11th Annual GC3 Innovators Roundtable Session Proceedings

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SESSION I

Learning from GC3 Collaborations to Drive Green Chemistry

Ashley Hall, Walmart
Eunice Heath, Dow
Jack Linard, Unilever
Roger McFadden, Replenish / McFadden and Associates *(moderator)*

This session reviewed three of the GC3's collaborative projects: the Evaluation of Alternative Plasticizers for Wire and Cable, the Collaborative Innovation Project on Preservatives, and the GC3 Retail Leadership Council. The panelists discussed the reasons that their companies got involved and the challenges and benefits of participating. One theme emphasized was that no single organization is big enough to overcome many of the challenges to advancing green chemistry and sustainable products. Therefore, collaborations are helpful to provide the resources and momentum needed to overcome barriers. Supply chain collaborations can enable companies located at different parts of the supply chain to better understand each other's needs and challenges. A key success factor for successful collaborations is addressing a problem or challenge that an individual company cannot address on its own.

KEY TAKEAWAYS

Key Drivers for Safer Chemicals and Products:

- Retailers are facing demand pressures for safer products.
- Desire to be ahead of regulations.
- Retailers are communicating the benefits of safer ingredients and products.

Challenges for Implementation/Lessons Learned:

- To make these collaborations as global as possible.
- Successful collaborations take time to set up and become effective.

Helpful Actions to Advance Green Chemistry (Policies, Education, Partnerships):

- Share progress with competitors and the public.
- Communicate up and down the supply chain.
- Transparency with results (databases, labels, standards).
- Improved green chemistry education to create green chemistry skills in the workforce.

Role for the GC3 in Helping to Advance Green Chemistry in This Area:

- Lay ground rules and determining metrics when setting up collaborations so that progress can be measured.
- Bring dissimilar individuals and organizations to the table.
- Act as a catalyst to set the stage and get the collaborations going.

Key Factors for a Successful Collaboration:

- The "hook" – knowing what brings the group together.
- The roadmap to success – articulating what it looks like.
- Being open to different points of view.
- Collaboration doesn't end on paper –to put theory into action.

SESSION II

Investing in Green Chemistry Solutions: Challenges & Opportunities

Judith Giordan, ecosVC
Adrian Horotan, Safer Made
Michele Jalbert, re:chem
Joel Tickner, University of Massachusetts Lowell *(moderator)*

The major types of funding sources for green chemistry are: 1) government (formerly the largest funder of green chemistry, now corporate investment is the largest) 2) corporate investments, 3) angel funding, and 4) venture funding.

- Government funding – is comprised of federal, state, and local sources, it is mostly policy-driven. Defense and healthcare industry sectors receive the largest amounts of funding.
- Corporate funding – electronics and healthcare industry sectors receive the largest funding.
- Angel investors – invest their own money. Funding tends to be mission driven. Twenty-three billion dollars was invested for 67,000 deals in 2012, nearly all seed/early funding; software receives the most funding.
- Venture capital funding – software receives the most funding. Venture funders usually provide larger funding amounts than do angel funders.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- Safer chemicals are emerging in purchasing considerations.
- State agencies with one-year funding limitations can network with angel funds and venture capital funds with similar areas of interest to collaborate on funding opportunities.

Key Drivers for Safer Chemicals and Products:

- Companies are interested in safer chemicals to protect their brands and create a competitive advantage.
- End use function is key: enabling technologies are not as useful as demonstrating where a particular chemical may function in a particular end use.

Challenges for Implementation/Lessons Learned:

- The current low costs of fossil fuels may change the business case and value proposition for funding requests; ensure that the value proposition is not tied to fossil fuel prices.

Helpful Actions to Advance Green Chemistry:

- Communication is critical to understand what the market will be in five or more years and to clearly articulate the message and value proposition that will resonate with the relevant funding organization.

Role for the GC3 to Advance Green Chemistry:

- Use the annual Roundtable to provide a forum to bring together: 1) funders to share the GC3's vision of the safer chemical market now and in the future, and 2) funders and start-up companies in the safer chemicals and materials space to share their collective knowledge and explore funding opportunities.
- Identify end use markets for each safer chemical and materials; the value proposition will be different for each end one.
- Help the world understand "what" is needed in green chemistry and drive national policy in that direction.
- Tie the case for green chemistry funding to US policy priorities.

