9th Annual GC3 Innovators Roundtable

Session Summaries

Wednesday, May 28

Welcome and Opening Comments

- Robert Skoglund, Senior Laboratory Manager, 3M
- Jean Bennington Sweeney, Vice President for Environmental Health, Safety and Sustainability, 3M

GC3: A Year in Perspective

Joel Tickner, Director, Lowell Center for Sustainable Production

Keynote Presentation

Mark Ritchie, Secretary of State, State of Minnesota

Green chemistry has an important role in ensuring a more sustainable planet. It is critically important that education inspire young people to become green chemistry leaders. They will be the champions for safer chemicals and products.

The green chemistry economy needs to demonstrate that there are interesting career opportunities that can attract the brightest students to enter this field.

This will take long-term investment and engagement—maybe 30 years—much like the vision that led to what is today a vibrant stem cell research agenda. But this requires actions today to provide incentives and opportunities for careers in green chemistry. Companies can help by investing in innovative activities at the K-12 level, such as Fab Labs that train and inspire the next generation of chemists.

Mainstreaming Green Chemistry, Part I

Panelists

- Tracey Easthope, Director, Environmental Health Program, Michigan Ecology Center
- Patrick Harmon, Industry Manager, Industrial Petrochemicals, BASF Corporation
- Robert Israel, Director, Global Product Stewardship, Valspar Corporation
- Martin J. Mulvihill, Ph.D. Executive Director, Berkeley Center for Green Chemistry
- Amy Perlmutter, Principal, Perlmutter Associates
- Ken Zarker, Pollution Prevention Section Manager, State of Washington

Green chemistry will be considered mainstreamed when all chemistry is green chemistry, and any distinctions are no longer needed. The Mainstreaming Green Chemistry project is using GC3 member and stakeholder input to identify steps that the GC3 can take to move green chemistry into the mainstream. What will it take for all chemistry to be green chemistry? What are the current barriers and drivers, what partnerships will have to be built, policies put in place, educational needs met, and investments made? This session included an overview of the project, a summary of findings from a GC3 business member survey, and a panel discussion about some of the survey results. This was followed by breakout sessions to discuss how the GC3 can help its members promote green chemistry and who else should be engaged in the discussions.

Seventy five percent of GC3 member companies responded to the mainstreaming survey. Among other findings, it found that GC3 members work in many parts of their companies: sustainability, R&D, sourcing, materials, and more. The vast majority of companies have a chemicals policy in place, with green chemistry an explicit priority for the next 3-5 years. Concern for worker health and safety, concern for the environment, and competitive advantage are the top three factors driving green chemistry activities.

Top barriers are mainly in the economic realm: high cost to scale up, lack of economically feasible alternatives, high costs of researching alternatives, and perceived high costs of alternatives. Lack of technically feasible alternatives was also a top barrier. Over half the companies said that government R&D funding and chemical bans are policies that would help their efforts. The top non-policy action that would drive more activity in green chemistry is increased consumer demand, followed by partnerships with researchers. Companies felt that the GC3's top two priorities should be matching company needs with resources, and facilitation of information sharing.

Challenges for Implementation

- High costs of product development are not unique to green chemistry, but redesign can take longer than substitution, and data generation and certifications can add to costs—if you say something is safer, you have to prove it!
- National funding for manufacturing infrastructure and advanced technologies are not focused on green chemistry but should be.
- Business/academic partnerships are challenging — academic labs move slowly and IP gets complicated—but academics can be good long-term partners.

Helpful actions to advance Green Chemistry

- Celebrate continuous improvements rather than criticize them.
- Pitch green chemistry to university entrepreneurship programs.
- Engage consumers by focusing on safety, rather than green chemistry.
- Chemicals in school labs can be hazardous. GC3 members can talk with their alma maters and share their insights about how they evaluate materials use in their labs.

Role for the GC3

- Foster partnerships that focus on 1:many, rather than 1:1. Include all sectors at the table.
- Evaluate which GC3 activities are working best to overcome barriers.
- Examine how to overcome IP issues between universities and businesses.

- Identify the pre competitive activities that would give value to GC3 members while helping to mainstream green chemistry.
- Aggregate product demands by groups of companies.
- Create functional substitution working groups, e.g., adhesives, flame retardants, dyes, fragrances, preservatives, solvents, and emulsifiers.

Mainstreaming Green Chemistry, Part II

The Mainstreaming Green Chemistry break out groups discussed two key questions on GC3's role in mainstreaming green chemistry: *(1) What are the most important things the GC3 can do to help your business or organization in its efforts to bring GC to the mainstream?; and (2) Who should we be engaging in the implementation of these ideas, and how?* Compiled points from the small group and panel discussions are listed below.

Outreach/raising visibility

- Write articles—about GC3 projects, members, etc. Audience: mainstream press, sustainability outlets, chemistry/green chemistry outlets
- Speakers bureau: for news outlets, policy makers, corporate decision-makers, etc.
- Pitch some story idea to NPR or other news/talk org Revenue for GC3 members = 7% of GNP
- Keep promoting the GC3's Green Chemistry challenge

Build consumer demand -- work with NGOs and businesses.

Assisting Members

- Continue to identify needs and gaps in supply and product development chains and address them
- Develop tools
- Portal for chemical companies to list alternative chemicals
- Include place at GC3 for companies to bring their chemists and get a one day training
- Internship program
- Demand aggregation
- Identify priority chemicals and find substitutes
- Supply chain pilot
- Peer to peer support/SWAT team/consulting
- ID partnerships and break logjams- university:business, supply chain (as in retail work; this is our strength)
- Match company needs to resources (came up in survey)
- Create functional substitution working groups- adhesives, FRs, dyes, fragrances, preservatives, solvents, emulsifiers, etc.

