Green Chemistry and Commerce Council
Policy Statement on Green Chemistry in Higher Education

We are deeply concerned that students are graduating from our colleges and universities with insufficient understanding of environmental and sustainability issues. For our companies to compete successfully in a global economy, it is imperative that principles of sustainability[1] be incorporated throughout the curriculum. Within this sustainability framework, it is critical for our industries that green chemistry principles[2] are deeply embedded in both the technical and non-technical education of our workforces.

We call on institutions of higher education to integrate green chemistry and sustainability principles into chemistry, engineering, science, and business curricula. This will serve two primary goals:

- Enabling scientists, engineers, and others to enter the workforce with the skills to solve the many challenges today's industries face
- Endowing students with the skills to design and apply safer, more sustainable chemicals, materials, products, and processes.

We also call on institutions of higher education to work with companies, governments, and other stakeholders to develop educational programs and internship opportunities that ensure a well-trained workforce provided with the most up-to-date knowledge on green chemistry and sustainability. These advances in curriculum will require a top-level commitment from university leadership that supports interdisciplinary education.

Science and Engineering Disciplines

Institutions of higher education should incorporate green chemistry and green engineering principles[3] throughout science and engineering curricula. Green chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture, and application of chemical products.[2] Green engineering is the design, commercialization, and use of feasible and economical processes and products while minimizing 1) generation of pollution at the source and 2) risks to human health and the environment.[4]

---

[1] Sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" by the United Nations Report of the World Commission on Environment and Development: Our Common Future (1987).

[2] As defined in *Green Chemistry: Theory and Practice* Paul T. Anastas and John C. Warner, (New York: Oxford University Press, 1998).

[3] As defined by more than 65 engineers and scientists at the Green Engineering: Defining the Principles Conference, held in Sandestin, Florida in May of 2003 and Anastas, P.T., and Zimmerman, J.B., "Design through the Twelve Principles of Green Engineering", Env. Sci. and Tech., 37, 5, 94A-101A, 2003

[4] U.S. EPA, Green Engineering [http://www.epa.gov/oppt/greenengineering/pubs/basic_info.html, accessed December 2011]

We believe that chemists, materials scientists, and engineers have unique abilities and therefore responsibilities to protect human health and the environment. Training these professions to incorporate knowledge of toxicity and environmental hazards from the start will yield significant results, including less pollution, increased energy efficiency, increased mass efficiency, fewer hazards, less generation and use of toxic substances, creation of products from renewable resources, and creation of products that can be readily recycled or that fully biodegrade at the end of their useful lives. Training in green chemistry and sustainable design shifts attention from simply avoiding problems to creating solutions.

We encourage academic institutions to strengthen coursework, internships, and service learning opportunities so that science and engineering students are equipped with the following knowledge and skills:

- A working knowledge of the Twelve Principles of Green Chemistry.
- A working knowledge of the Principles of Green Engineering.
- A basic understanding of toxicology and public health, including addressing data gaps and tools for evaluation of toxicity, alternatives and trade-offs.
- The ability to recognize and assess the relative "greenness" (incorporating lifecycle impacts) of a chemical, product, material, or process. This includes familiarity with tools and strategies for evaluating alternative options.[5]
- An understanding of how molecular and material design can affect the health, environmental, and performance attributes of a chemical or material.
- An awareness of environmental laws, policies, and market drivers that influence the use or generation of hazardous substances in industry.
- An appreciation of performance, economic, technical, and other considerations that are critical in moving from laboratory to commercial production of a new chemical, material, product, or process.

We further encourage institutions of higher education to ensure opportunities for science and engineering students to collaborate with students and faculty in environmental health sciences so that considerations of health, safety and environment are better embedded in design and material decisions and so that health and safety research better reflects the needs of design disciplines.

Disciplines Other Than Science and Engineering

Employees in our companies who do not have science or engineering training also need solid grounding in sustainability and green chemistry principles.

A large percentage of the workforce in our companies has majored in fields such as business, management, finance, and economics.

We need these students to enter the workforce with enough knowledge of sustainability principles and green chemistry to understand and support those developing clean technologies.