KEYNOTE I

Gary Cohen, Health Care Without Harm and Practice Greenhealth

Dr. Cohen made the link between the growing incidences of disease due to toxic chemical exposure, increase in disease due to a climate change, and the role that the health care industry plays in adding to these problems as well as in driving solutions. He discussed the growth in cancer throughout the world and that everyone now is touched by cancer, whether they have contracted it themselves or know of someone who has. He stated that it is morally wrong that we have become normalized to the fact that children are born into the world having been exposed to chemicals in the womb that are known to cause birth defects and cancer. On top of that, they grow up being encouraged to eat food that is unhealthy and linked to obesity and diabetes.

In addition, climate change is reversing years of public health improvements, leading to more water born diseases, asthma, and infectious diseases. Indoor and outdoor air pollution kill twice as many people as AIDS, malaria, and TB combined. The US spends more on health than any other country in the world, but with the worst outcomes because we don't focus on preventative health.

Environmental factors are a key driver in human health outcomes, and health care itself has a huge environmental impact; it is one of the largest users of toxic chemicals in the US, and indoor air quality in hospitals is the most frequent cause of workplace asthma. The health care sector is the largest part of the economy after the military; it has a moral obligation and good business reasons to be the leader in improving environmental health. Health Care Without Harm and Practice Green Health work with hospitals worldwide to transform health care, leading to policy and market changes that impact the rest of the economy. They are looking for the next innovations to drive the next generation of what health care is about.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- The health care sector is looking for safer products for food and food service; furnishings for office, waiting area, exam rooms, and surgical suites; administrative products; medical products; lighting; paint; cleaning products; and more.

Key Drivers for Safer Chemicals and Products:

- Health care can model the transition to low carbon and low toxicity for the rest of the economy.

- We will do better when we stop defending products on the market that have risk, and instead put energy into new innovations that create fewer environmental and health harms.
- If we can create social and environmental improvements, we can scale improvements in health outcomes more quickly than if we focused on new treatment technologies or waited for policy change.

Helpful Actions to Advance Green Chemistry:

- Due to the scale of the health care industry, change can happen quickly when hospitals pool their buying power. Examples include phasing out mercury, moving the market towards sterilization (rather than incineration or disposal) of equipment, sustainable food, and flame-retardant-free furnishings.

Role for the GC3 to Advance Green Chemistry:

- Identify new green chemistry opportunities and innovations for the health care sector.

May 25th, 2016

KEYNOTE II

John Warner, Warner Babcock Institute for Green Chemistry (WBI)

Dr. Warner provided an overview of the core aspects of green chemistry that relate to innovation and getting products to market. Central to the topic of ensuring that green chemistry innovations get to market is a focus on creating safer more sustainable materials that make up the products that we buy. If the building blocks are not safe and sustainable it is impossible to build a safe and sustainable product. We therefore need to focus on training chemists to create safer materials and building blocks. In particular, training of the next generation of students is crucial to harnessing the power of green chemistry.

Dr. Warner also discussed several key elements of innovation. At WBI, they have created a business model, termed a "Technology Greenhouse," in which the technical and economic factors are integrated into the design process to ensure that when the actual prototype is ready, it is faster to market. Researchers at WBI spend about 80% of the time doing contract innovation and 20% on self-funded in-house innovation. Over the past few years, they have invented a number of new innovative green chemistry solutions in a variety of product categories, ranging from hair dye that returns grey hair to a person's natural hair color, to asphalt that can be more effectively recycled, to a formaldehyde-free wood composite. He stressed that they have been so successful not *in spite* of green chemistry but *because of* green chemistry. By looking at things through a green chemistry lens, it has forced he and him team to think of things differently, resulting in innovative new ways to look at and solve technical challenges.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- If the building blocks, the materials that make up a product, are not sustainable it is impossible to build a sustainable product. Programs are needed to train the people who can make these materials.
- Innovation happens not within the field of focus, but in the periphery – most invention happens when we are trying to do something else, but then notice an outlier.
- Innovation is orthogonal to complexity – the simpler the better.

Key Drivers for Safer Chemicals and Products:

- Products must have excellent cost and performance; being more environmentally benign is an added benefit.

- Necessity is the mother of invention – looking at things through the lens of green chemistry leads to success.