Engaging Members

- Chemists in chemical companies talk to alma maters about GC (what is in school labs wouldn't be allowed in their company labs), write articles for alumni magizines
- Sponsor research challenges
- Talk to GC3 CEOs more about barriers/drivers/needs, what it would take to make the business case to them. "Get our own house in order, first."

Developing Information

- Systems mapping/leverage points

- ID Pre-competitive strategies (came up on panel and breakouts)
- Gather information about worker health and safety and environmental benefits (came up in survey)
- Look at ways to reduce high costs of scale up (came up in survey)
- Identify (and track) metrics
- Include questions on GC in annual global CEO survey
- Talk to Brookings about GC in their green jobs report
- Talk to applicable federal agencies about collecting data on GC- jobs, skills, etc.

Expanding the Network

- Pitch the idea of GC to investors, why it's a worthwhile investment
- Work with MEPs on chemical ID and substitution
- Develop project that engages business/NGO/government/researcher

Big Ideas

- Research Center(s)
- National Manufacturing Initiative Center for GC
- R&D funding
- Legislation- America Competes Act reauthorization
- Federal Executive Order
- Green Chemistry Export Program through international trade offices
- CEO forum (Chemical companies)

Misc

- Rewards for employees doing GC- identify models
- Build competition w/in industries--what can we learn from the carpet industry about why they competed against each other on sustainability when other industries do not? Promote Sustainable Biomaterials Collaborative guidelines in federal purchasing
- Training materials for chemists

Webinars-

- Successful business/university partnerships, and other partnership models (e.g., NGO/business)
- NIH/federal purchasing- how to get on purchasing lists
- Along with innovation group - where should the next big disruptions be (after fungus and sugar), and how can we support them?

Keynote Presentation

Marc Verbruggen, President and CEO, NatureWorks

The Natureworks business model is based on "the 3 P's": Properties, Price, Preferences. Preferences include lower carbon footprint, renewable resources, and health and safety of materials. Selling the health and safety of materials has more traction than carbon footprint. When you have five seconds to get the consumer's attention, a global warming message is harder to convey than consumer safety. Currently, messaging about the hazardous properties of styrenics and phthalates is easier than messaging around carbon footprints. That could change over time, particularly if impacts from climate change become more extreme. Natureworks is is confident about the safety of polylactic acid (PLA).

Key drivers

- Ingeo, Natureworks' PLA-based material, competes today in all petroleum commodity markets. The commodity business is 70% based on price, 30% everything else, assuming the same

properties. PLA can now compete with polypropylene.

- Using PLA-based food serviceware in contained venues such as sports stadiums helps achieve achieve one of the 3 P's -- environmental "Preference" -- because used serviceware can be captured separately from other plastics and composted. It is cheaper to compost than landfilling these materials. Stonyfield Farms has been using Ingeo in its multi-yogurt packs and found that it has provided great performance for the same or slightly lower cost. In the future, it can be used in 3D printing. PLA sales are growing 25% per year, with 2013 aggregate production of over 1 billion pounds.
- Natureworks has "rich parents." Not all start-ups have them. How do you weather the first 10 years? Wealthy parent companies can help provide financing for the first 10 years, such as Cargill did for Natureworks. Today, PLA is where PET and PS were in the 1950s. Today the company is making money so parent company is happy! It is better to have "rich parents."

Barriers

- The lack of incentive programs is a barrier to siting additional manufacturing in the U.S. The bioplastics industry is ready for rapid expansion, but like the petro plastic industry, it is very capital intensive. Financial markets are scared to invest in such start-ups, so government assistance is needed. The U.S. competes globally for investments – an incentive basket like what Thailand offers is needed.
- Long time needed for R & D. It has taken 10 years to achieve this level of competition because it takes significant time and effort to develop the polymers for specific applications.
- Lack of infrastructure. Technically, PLA can be recycled. In a controlled venue, such as Yankee stadium, it can be easily recycled. If it could be sorted as part of a municipal solid waste (MSW) stream, recycling is feasible. However, there is not enough volume in any metro area for the municipal recycling facility (MRF) to separate out PLA.

Helpful Actions to Advance Green Chemistry

- Governments can offer incentives that encourage companies to build plants in the U.S.

Thursday, May 29

Welcome and Opening Comments

Joel Tickner, Director, Lowell Center for Sustainable Production

Keynote Presentation

Eben Bayer, CEO and Co-Founder, Ecovative

Ecovative developed a polymer based on fungal mycelium. This entails an alternative polymer chemistry—closer to the assembly of tissues in animals than what is usually thought of as chemistry. Producing a product can start with less than 0.1% mycelium and grow to 25% of the material in 96 hours.

Using this technology, the company has developed products for building insulation, product packaging,

automotive composites, and engineered wood. They have demonstrated that they are able to grow the structure and insulation for a small house.

Ecovative has been recognized as a "Tech Pioneer" by the World Economic Forum and recently won the Buckminster Fuller challenge for socially responsible design.