[5] Tools and strategies may include, but are not limited to: life cycle assessment, alternatives assessment, greener chemical design tools, green engineering tools, hazard assessment tools, etc.

For students who are not scientists or engineers, we encourage academic institutions to strengthen courses in business, finance, policy, and relevant sciences as well as service learning opportunities and internships to equip these students with the following knowledge and skills:

- An understanding of the Twelve Principles of Green Chemistry.
- An understanding of the Principles of Green Engineering.
- An appreciation of the roles of science and engineering in society
- The ability to recognize ways in which technologies, processes, or products may harm the environment.
- An understanding of environmental laws, policies, and market drivers that influence the use or generation of hazardous substances in industry.

Continuing Education and Training

Continuing education and extension service programs should also incorporate sustainability and green chemistry principles. Our dynamic workplaces require appropriately trained employees. Life-long learning is increasingly essential for both technical and non-technical employees. Training of a broad range of employees, from manufacturing, to administration, to sales, purchasing and marketing, will help broadly embed green chemistry and sustainability thinking in our companies.

It is crucial that continuing education programs ensure that both technical and non-technical employees acquire the following knowledge and skills:

- An understanding of the Twelve Principles of Green Chemistry.
- An understanding of the Principles of Green Engineering.
- An understanding of life cycle analysis and systems thinking in the design of products and processes.
- An understanding of environmental laws, policies, and market drivers that influence the use or generation of hazardous substances in industry.
- An appreciation of the performance, economic, technical, and other considerations that are critical in moving from laboratory to implementation of a new chemical, material, product or process in industry.
- An understanding of chemical hazards and hazard communication.
- An understanding of how to manage data gaps and tradeoffs
- An understanding of the roles of supply and value chains in advancing safer chemicals, materials, and products.

Our Recommendations

We call on institutions of higher education to implement the recommendations outlined in this document. Implementing these recommendations will ensure that a generation of talented and highly skilled chemists, materials scientists, engineers, and other business professionals are prepared to solve significant and continuing sustainability and green

chemistry challenges. Students and employees with these valuable skills will have greater opportunities for hiring, promotion, and professional growth in our companies.

Incorporating green chemistry and green engineering principles across the curriculum will not only enhance protection of health and the environment; strengthening academic programs as we recommend here will also increase economic value for both our firms and for our country.

We also call on our manufacturing firms and their suppliers to commit to ensuring employees receive continuing education that allows them to be knowledgeable in green chemistry and advocates for sustainability and continual improvement in process and product design.

Our Commitment to Support These Recommendations

We commit to providing resources and support to work with academic institutions and suppliers in advancing these recommendations.

As we continue to balance the needs of our businesses, and all other aspects being equal, we will value and support through our hiring preferences people with a demonstrated knowledge of and ability to utilize the principles of green chemistry and sustainability.

We will value and support research and innovation, all other aspects being equal and necessary preconditions met for our firms, in universities where administrations, faculty, and students are committed to and trained in green chemistry and sustainability principles.

We will value and support continuing education on green chemistry and sustainability issues among a diverse range of staff in our companies as well as encouraging similar practices in companies in our supply chains.

Further, as we continue to balance the needs of our business and all other aspects being equal, we commit to encourage, value and support the recommendations set forth in this document in our innovation, product development and sourcing practices by encouraging our suppliers to share our commitment to sustainability and safer chemicals in products.

Signatory Companies Include:

- Anvil Knitwear
- Construction Specialties, Inc
- EPEAT, Inc
- Green Depot
- Hewlett Packard
- Johnson & Johnson
- Nike, Inc.
- Seventh Generation
- Steelcase
- Sustainable Research Group
- The Dow Chemical Company
- The Wercs Ltd.

The Green Chemistry and Commerce Council (GC3) is a business-to-business forum that advances the application of green chemistry and design for environment across supply chains. It provides an open forum for cross-sectoral collaboration to share information and experiences about the challenges to and opportunities for safer chemicals and products. For more information please contact Sarah Shields: sarah_shields@uml.edu, 978-934-2997.