Challenges for Implementation/Lessons Learned:

- Integrate business and science into the beginning of the design process in order to speed the time from innovation to market.
- There is a linear relationship between the number of people and how innovative the group is: the more people, the more ideas the group has access to. However, decision-making is non-linear; having more people does not lead to better decisions. This is why some large companies can have trouble innovating.
- Customers might not always be loud enough or well-articulated enough to communicate what they want.
- Lack of trained workforce is a barrier to truly harnessing the potential of green chemistry.
- The point of the 12 Principles of Green Chemistry is to address that which someone wearing a lab coat can do – it is not intended to tackle social justice.
- Focus on what is being done, not on what isn't being done, in order to get things done.
- Play to our strengths- identify what we are good at. Chemists should do chemistry, others can focus on areas in line with their strengths.

Helpful Actions to Advance Green Chemistry (E.G. Policies, Education, Partnerships):

- Training of the next generation of students is crucial to building a workforce that knows how to harness the power of green chemistry.
- Give a voice to the customer–educate them and articulate their needs.

Role for the GC3 in Helping to Advance GC in This Area:

- Help to build a better-trained workforce through education.
- Advocate on behalf of the public for safer chemistries.

SESSION III

Climate Change and the Circular Economy: How Green Chemistry Connects

John Ortiz, HP Inc.
Arlan Peters, Novozymes North America
Jon Smieja, Steelcase
Sally Edwards, University of Massachusetts Lowell *(moderator)*

This session explored the connections between green chemistry, climate change, and the circular economy to identify the need for, and opportunities to, bring green chemistry into these discussions. Dr, Edwards opened the session with a primer on these issues and emphasized the following points to set the context for the subsequent panel discussion:

- *Green chemistry solutions hold promise as an important adaptation strategy to lessen the impacts of climate change on the health of the environment and humans.* A 2013 International workshop convened through the Society for Environmental Toxicology and Chemistry (SETAC) identified multiple ways that climate change and toxic chemicals interact in negative ways that are greater than additive effects.
- *A circular economy will not succeed with a contaminated stream of materials targeted for reuse.* Principles of the circular economy such as "waste is food'" point to the critical importance of designing out chemicals of concern and the role for green chemistry in developing benign materials and chemicals. Customers and the public need to be confident in the quality of recyclable material. If this confidence is lacking, the market will demand virgin materials and the attempt to create a circular economy will fail.

The panelists represent companies that are engaged in different types of product manufacture and therefore face different challenges within a circular economy. Novozymes primarily uses "biological nutrients" (materials that are not harmful to living systems after human use and can be safely returned to nature) and HP, Inc. and Steelcase primarily use "technical nutrients" (polymers or minerals that have the potential to be securely reused in a continuous industrial cycle). The panelists discussed the connections between green chemistry, climate change, and the circular economy.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- Green chemistry innovations that reduce the toxicity of products and increase their potential as inputs for new products at end of life.

- Increased transparency of supply chain information that allows manufacturers to more easily select high quality/benign materials.
- New, innovative bio-based chemicals and materials for industrial processes that provide restorative as well as non-hazardous properties.
- Improved systems for reverse logistics.
- A sufficient inventory of restorative and renewable materials and energy.

Key Drivers for Safer Chemicals and Products:

- HP, Inc. has adopted the following definition of a circular economy: "Keeping materials in use for the longest period of time at the highest state of value."
- Novozymes' business model applies biological processes to industrial processes and is directly connected to the circular economy principle of restoration. The company collects data from life-cycle analyses to demonstrate restorative benefits.
- Steelcase and HP, Inc. both incorporate "product as service" capacities in their business models. This approach changes design incentives because the companies will get their products back for re-use/re-manufacture. It provides additional incentives to use innovative and safer chemicals and materials.

Challenges for Implementation/Lessons Learned:

- Business models depend on the paradigm that the only way to make money is to "sell more stuff." Moving towards a circular economy requires embracing different business growth models (e.g., adding service components).
- Customer preferences for the newest trend.
- Lack of economies of scale in the biomaterials area, and necessary supplies of energy from renewable sources.