Opportunities for Safer Chemicals and Products

- Fungi offer a good value proposition for performance, cost, and sustainability. However, they have been totally ignored as a system for innovation. Because it is a living polymer, the morphology can be changed with different environmental conditions.
- Numerous applications are waiting to be developed. The technology is being licensed to promote a new platform that many industries can use.
- Existing infrastructure can be utilized in some cases. To create automotive composites, they impregnate mats made from natural fibers, such as hemp, with mycelium. This process can use the same presses already used in the industry.
- Properties can be modified. For example, automotive composites can be chemically changed from hydrophobic to hydrophilic.
- Fungi can be used to replace chemical adhesives. Adhesive costs for making traditional plywood have increased dramatically from the 1960s when it was about 3% of the cost. It is now 20 to 40% of the cost. Plywood can be made with fungi instead of chemical adhesives. Plywood manufacturers that use this technology could realize substantial cost savings.

Key Drivers

- The products help to meet the growing demand for safer alternatives to styrene and for climate-friendly materials.

Challenges for Implementation

- Initial investment. Their first product was an insulation material for buildings. They had difficulties raising capital to commercialize it -- investors would laugh at them. Then they won a global competition for the best green technology to address climate change. Their prize of a half million euros gave them funding to begin commercialization.
- New infrastructure is needed in some cases. The mycelium system often requires new production processes and infrastructure all along the supply chain. This can be a long term project.
- Phobias about fungus and microbes. The fungus they use does not produce spores. Honest, factual communication has been key to overcoming such fears.

Helpful actions to advance green chemistry (e.g. policies, education, partnerships)

- Government funding programs. Significant funds were needed to conduct the necessary scientific research. New York State provided the first funds. Those funds gave the company the ability to raise capital. The company has also received funds from the EPA, NSF, and USDA.
- Changing codes and regulations. The company can build tiny houses in which the mycelium grow inside the walls to provide insulation and structure without needing studs. However, building codes are incredibly restrictive and can block such innovative technologies.

How Leading Retailers are Advancing Green Chemistry and Sourcing Safer Products

Facilitator: Sally Edwards, Senior Research Associate, Lowell Center for Sustainable Production

Panelists

- Roger McFadden, Senior Scientist, Vice President, Staples
- Kate Heiny, Senior Group Manager of Sustainability, Target
- Rob Kaplan, Director, Product Sustainability, WalMart

Consumers increasingly want to know product ingredients and want to purchase products with safer chemicals. Retailers are working to meet these demands, but face several challenges. To help overcome these challenges, the GC3 formed the Retailer Leadership Council (RLC) in 2013. The RLC promotes safer chemicals, materials, and products across retail supply chains. The founding members of the RLC are CVS, Home Depot, Target, Staples, Walmart, and Wegmans.

Just prior to the 2014 GC3 Roundtable, the RLC met with five chemical companies—Dow, BASF, Segetis, Akzo Nobel, and 3M—to share their concerns, challenges, and priorities, and to hear from chemical manufacturers about their challenges and priorities for green chemistry. The meeting was primarily a listening session. Topics included transparency, the need for better chemical information flow, barriers to obtaining information, harmonization of definitions and data requests, identifying priority chemicals of concern, communicating and building demand, lack of availability of alternatives, customer demand for safer products, and the importance of retaining brand integrity.

In addition to issues discussed in the listening session, speakers on this panel discussed how they are working to source safer products, including tools they are using and partnerships they are building. All retailers noted that, while they are helping their customers make safer choices and communicating the demands of customers through their supply chains, it is not the job of retailers to limit customer choices by removing products from their shelves. Choice is still key and decisions will be made by consumers in the marketplace. However, the marketplace is changing.

Opportunities for safer chemicals and products

- What goes “in, on, or around the body” are the products that customers care most about, such as products for cleaning (household and business), personal care, and baby care.
- In the business-to-business arena, products that support purchasers’ sustainability goals are driving the demand for safer products.
- This demand is creating opportunities for products that don’t need exposure controls or do not include ingredients on hazard lists

Key Drivers

- Customers are in a hurry and want the retailer to help them make decisions.

- Meeting the demands of customers: chemicals are the most important sustainability issue to Target customers. In Staples' case, their large corporate clients, which comprise 50% of the company's revenue, are demanding safer products.
- For Walmart, sustainability is a way to maintain the store's relevance and trust into the next generation.
- Filling information gaps that others in the supply chain should be filling, but are not.
- It would be a business risk not to pursue the sourcing of safer products.

Challenges for Implementation

- Learning how to better respond to the customer.
- Customers make their purchasing decisions quickly; they don't have time to think about the complexities of sustainability.
- For a company like Walmart, which sells 1 billion pounds of bananas a year, finding sustainable products that are available at the scale they need is a big challenge.
- Store merchants are balancing many issues in their purchasing decisions; what are the best ways to integrate sustainability?
- Lack of transparency about chemicals and risks.
- Retailers are not chemical experts; they can't always tell supply chain exactly what they need, but can provide them with expectations.

Helpful Actions to Advance Green Chemistry

- There are growing opportunities for partnerships, collaboration, and information (in supply chains, between retailers, with NGOs, etc) that weren't there even a few years ago; these should help to scale up change.
- Building on and learning from other tools, such the Sustainable Apparel Coalition's Higg Index, to create common language and measurement tools for supply chains.
- More collaboration, harmonization, and cross-industry work.
- More investment by suppliers in developing safer products.
- Developing common language between product sales representatives and retail merchants, among others.

Role for the GC3

- Continue to foster collaboration among retailers, and with their supply chains.

