.

Robert Lehmann (lehmannr@michigan.gov) - MDEQ and Saginaw Valley State Univ.:

Robert teaches the Environmental Chemistry I class at SVSU. This focuses on the natural chemistry and biochemistry of air, soil, and water, but it also includes the fate and effects of pollutants that enter the environment. The Environmental Chemistry II class is being designed around the principles of green chemistry and pollution prevention. It will be taught this fall as an independent study for interested students.

Doug Mandrick (jmandrick@portageps.org) - Portage High School:

Doug is currently working to convert high school level chemistry labs to be entirely green. He has recently done research with Dalila Kovacs at GVSU. In the past year he has attended a Beyond Benign session in Colorado to learn green techniques for high school courses.

Simona Marincean (simonam@umd.umich.edu) - University of Michigan Dearborn:

Simona teaches organic chemistry at U of M Dearborn, and will be teaching a green chemistry course in the near future. She is also active in experimental work in carbohydrates and corresponding polyols hydrogenolysis.

Dennis Miller (millerd@egr.msu.edu) - Michigan State University:

At MSU, Dennis heads research on several green chemistry related projects. These include the hydrogenolysis of carbohydrate feedstocks into various polyols, hydrogenation of organic acids into their corresponding alcohols, the development of advanced biofuels, and separation schemes for purifying products from renewable resource feedstocks.

Partha Nandi (nandipar@msu.edu) - Michigan State University:

Partha is currently working on design and applications of heterogeneous porous materials that have alkali-metals and their alloys. These new class of reagent/materials have found a wide range of applications in pharmaceutical, chemical, environmental remediation (e.g., freon destructions, PCB removal, diesel desulfurization) and material research (vinyl norbornene isomerization, preparation of initiators for polymerization). She is finishing up her PhD degree at Michigan State University and will be headed for a post-doctoral research in the area of heterogeneous catalysis.

Min Qi (qim@gvsu.edu) - Grand Valley State University:

Min plans to visit National Institute of Biological Science in Beijing in Aug. 2009. There, she will teach a short course on supercritical fluid extraction and supercritical fluid chromatography and their green applications. The class will be taught at the graduate level and consists of lecture and group discussion. While there, she will also meet faculty members in the institute to discuss future joint research opportunities.

Sudhakar Reddy (redv@bf.umich.edu) - University of Michigan:

The University of Michigan, through Occupational Safety & Environmental Health (OSEH), is promoting Green Chemistry among the teaching and research entities across the campus. They are closely working with the faculty to 'green' the experiments in the teaching labs while working on the syllabus to introduce Green Chemistry at undergraduate and graduate level courses. They are also working to advise research groups on pollution prevention, waste minimization, safer methods and substitution of chemicals with 'greener' alternatives.

Phillip Savage (psavage@umich.edu) – University of Michigan:

Phillip teaches chemical engineering courses at the U of M, and is active in various aspects of green chemistry research. His areas of interest include sustainable energy, green chemistry, synthesis in high-temperature water, supercritical fluids, and renewable energy.

David Shonnard (drshonna@mtu.edu) - Michigan Technological University:

David's current work is based on a research initiative across the entire value chain of transportation biofuels from forest resources; forest function genomics, sustainable forest management, conversion of biomass to biofuels, fundamental combustion and emissions measurements in modified engines, and integrated sustainability assessments. Specific green chemistry projects include:

- A. Chemical kinetic studies of sugars produced from forest biomass by acid catalyzed hydrolysis
- B. Enzyme engineering - directed evolution studies for improving wild-type fungal cellulases
- C. Fermentation - metabolic engineering and adaptation of biofuels-producing microorganisms.
- D. Ionic liquids - design of novel reactive ionic liquids for biomass hydrolysis and pretreatment
- E. Catalysis - design of nano-scale catalysts for conversion of pyrolysis bio-oil to hydrocarbon biofuel
- F. Separative reactor design - integration of membrane separations with catalysis for biofuels recovery.
- G. Durable biopolymers for automotive applications - co-polymerization of conventional biopolymer materials with residuals from fermentation for efficient mass utilization.
- H. Life cycle assessment - carbon footprint analysis of biofuels and other bioproducts from forest resources.

Collaboration Requests

Jennifer Aurandt (jaurandt@kettering.edu) - Kettering University:

Jennifer is seeking a group that is interested in developing a mechanistic toxicology or similar course for chemistry major undergraduates. She would also like to work with them in developing an upper division course and seeking funding for distributing materials to other universities for toxicology courses.

Jennifer Grivins (jgrivins@erpsk12.org) - Eaton Rapids High School:

Jennifer hopes to initiate a community, industry, and K-12 initiative for the city of Eaton Rapids. She is currently seeking contacts in these areas who are interested in contributing to this network as well as grant postings and funding support.

Future Newsletter Submissions

If you wish to have your work in green chemistry included in an upcoming edition of the MI Green Chemistry Education Newsletter, please submit a short summary to MIGreenChem@gmail.com. All members of the green chemistry community are encouraged to submit news items, regardless of the scale or scope (including research, education, or other areas). Photos of your class, group, or project are welcome. Also, if you are looking for colleagues to collaborate with on future projects at your school or institution, please submit these requests as well.