SESSION IV

Accelerating Green Chemistry at a Global Level: Building International Collaborations

Petra Greiner, Umweltbundesamt Federal Environment Agency, Germany
Avtar Matharu, University of York, UK
Nitesh Mehta, Green ChemisTree Foundation, India
Ken Geiser, University of Massachusetts Lowell *(moderator)*

This session explored the status and role of international initiatives in green chemistry and how greater global collaboration can accelerate growth of green chemistry in research, education, and industry. Petra Greiner discussed how the German government is initiating an International Sustainable Chemistry Coordinating Center (ISC3) to build greater connections and understanding among green (or sustainable) chemistry efforts globally. She discussed the need and opportunity to link sustainable chemistry to global initiatives. The ultimate goal of these efforts should be a "chemiewende" – analogous to the "energiewende" or "energy turn," the German major policy and market effort to move towards sustainable energy.

Avtar Matharu discussed York University's efforts to build connections globally between researchers as well as to build a new generation of practitioners in academia, government, and industry that can accelerate green chemistry. He discussed the Global Green Chemistry Research Network (G2C2) and the Network of Early Career Sustainability Scientists and Engineers (NESSE) as models for global collaboration that bridge knowledge, increase the number of practitioners, and build partnership at a global level.

Nitesh Mehta discussed a number of efforts in India to engage industry, government and academic stakeholders to build a green chemistry movement. He noted various approaches taken including regional workshops with small- and medium-sized enterprises (SMEs), discussions for corporate decision-makers on green chemistry investment, meetings with local pollution control boards, and trade expos to connect green chemistry needs to solutions. He discussed a number of barriers to green chemistry as well as potential drivers.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- To grow sustainable chemistry globally it should be linked to the UN Sustainable Development goals, particularly the goal of ensuring sustainable consumption, so that it is viewed as critical to achieving sustainable development.

- Take advantage of voluntary and globally binding instruments to accelerate the growth of sustainable chemistry.
- Make global connections to inspire action at home.
- Engage multinational companies more to drive green chemistry in developing countries.
- Create better and more effective supply chain messages about green chemistry so that companies in developing countries may be able to distinguish themselves in the market for their green chemistry efforts.

Key Drivers for Safer Chemicals and Products:

- Increasing worker recognition of environmental health and safety rights, which may drive demand for safer chemicals in the workplace.

Challenges for Implementation/Lessons Learned:

- Lack of a link between academic research and commercialization.
- Lack of a long term investment view and policy incentives.
- Large growth in green chemistry centers in China in recent years is well funded, but not translating research into action.
- There are not enough clear demands from consumers or support to companies to implement green chemistry changes.

SESSION V

Overcoming Barriers to Mainstreaming Green Chemistry

1) How Can We Effectively Track Progress in Green Chemistry?

Facilitator: Sally Edwards

Summary
Metrics are essential to communicating the value of green chemistry. They are needed at all levels of the supply chain and can be used to set corporate policy, track progress, measure the impact of green chemistry innovations, and facilitate communication and dialogue between buyers and suppliers around greener products and solutions. Being able to track progress and demonstrate tangible benefits of green chemistry using clear metrics is the most compelling way to communicate value and ultimately drive action. Product level metrics are very helpful because they can be directly related to sales and can be used to build a strong case for the financial impact and growth opportunities of greener products/formulations. Corporate level metrics such as the Chemical Footprint Project are also very valuable because they enable a holistic examination of how chemicals are managed within an organization and can facilitate internal dialogue. While there are many metrics currently being used, new metrics, or new ways of using existing metrics, are necessary. Particular focus is needed on metrics that can communicate the value of green chemistry innovation to key decision-makers throughout the value chain and drive action and investment in green chemistry solutions.

Important Functions of Green Chemistry Metrics:

- Tracking progress.
- Being able to communicate *benefits* using metrics.
- To tell a story about progress.
- Metrics should to matter to the target audience —e.g., identify key decision makers in the supply chain and determine what information would be compelling to them.

Priorities for Metrics Development:

- Product level metrics – are needed to be able to prominently identify products of green chemistry to:
    - enable retailers to demonstrate increased sales in those products.
    - help enable decision-making for buyers – e.g., the buyer doesn't really know what a carbon footprint is, but they know that it should be minimized because it's a corporate goal.
    - tell suppliers "we want these products, which represent this dollar amount of revenue, to be made with safer ingredients."