Green Chemistry Innovation Workshop

Facilitator: Monica Becker, Monica Becker & Associates Sustainability Consultants

Panelists

- Steve Domeck, Vice President, US Commercial, InnoCentive
- Homer Swei, Associate Director, Product Stewardship, Johnson & Johnson

Summary

This workshop explored how InnoCentive uses Challenge Driven Innovation (CDI) to help companies solve problems. It illustrated how CDI could work using a real example faced by Johnson & Johnson and explored the idea of a collaborative green chemistry challenge for the GC3.

Models of innovation are changing from hierarchical to more networked or open models. InnoCentive helps companies (Seekers) identify hurdles in a challenge and break them into smaller, more solvable parts, and identifies and engages a network of Solvers from around the world to help solve the challenges. InnoCentive provides the process, platform technology, and network. Seekers evaluate the submissions for the best solutions.

Johnson & Johnson is concerned about the lack of diversity of effective preservatives for cosmetics. Regulatory and consumer concern over certain preservatives is leading to the "deselection" of certain chemicals and shrinking the pool of options for formulators. This shrinking pool of preservatives could lead to increased allergies and sensitivities from overexposure.. Of 64 registered preservatives, only 16 are commonly used. Johnson & Johnson wants to expand the pool of safe, mild, and effective preservatives. A related challenge is how to label these preservatives so that customers can make informed choices.

Challenges for Implementation

- How to involve other industries in solving problem
- Long and expensive timelines for getting regulatory approval
- Do the market benefits to one company outweigh the collaborative benefits of working together?

Helpful Actions to Advance Green Chemistry

- The issue is common to products in other sectors that use preservatives

Role for the GC3

- Facilitating collaboration among personal care/cosmetic companies and/or across the supply chain to solve this problem. There is precedent for the GC3 doing this -- the alternative plasticizer project.

Keynote Presentation

John Stine, Commissioner, Minnesota Pollution Control Agency (MPCA)

Commissioner Stine discussed efforts in Minnesota to advance a green chemistry agenda and the important role of government policy in making this happen. The current "Better Minnesota Vision" is an excellent rallying cry for green chemistry.

MPCA was created to clean up impacts from chemical spills. The agency is adapting to a younger generation that wants to move from cleaning up unsustainable practices to advancing more sustainable solutions. Policy is a critical driver for moving green chemistry into the mainstream, starting with better data and public information on chemical hazards. While understanding the chemicals used in a product and their potential impacts is a good first step, there is a need to acknowledge that there will always be uncertainty about the impacts of chemicals on health and ecosystems. This scientific uncertainty needs to be linked to consideration of safer alternatives.

Minnesota is uniquely situated to be a leader in green chemistry. It has substantial biomass availability,

significant private capital, low unemployment rate, good tax structures, and successful collaborations of academics, government, and industry to promote green chemistry. However, there is not sufficient funding to provide companies with necessary technical assistance or research funding. Forward-looking companies are the exception rather than the rule.

An ecosystem model of safer chemicals innovation is needed that identifies the most effective ways for government to leverage efforts to advance green chemistry. It is important to acknowledge the role of government policy in helping industry to move forward. Such policy reform is not happening at the federal level and it is up to states to move beyond the chemical-by-chemical approach to a more integrated vision. Earlier assumptions of how change happens or the value of certain policies or approaches may need to be reconsidered.

Biobased Feedstocks and Chemicals: What are the Opportunities for Advancing Green Chemistry?

Facilitator: Martin Mulvihill, Berkeley Center for Green Chemistry

Panelists

- Mikhail Davis, Interface
- Babette Petersen, BioAmber
- Michael Saltzberg, DuPont
- Martin Wolf, Seventh Generation

Seventh Generation is seeking ingredients/materials that are sourced in a sustainable way, which can be a driver for biobased chemicals that are truly sustainable. They do not assume that "biobased" means safer. "Nurturing nature" means sourcing materials sustainably, such as sustainably grown palm oil, non-petroleum carbon sources, no waste, and materials used in packaging come from a renewable source. Plastics should have 100% recycled content and oils should be plant based. A Renewable Carbon Index (RCI) helps track progress in improving their products' sustainablity. For example, their dish soap has an RCI of 97%. Preservatives continue to be a challenge.

Interface has a goal that its products be made from 100% rapidly renewable and recyclable materials by 2020. They are about halfway to that goal. Biobased can help them fill this gap. "Biobased" is not an environmental claim for Interface. They want to move away from petroleum feedstock but they need other justifications to move to biobased. However, as a brand, Interface does not fully understand how to make biobased chemicals healthy. They do not know the toxicity of these intermediates so this is impeding the uptake of biobased materials. They need biobased chemical/material manufacturers to demonstrate safety. One advantage of recycled content is the avoidance of the chemical production pathway.

Dupont is shifting from a chemical company to an advanced materials and agricultural company. It has three strategic businesses: 1.) Agriculture and Nutrition. These are crop protection chemicals. 2. Advanced Materials. Kevlar is an example. 3.) Bio-Based Industrials. This small but growing business includes enzymes, biomaterials, and biofuels. Biomaterials are central to their new strategy, but must offer performance, cost, and environmental benefits.

Dupont would like to make products from agricultural intermediates. The Sorona polymer used in carpets, apparel, automotive products grew 15% last year. It is too costly to make from a petroleum

pathway. Rather, it is made with propanediol (PDO) (made from cornstarch through fermentation). The strategy is to sell farmers Dupont hybrid seeds and Dupont crop protection products and in turn, DuPont provides end-use markets for their farmers by buying their biobased feedstocks to produce biobased chemicals. Dupont is particularly interested in obtaining biobased feedstocks from its biggest customers for agricultural chemicals.