- Financial impact and growth opportunities of reformulation:
    - e.g., for new formulations - how much was sold after reformulation, how much of a chemical of concern was removed from the market?
    - e.g., for new products – how do sales compare to other products in that category?
- Increase in use of safer alternatives as well as elimination of chemicals of concern:
    - Walmart has done a good job of *calculating the reduction in use* of high priority chemicals for certain product categories (95 % by weight reduction).
- Innovation metrics:
    - Measuring the integration of green chemistry in the design process – e.g. do product designers in an organization have the tools needed to make good decisions? The Materials Sustainability Index at Nike has been a huge driver of innovation internally. In the end performance is the key metric - performs "as well" doesn't get much traction

Potential Next Steps:

- How can we scale up existing tools like the Chemical Footprint Project?
    - Chemical footprint project is a corporate level metric – evaluates how chemicals are systematically managed in an organization.
    - The Chemical Footprint Project can help frame a high level conversation in a firm and help to set goals and priorities for chemicals management.
    - It would be valuable to get wide participation in the Chemical Footprint Project (similar to the widespread adoption of the Carbon Disclosure Project).
- Identify ways to improve communication from buyers about the opportunities for suppliers for greener chemistries:
    - get retailers to say that they will be assessing suppliers on some key metrics to challenge suppliers and drive knowledge, dialogue and innovation.
    - data from large institutional purchasers (like group purchasing organizations in healthcare) can give an indication of what suppliers should focus on in regard to greener products.

2) What are the Key Elements of a National Green Chemistry Research and Education Summit?

Facilitator: Saskia Van Bergen

Summary

One of the actions in the GC3's Agenda to Mainstream Green Chemistry is to "convene a National Summit on Green Chemistry Research and Education." The vision for such a

"White House" summit, modeled after a similar one for climate change and health, is to bring industry leaders and academic chemists and chemical engineers together with top-level state and federal officials from environmental, public health, education and funding agencies to discuss the workforce and research needs of institutions and firms working in the field of green chemistry. This group discussed ideas for what the desired outcomes and design of such a summit might be and the types of firms, federal agencies, and academic institutions that should be involved.

Key Messages:

- Green chemistry is innovation.
- Green chemistry can grow and sustain jobs.
- Green chemistry can reduce climate impacts associated with conventional chemistry.
- Green chemistry education is needed to accomplish the above.
- Funding for R&D is necessary; it can be done through re-prioritizing existing sources of funding.

Jobs, innovation, climate change, science standards, competitiveness, building a circular economy, a world with shrinking resources: green chemistry can help address these.

What Problems is the Summit Solving:

- Students are not being trained in green chemistry, partly because professors were not trained in green chemistry.
- The current way that academic programs are evaluated does not prioritize green chemistry.
- Companies are not able to find enough workers with green chemistry and green engineering expertise.
- State and federal funding drive university research priorities- more funding is needed for green chemistry-related R&D.

Who is the Audience:

- Decision-makers: federal as well as from states that support green chemistry.
- Funding agencies.
- K-12 science standards developers.
- Higher education representatives.

Desired Outcomes of Summit:

- More priority for green chemistry research and development funding.
- Academic evaluations that value green chemistry.

- Strengthen the link between industry needs and academia.
- Identify the unique role of the federal government in mainstreaming green chemistry.
- Build better relationships with federal agencies on the topics of green chemistry research, funding, and education.
- Funding for an Industry/University Cooperative Research Center on green chemistry.
- Funding for a national green chemistry center.

Programs to Highlight:

- Minnesota: $10-15K state grants to integrate green chemistry into education programs, develop a lab or change the syllabus.
- UC Berkeley: Greener Solutions course.
- Toledo: Integrating engineering into chemistry.

What Role Should the GC3 Play:

- Help to align people / facilitate a plan.

3) How Do We Increase Funding for Green Chemistry?

Facilitator: Joel Tickner

Summary

Lack of funding for green chemistry, from research through development and commercialization, is commonly stated as a critical barrier to the creation and scale up of new innovations by firms and academic researchers. This group discussed the types of public and private funding needed to develop and commercialize products of green chemistry, and ways to engage government agencies and private investors in attracting sufficient funding to grow green chemistry solutions.

What are the Funding Needs/Barriers of Different Players in the Supply Chain, from Researchers to Companies:

- Academic researchers will be hesitant to engage in green chemistry research without dedicated research funding. Yet, there are few extramural federal research programs dedicated to green chemistry.
- There are shrinking federal research dollars to support industry research, e.g., de-prioritization of sustainable chemistry funding program at NSF.
- There are some existing funding programs at EPA, DOD, DOE, and NIH that could be focused on green chemistry.