For Dupont, biobased alone is not good enough. It will not fund development of a new chemical if it is not cheaper. In developing renewable intermediates, they ask: What are new products that we can make that can bring new functionality? Half of Dupont's new technology portfolio is the cheaper category; half is new functionality category. They have created a tool to estimate life cycle impacts/benefits to use at the design stage. It is challenging to develop new preservatives because the market is very small.

BioAmber is a five-year-old biochemical company, with its core business in biobased chemicals – bio succinic acid (Bio-SA). The major challenge is to be cost effective. It costs $100's of millions to build a production plant. Unlike NatureWorks, BioAmber went public because they did not have a larger (parent) company to fund them. Bio-SA platform chemical can be used in a broad range of applications. In order to succeed, the company must work with partners (e.g., customers) to develop new markets for Bio-SA. Drivers for siting plants: Availability of feedstocks, price of energy, government support for scaling up, i.e., building a plant.

Challenges

- Need to obtain funding for scaling up.
- The audience noted: Brands are concerned about the additives used in plastics – petro or biobased. Transparency and health and safety assessments are needed to support adoption of safer alternatives. There is a concern that there might be a greater desire to conceal the types and safety profiles of additives used with novel biobased polymer blends.

Helpful actions to advance green chemistry (e.g. policies, education, partnerships)

- The biobased chemical industry needs to demonstrate to brands and consumers the green chemistry benefits of its products and technologies, beyond renewability.
- Provide assistance for moving from first-generation feedstocks, such as wheat and corn, to non-agricultural materials such as wood waste.

Role for the GC3 in helping to advance GC in this area

- Promote certification program for biochemicals/biomaterials to stimulate the market
- Educate about the benefits of biochemical/biomaterials

Friday, May 30

Welcome and Opening Comments

Joel Tickner, Director, Lowell Center for Sustainable Production

Keynote Presentation

Marc Hillmyer, Director, Center for Sustainable Polymers, University of Minnesota

Biobased polymers are a very small fraction of the over $400 billion global polymer market. The goal of the Center for Sustainable Polymers is to develop sustainable alternatives to petroleum-based polymers. A significant requirement is that sustainable polymers have equal or better performance than incumbent polymers, competitive cost, and can be easily and safely recycled or degraded.

He presented the Center's successful program to develop a fully functional, renewable, and degradable ABA triblock copolymer utilizing PLA and menthol. This new block copolymer is a viable alternative to traditional petroleum-based styrene block copolymers that are used for pressure-sensitive adhesives and as TPEs (thermoplastic elastomers) for polymer modification.

Opportunities for safer chemicals & products

- Finite resources will necessitate that sustainable polymers be the economic alternative to macromolecular materials based on fossil fuels.
- There are significant opportunities for conversion of biomass to new monomers. These are then converted to targeted polymers via controlled polymerization which are then used to create hybrid polymers.

Key drivers

- Most polymers are derived from non-renewable fossil resources. Their disposal at end of life presents significant environmental problems. This is driving the public, academics and industry to look for viable sustainable alternatives.

Challenges for implementation

- Need to engage interested and disinterested public
- Need industry participation. Their engagement is critical for funding and insight.
- Need to develop and design new polymers and hybrid polymers that meet/balance the three "E"s. An example is their work to create lower cost alternatives to menthol. Work was done to create a cyclic ester and then further polymerize to arrive at a PLA-PM-PLA block co-polymer. The material is still higher cost, but work continues on beta menthyl and valerolactone to bring the third "E" into the fold.

Helpful actions to advance green chemistry (e.g. policies, education, partnerships)

- The Center for Sustainable Polymers has a very active community outreach and education program to mainstream green chemistry. Examples: Minnesota State Fair Sustainability Eco-exhibit, 4H program, secondary school teacher education program.
- There are also active programs beyond the classroom. They invite local companies to present information about their green chemistry activities and collaborate with industry partners.

Role for the GC3 in advancing green chemistry

- There is a need to mainstream green chemistry at academic institutions. The key is to bring sustainability training and thought processes to the forefront of science programs.
- There is a need for continued visibility and outreach on green chemistry.

Adventures of a Disruptive Green Chemistry Technology: PureBond® Plywood

Facilitator: Gregory Morose, Toxics Use Reduction Institute

Panelists

Kaichang Li, Oregon State University
Todd Vogelsinger, Columbia Forest Products
Brendan Owen, US Green Building Council

The US Green Building Council's LEED rating system is a benchmarking eco-label that uses market based-information to accelerate sustainability in the building industry. The program addresses issues such as energy, water, nonrenewable resources, social justice, and community quality of life. Ultimately, it is about making buildings that are more healthy and humane.

Material resources and indoor air quality are the LEED issues most relevant for green chemistry. Disclosure of technical product information, including ingredients, is a key element of the system. The program has aspirational goals such as buildings that produce more water and energy than they use but it also works with market players to be realistic about what can be accomplished. It is therefore a step-wise evolution toward a better paradigm for buildings and materials. The LEED program is moving away from single selection criteria to more holistic evaluation of multiple criteria

Inspired by the ability of mussels to adhere strongly to surfaces in the ocean, Dr. Li created an adhesive for wood products that does not contain formaldehyde or other toxic chemicals. Traditional adhesive companies were not interested in the product because they viewed formaldehyde adhesives as their core business. However, Columbia Forest Products had been searching for a non-formaldehyde alternative and helped fund the scaling up of production. After the adhesive was commercialized, donors to Oregon State who are from formaldehyde-using companies began pressuring the university to be sensitive to their needs and to not talk about the hazards of formaldehyde.