How Can the GC3 Help Overcome Those Barriers:

Education:

- Identify the realms (or lack thereof) of research funding sources for green chemistry innovations.
- Educate government extramural grant program officers about the business proposition for investing in green chemistry research through group briefings and individual meetings.
- Encourage agencies to consider green chemistry needs when establishing program funding priorities and strategies, including review criteria for grant proposals.
- Take on the role of "funding navigator" for GC3 members to help them find and access green chemistry funding opportunities.

Policy Engagement:

- Explore opportunities to leverage or establish green bonds for green chemistry innovation and process-redesign for green solutions. Many green bonds are currently attached to job creation.
- Integrate green chemistry investment into emerging policy opportunities. It could embed a revolving fund for retooling greener solutions, including green chemistry research and green engineering for process redesign research, in the COMPETES bill.
- Explore options within the Affordable Care Act – link green chemistry solutions, primary prevention and provision of products, technologies and settings for safe health care.
- Explore state funding opportunities. Several states have innovation development funds, yet none to date align with green chemistry needs.

Investor Engagement:

- Explore establishing and leveraging a GC3 angel circle fund, including exploring partnership opportunities with existing angel funds (e.g., chemicalangel.org) to provide further support for promising green chemistry research innovations.
- Link existing GC3 projects (e.g. Preservatives Project) with existing angel funds and connect end-use functions with company needs as a model for prioritizing funding.
- Explore GC3 partnerships with incubators/accelerator funds. In some cases regional opportunities may exist, e.g., Flagship Ventures in the Boston area.

4) What Will It Take to "Mainstream" Green Chemistry?

Facilitator: Amy Perlmutter

Summary
The GC3 has developed as its mission the "mainstreaming" of green chemistry. To help it accomplish this mission, it released in December, 2015, its Agenda to Mainstream Green Chemistry (the Agenda). The Agenda makes the case for green chemistry, discusses drivers, barriers and opportunities, and recommends five strategies that can be taken to accelerate the practice of green chemistry:

- Enhance market dynamics
- Foster collaborations
- Inform the marketplace
- Support smart policies
- Track progress

Green chemistry will be mainstream when:	We will need these partners to help make this happen:
It is embedded in the sustainability goals, innovation, R&D and sourcing strategies of firms through design guidelines, personnel hiring and reward practices, and metrics.	businesses across value chain
It is an integral part of all chemistry education, including workplace education.	educators, government, business
It is a core element of all government and private sector funding for chemistry and materials research and sustainability initiatives.	businesses, government, investors
Products of green chemistry are readily available throughout the value chain at high performance and reasonable cost.	businesses, researchers, advocates, consumers
An ecosystem of green chemistry entrepreneurs is flourishing.	government, business, advocates, researchers

To help clarify what is meant by mainstreaming green chemistry, and create metrics that can track progress in the right direction, the GC3 developed the vision below, and identified key partners to help make this happen. This group discussed what it would take to achieve this vision.

What are the Barriers to Mainstreaming:

- Green chemistry solutions and options from suppliers are limited due to regulatory barriers that inhibit innovation.
- There is a general consumer perception that green materials/products don't work.
- There are currently limited incentives, and therefore a need for more incentives to promote green chemistry.

- Sometimes the complexity of green chemistry is a barrier for consumer understanding and caring about the issue.
- There is limited linkage of green chemistry to sustainability, management is not always aware that green chemistry impacts sustainability.
- The GC3 is currently very U.S.-centric, but needs to be more global in thinking.
- The "innovators dilemma" is present, which means it is difficult for a small innovator to adequately supply a large company.
- Removing a hazardous material from an existing process/infrastructure for a large company is very expensive.

What Needs to Be Done to Mainstream Green Chemistry:

- There are no green chemistry metrics in the GR4 sustainability metrics, so green chemistry metrics should be proposed.
- When green is just one of many attributes for a material/product, not "the sole" attribute, the likelihood of success is much greater.
- Take out the word "green," and instead focus on "safety" and "human health" or "wellness."
- To reduce the complexity of the message, focus and communicate on an entire class of chemicals, instead of a chemical-by-chemical approach.
- Broaden the discussion and scope of what green products are to include chemistry, engineering, business, material waste, etc.
- Reach the players that have the purchasing power.
- The U.S. Green Building Council has done more to drive Green Chemistry than any other organization as a result of the LEED standard and their willingness to lead in this area. Material disclosure requirements are driving Life Cycle Analysis and other environmental impact analysis. LEED certification has significant market value in the construction industry.