Dr. Li has developed two other products. One is a pressure-sensitive adhesive tape made from vegetable oil. The other is a styrene-free polyester resin that is used to make a fiber-reinforced composite material. The composite can be used in airplanes and wind turbines. Given the pressures brought against him for promoting a safer alternative to formaldehyde, he is hesitant about being the target of similar pressures from the styrene industry.

Columbia Forest Products is a diversified company with long experience as an early adopter of innovations. When formaldehyde was classified as a probable or known carcinogen, the writing was on the wall. The company introduced PureBond® with a marketing campaign focused on the

dangers of formaldehyde. This led to a cascade of opposition from industry and customers that was swift and lasted for years. After Hurricane Katrina, it became well known that the formaldehyde in FEMA trailers made the occupants sick. The debacle increased demand for safer alternatives and for tighter regulations.

Opportunities for Safer Chemicals and Products

- By conferring points for greener materials and products, the LEED rating system creates market opportunities for safer products.
- As an employee-owned company, Columbia Forest Products has the ability to follow long-term strategies.
- The plywood industry is under attack from cheap imports that use urea formaldehyde. Non-formaldehyde alternatives can be attractive as both safer and domestically produced.

Key Drivers

- The LEED rating system is helping to drive the growth of the green building sector, which is now worth $100 billion.

Challenges for Implementation

- IP concerns. Oregon State University did not want to license the formaldehyde-free adhesive to an end-user such as Columbia Forest Products. The concern was that the company would keep the technology and not share it. The university addressed the problem by a connecting with a chemical company that would serve as a go-between.
- Funding. Scaling up the formaldehyde-free adhesive required outside funding. Fortunately, Columbia Forest Products and a chemical company helped pay for piloting and commercialization costs.
- Threats to/tying up intellectual property. A chemical company was interested in the pressure-sensitive adhesive tape made from vegetable oil. However, the company said that it would not license the technology because its own PhDs could create a similar product and patent their version. The chemical company eventually licensed the adhesive tape but has not been selling it, even though it has paid licensing fees for four years. It has not explained why it is not producing the product.
- Opposition from companies and organizations trying to maintain market share/status quo. Opposition forces tried pressuring Oregon State to prevent Professor Li from promoting his formaldehyde alternative. Columbia Forest Products did not foresee the strength of the backlash against it. The opposition has been well funded and has not yet ended.
- Charging more for green products even though costs are not higher. Some cabinet companies would try to charge twice as much for PureBond®, even though the retail price should be comparable to competitors' prices. That creates the false impression in the marketplace that the product is more expensive.

Helpful Actions to Advance Green Chemistry (policies, education, partnerships)

- Health product declarations and environmental product declarations are useful tools that can open markets for producers willing to provide information about the chemicals in their products.
- Don't rule out anyone as a potential adopter. Focus in particular on people in the middle who

neither support nor oppose the technology. They may be confused or even threatened by any controversy.

- Be open to unforeseen early adopters. Columbia Forest Products had thought that their strongest supporters would be architects and builders influenced by LEED. However, homeowners started to demand their product for health reasons, especially after Hurricane Katrina.
- Support early adopters. Columbia Forest Products created the PureBond® Fabricator Network to help early adopters with information, marketing materials, and recognition.
- Don't burn bridges and take the long-term view. Columbia Forest Products was able to collaborate with its competitors a few years ago to lobby against imported Chinese plywood.

Project Group Breakout Sessions

See Appendix

Wrap Up and Closing Keynote

Jim Jones, Assistant Administrator for the Office of Chemical Safety and Pollution Prevention, US EPA

Mainstreaming of green chemistry is happening. The participation of many large corporations in the GC3 Innovators Roundtable is not just an intellectual exercise. There is a remarkable amount of activity throughout the supply chain.

To advance green chemistry, government needs to both "push" and "pull." At the federal level, push is needed to reform TSCA. As an example of such a push, Clean Air Act regulations on ozone depletion effectively pushed corporations to innovate new products. As an example of "pull" activities, the EPA has identified a list of priority chemicals and is in the process of conducting risk assessments on them. The first reports on TCE, methylene chloride, and NMP will be completed this summer. EPA will work with companies to identify safer alternatives to these chemicals.

Pull is also coming from consumers who are demanding safe products. Retailers are working to meet this demand. EPA is supporting this pull through the Design for Environment program, which identifies products that contain safer chemicals. Interest in the DfE program is increasing. The EPA is working to design a new DfE label to better communicate the intent of the program to consumers.

In addition, EPA has created a safer ingredient list of 650 chemicals. It would like to add chemicals to this list but needs the help of the private sector to provide dossiers so that additional chemicals can be screened against the criteria and added.

The EPA is also working to identify the characteristics of a robust ecolabel. These criteria are outlined in EPA's Green Guides. It is looking for a third party to evaluate existing ecolabels against these characteristics. Ecolabels that meet these criteria will be included on governmental preferred purchasing lists.

It is important that the green chemistry movement not get caught up on how to brand itself. The term

“safe products” may translate better as a message than the term “green chemistry.” In addition, green chemistry has a significant role to play in addressing climate change. Those in climate change conversations see green chemistry as outside of the discussion. But addressing climate change is a green chemistry challenge and when thinking about how to mainstream green chemistry it is important to connect it to this work.