Who are the Key Stakeholders:

- Academia: including both universities and accreditation bodies. Only four universities are represented at the current GC3 roundtable, and there is an opportunity to get more to join.
- NGOs, advocates, celebrities, chemical formulators, manufacturers, and government agencies are key stakeholders.

What Roles Can They Play?

- Consumers can sometimes drive what ingredients are used in products.
- Focus and communicate on an entire class of chemicals, instead of a chemical-by-chemical approach.
- Large companies are more likely to do incremental changes than breakthrough changes in the area of green chemistry.

- Universities can educate the next generation of chemists, not just about lab safety, but about green chemistry, toxicology, etc.
- ACS and ABET, the accreditation agencies, may be able to include green chemistry in their requirements.
- This is a marathon not a sprint. it is a long process to mainstream green chemistry.

How Can GC3 Engage Them:

- There is an education component to LEED certification for professional certification. GC3 or ACS can do something similar for green chemistry.
- Have a public signatory initiative to get companies to sign on to adopt green chemistry principles.
- GC3 can initiate a reward system in addition to the Presidential Green Chemistry award. It can also be a good vehicle for public relations. Competition for the award can drive future innovation.
- There is a large need for more small breakout sessions at the Roundtable and/or satellite meetings throughout the country that would be effective at getting more and valuable input from participants.
- Challenge GC3 members to adopt new chemistries and materials that are discussed at the Roundtable.

SESSION VI

Effective Communication to Mainstream Green Chemistry

Paul Ellis, Kingfisher
Steve French, Natural Marketing Institute
Jim Jones, EPA
Denise Petersen, BASF
Andy Shafer, Shafer's Innovation and Business Building Services
Paula Schaper, WestWordVision *(moderator)*

Effective communication is key to helping green chemistry become mainstream. One of the five strategies in the GC3's Agenda to Mainstream Green Chemistry is to *Inform the Marketplace*, and the GC3 Retail Leadership Council and chemical manufacturer Joint Statement on Using Green Chemistry and Safer Alternatives lists communication as one of the five key areas of effort. This session looked at how to communicate about green chemistry to various audiences—consumers, within firms, and throughout the value chain—in order to drive demand for green chemistry materials and products.

Steve French, from the Natural Marketing Institute (NMI), framed the discussion by showing a series of slides with findings from consumer insight surveys that his company has been performing over the years. He stressed that, while this information is mostly from consumers, it has relevance to the entire value chain. He stated that consumers are increasingly more aware of the types of items they are trying to avoid: for example, between 2011 and 2015 there was a growth of 103% in awareness of parabens, 36% in sodium laurel sulfate, and 22% in phthalates. Consumer concern about chemicals in specific categories of products is increasing as well. Consumers also believe there is a link between chemicals in products and the rise of childhood diseases.

Effectiveness of a product and its safety are top drivers for consumer behavior; attributes around chemicals, such as low toxicity, are a secondary driver. Consumer purchases are mostly driven by information from friends and relatives and from receiving product samples, among other sources; social media ranks low as an influencer.

In the workplace, 41% of those currently employed want to know more about what their company is doing to be socially and environmentally sustainable.

Consumer decision-making starts with awareness, which transfers to a level of concern, and then leads to behavior change. It doesn't necessarily matter if a consumer understands an issue or not; if they believe it is a better choice to change their behavior, they may do so.

NMI categorizes consumers into the following categories:

- LOHAS: 22% of consumers, proactively environmental
- Naturalites: 21%, environmental strivers with some price sensitivity
- Drifters: 22%, want to be sustainable but need easy solutions
- Conventionals: 17%, are practical and conventional, looking for cost and environmental savings
- Unconcerneds: 18%, not involved with environmental issues

LOHAS purchasers drive products to the mainstream and influence others, they are most concerned with specific chemicals in products and are the early adopters. NMI calls the Naturalites, Drifters, and Conventionals the Sustainable Mainstream- this group wants to be more involved in sustainability, but there needs to be something in it for them; they feel somewhat empowered that they can make a difference.

Awareness of chemicals in products is increasing, and concern is up. Transparency is key, consumers want to know what is in their products- not just concerning chemicals, but everything.

The presentation was followed by a panel discussion with representation from a chemical company, a former bio-based chemical company start up executive, a UK-based retailer, and government.