The green chemistry community has made tremendous progress. The diversity of stakeholders participating in the GC3 Roundtable indicates that it is not a fringe group. In fact, it is in the mainstream and is well poised to solve important global problems.

GC3 Green Chemistry Innovation Project Group
Project Break Out Group Discussion, May 30, 2014

See slides presented during meeting that summarize work done last year and ideas for the year ahead.

Plan for 2014/2015 Project Year

- **Webinar topics proposed by group**
  - Co-development of new chemicals/technologies, especially brand/manufacturer-suppliers
  - Warner Babcock, but not generally about the institute, rather a case study if they will share
  - Innovation programs at chemical/material companies
  - Innovation at large companies – how do they innovate as model for younger smaller co's
  - General Innovation – how does it translate? Is it different from "green" innovation?
    - Potential presenters:
      - Henry Cheesborough,
      - Peter Scarzinski
  - Sector driven innovation – identify problems within sectors and path to innovation
  - Pick few strong research universities and have them share their process/practice of innovation
    - Potential presenters:
      - Marc Hilmeyer U or MN
      - DuPont/MIT alliance
  - LAUNCH Green Chemistry Challenge – when they get down to 8 – 10 finalists

Innovation Portal & Forum (see slides for overview)- Online portal to share innovation

Ideas from group:

- Bulletin board
- Post questions that people can answer
- Post needs by sector to generate material innovation
- Cross industry sectors sharing of ideas/questions, problems, solutions
- Bring experts in as needed to help with solutions
- Key word search or text search
- Address copyright concerns with articles
- Open or closed forum – only registered users can post/respond, world can see the forum content
- Indicate whether it's urgently need technology or want over longer term
- Assign topic (category) moderators
- Anonymity – can choose to anonymous or not
- Drive good quality traffic to forum, partner with:
  - UC Berkley Center for Green Chemistry
  - ACS Green Chemistry Institute
- Sign up for email "alerts" on what is of interest to you

- A Place for GC3 Members to communication
    - Facilitate communication between meetings – GC3 members only
    - E.g., topics for next Roundtable; who is going to a meeting – willing to share notes, meet up
    - Calendar of events and who is going
- Concern: don't duplicate forums or work already done

GC3 Facilitated Collaborative GC Challenge

- Interest in pursuing
- Review flip charts from GC3 RT Innovation session discussions – go through list and send summary (simplified) provide a 2Q survey [not huge survey]
- Use the GC3 Community page to post and discuss
    - What are the challenges?
    - Post comments and have polls that are generated
- Email to GC3 members
- Provide cross fertilization opportunities with different fields
    - Microbiology
    - Polymer science
- Communicate through newsletter

GC3 Mainstreaming Green Chemistry Project Group

Project Break Out Group Discussion, May 30, 2014

Some overarching thoughts provided by Bob Israel (Valspar):
What role can GC3 play? How can we level the playing field? What role can government play? Can we build a framework of how things work from ideation to product launch?

- Who identifies the problem (or opportunity)
- what are we going to design
- who should be involved
- what communication is involved
- R&D
- Scale up
- Launch

This could be a framework for developing case examples and involving stakeholders

Discussion

- Who is the audience? Everyone
- Map who is doing what (alternatives assessment needs case examples), how to mainstream the next generation, how raise all ships to a common focus
- Education group is already doing that, innovation group looking at how product is brought to market. What are the other barriers? Look at Presidential GC Award Winners
- Unified vision needed, macro scale. EPA could serve a role by putting out a challenge
- What is driving the market? Electronics (WEE), automotive (End of Life Vehicle), different end market and sectors, where is the driver?
- NGOs have a role to play in education, explaining why green chemistry is good for the environment and public health
- Alignment of purpose is needed
- Lots of research goes on, but little gets to market. Innovation doesn't mean something gets to market.
- Overlay the map idea with presidential green chemistry examples- map success stories and failures.
- ACS works on analysis of presidential GC awards. Produced two documents with real world cases on GC. A lot of documents have been published about the winners. What is our endpoint? Language- toxics removal and safer chemicals, have to change chemistry and chemical enterprise to do that. Need big disruptions, like Ecovative and fungus, new chemical feedstocks such as sugar. These can eliminate jobs, need business case on a macro scale about how jobs are created overall.
- The challenge is in engaging and coalescing the pieces, finding examples
- Use social media to disseminate information
- Look at supply chain, horizontal and vertical integration
- Big end users out there need the pull, need the customer. Who is next to get in the room after the retailers

- Help chemical companies see the next issues, bring together, or have tool. How enlighten issues/concerns that companies are facing?
- Reach outside of this community- marketing, purchasing, economic developers
- Visions/goals for specific areas? Do back-casting- in 20 years, how would companies be acting differently? Government? Customers? Investors? Etc? Then actions would be clearer
- Waste treatment people are part of the supply chain, bridge the discussions
- Need whole session to talk about who the stakeholders are. What do we want to message
- Set the table and let stakeholders talk. Let them ID holes and ways to collaborate. Keep definitional bar of what Green Chemistry is high= big, transformational changes. Keep in mind language issues, for example, chemists vs biologists. Most success is 1:1 mentorship programs.
- Map ecosystem and build coalitions
- Cancer-free economy systems mapping would be useful for us to look at
- Investors- there is $ in early stage companies, money for commercialization is a problem. Investor community and banks look to industry for information about the industry (Natureworks example).
- How can the timeline of idea to commercialization be shortened?
- Regulation as driver. NGOs can work with industry to develop better regulations
- GC3 should make sure its own house is in order, first- get our members doing better before we broaden the message and ask more of others.

GC3 Green Chemistry Education Project Group

Project Break Out Group Discussion, May 30, 2014

See slides that were presented to the group, which provided an update on what was done this past year as well ideas for the year ahead.

Feedback on Recorded Webinar Portal:

- At this point the group thought that the portal looked like a good start. There were no additional topics or specific webinars suggested for the training, except one that was mentioned how databases work in a supply chain.
- The group discussed the options of the portal being free, partially free or not free, if the videos should be edited/polished, segmented or left alone. The advantage of the portal being entirely free is that it helps mainstream, the negative is that it is not a value added to the membership of being GC3.
- Is it possible to timestamp the webinars at the start of each speaker (if there are three speakers)? If not it might be helpful to cut them into sections. This would allow for people to watch segments easily at different times and would allow us to separate the sections into different levels (for Example Mulvihill presented an introduction to chemical design whereas Greene's presentation was very technical).
- Another question was if it was worth asking each speaker to rerecord their webinars in a non-live session?

How to do outreach on the live webinars and recorded trainings?

- One of the attendees mentioned that they never thought of forwarding the announcements to other contacts. Another said that while they were free, it still wasn't clear that they were open to everyone.
- **Communication of the live webinars**
    - When an email is sent out announcing the webinar to GC3 members, it should request that members forward to individuals who would be interested in attending.
    - If it hasn't been done already, one could create a listserv with the emails of people who have attended in the past. – can we see who has opened, forwarded email etc when there is an audience?
    - Webinars could be announced on the GC3 facebook page, Linkedin, Twitter (it was noted that it doesn't seem that GC3 has a twitter account).
    - If it hasn't been done already, GC3 could forward the email to groups/associations that they think would be interested.
    - In GC3 newsletter, mention actively inviting others to attend webinars.
- **How do we get people to use the portal?**

    - In occasional GC3 newsletter, mention that people should check out the portal- either in the education section or in the overview.
    - Counters for the videos?
    - Is there a way for an automatic update to go out when a new webinar is uploaded to the portal?
- Halfway through the webinars, we should get feedback from the GC3 members. Send out a survey?

Higher Education-

- Is there a way that there could be scholarships for 10 or so students to attend the GC3 as fellows? They could volunteer. This would allow the students to interact with directly with GC3 members in a networking setting.
- Could GC3 member companies hire interns for the summer? The interns could attend the GC3, work in internships and possibly have a wrap up at the end.
- Marty Mulvihill had mentioned earlier in the conference that GC3 members who are chemists should contact their alma maters and talk about what skills they are using now and what information they think would be helpful for students to get a leading edge. We should encourage GC3 members to do this.
- Webinar targeted to students- should we have a webinar targeted to students on what information would be useful for them to learn or for some GC3 members to say what would have been/was useful to learn? If they are interested, they could then talk to their instructors and request to learn information/some curriculum reform? Possibly mention the green chemistry commitment at the end?
- Companies should support the Green Chemistry Commitment. GC3 should go to all members again for sign on to the GC3 statement as well.

Industry

- Can GC3 help educate how green chemistry fits into company sustainability plans?
- Who is the audience to Mainstream? One is the Marketing lead at a company. They make decisions on which certifications to apply for.
- If multiple company staff can attend the GC3 conference, some that do not do green chemistry for a living should be invited.
- Do any GC3 companies want to look at the MI Green Chemistry Checklist- They are looking for companies to try review the checklist and provide feedback on what the

GC3 Retailer Project Group

Project Break Out Group Discussion, May 30, 2014

Agenda for session: provide input to Retailer Leadership Council and suggest possible speakers/topics for GC3 webinars over the next year

Discussion:

- How to help retailers communicate that a product is greener, better, safer? Issues: What does this message indicate about older, legacy products – are they not safe? How to not run afoul of FTC guidelines in making claims?
- One suggestion was to explain these changes as incremental. Introduction of seat belts in cars was provided as example of incremental change.
- How to help retailers with marketing of green products? How best to sell green chemistry? Who should do this awareness building?
- Marketing department decides how to message about products. It is also a legal, technical discussion. Claims need to be documented and also need to resonate with customers.
- Although there may be disagreements about risk from products, it may be easier to get agreement about reducing hazard. Example of low odor paint (low VOC)
- It was suggested that companies strive to use legitimate certification programs. (EPA's Green Guides may help here). Important to use ecolabels that are multi attribute.
- There was a brief discussion about alternatives to receipt paper with BPA and the option of using electronic receipts.
- One participant asked about where else in the supply chain could a dialogue be helpful? Dialogue with merchants is needed. Merchants need education so that they are not at mercy of suppliers. This is a challenge as merchants move around and do not stay in one product category. In broader supply chain – need to have dialogue with brands, component manufacturers.

Suggestions for possible companies to consider for webinars:

Marks and Spencer – Michael Barry – striving to be the world's most sustainable retailer – Plan A as there is no Plan B – company has developed a list of 100 activities and business metrics for them. This program makes money for the company.
Boots
Kingfisher
H& M
Patagonia
REI
Mountain Equipment Coop – in dialogue with its supply chain
Columbia sportswear
Keene footwear
Apple – has implemented aspirational goals
Solidaridad – program in China (Bob Buck to provide info)