KEY TAKEAWAYS

Key Drivers for Safer Chemicals and Products:

- Understanding consumer demand is key information for chemical and product manufacturers to direct where innovation dollars go, and for building the case for new product ingredients.
- If a trusted brand gets exposed for using a chemical of concern or not being transparent, it can damage the brand.

Challenges for Implementation/Lessons Learned:

- Green chemistry is complex and hard to communicate in a simple, high level manner.
- How to find the best person to be responsible for communicating about green chemistry.
- Getting corporate executives to understand that green chemistry goes beyond chemical substitution.
- Consumers don't always understand the issues or have an understanding of basic chemistry, e.g., they want products that are "chemical-free."

- Consumers don't yet understand that chemicals are in articles as well as formulations. Because articles are not covered by REACH, it is harder to build the case within a company for getting rid of these chemicals of concern.
- Find a way to talk about issues in a way that matters to consumers or business.
- Consumers want transparency, but how that gets delivered matters.
- While it is important to be open and transparent, it is hard to communicate that improvement is not always linear- improvement in one green chemistry principle may mean lack of improvement in another.
- Lots of new ingredients enter the market: what should consumers be told about what changed and why?
- Consumers think that many of the ingredients in their products have been studied for safety by the federal government, but they haven't; this creates a cognitive dissonance when consumers find this out.
- Many aspects of behavior in our society are becoming motivated by fear – how to deal with this in terms of business in general, and chemicals in particular, is challenging.
- The disconnect between consumer focus on hazard and government focus on risk creates misunderstanding and distrust.
- Entire value chain relationships are based on trust; communicating about issues that customers care about, and to do so honestly, is key to building trust.
- The chemical industry in developing countries may not have the same commitment to the environment as those in more developed ones. The trust of the entire chemical industry can be eroded by an incident in another part of the world, including potentially hazardous counterfeit materials labeled with a mainstream company name.
- Consumers don't necessarily believe that green products work.

Helpful Actions to Advance Green Chemistry:

- Help consumers understand risk and rewards.
- Make the message simple; through focus groups, develop a message that the average person can understand and care about, while keeping the "wow" factor of new green chemistry innovations.
- Figure out how to tell our story of green chemistry well.
- Find the right vehicle for communication—back simple labels with further information that is obtainable; be transparent.
- Communicate about product benefits, not ingredients.
- Match up chemical company commitments about where they want their portfolio of products to be with what is relevant to customers; compare these metrics and figure out how to meet consumer needs across the value chain.
- Educate executives and buyers in companies about chemical issues.
- Make safer products that are better and work as well as their traditional counterparts.
- Talk about positive attributes of new products, avoid negatives and fear.

- Be open and honest.
- Create products that are less expensive and perform well to attract a large number of buyers.
- Focus within the entire value chain on product benefits- how they work and that they are safer.

Role for the GC3 in Helping to Advance Green Chemistry in This Area:

- Foster more discussion about what companies are doing to address consumer concerns, and develop metrics for ways to communicate.
- Help pool efforts to understand how to make it easier for customers to make safer choices.
- Aggregate messages that members can use throughout the value chain, create common language.
- Bring companies together in a work-group to identify key messages to tell the C-suite, B:B, purchasers, consumers.
- Crowd-source the issue—generate questions, find answers, bring people together, focusing mostly on communicating through the supply chain.
- Use information from the Presidential Green Chemistry Awards and successes to date in the supply chain to make the business case.

KEYNOTE III

Alyssa B. Schuren, Vermont Department of Environmental Conservation

Commissioner Schuren oversees the State of Vermont's federally delegated and state environmental programs. Her department has 350 employees and a $7 million budget. Commissioner Schuren described the Department of Environmental Conservation's (DEC) recent response to PFOA contamination in the town of North Bennington, VT. While she is proud of their response to the local residents needs and concerns, she noted that the widespread use of green chemistry would have precluded the problem from happening in the first place.

In February 2016, test results showed PFOA contamination as high as 2700 ppt in well water. As hundreds of homes were on wells, DEQ worked with the National Guard and Emergency Response to put homes within a 1 mile radius on bottled water, and the long-term plan is to put homes on municipal water, which tested clean.

Commissioner Schuren noted that government failed here to protect people from toxic exposures and that there is a need to address the root cause of a toxic exposures such as this one. PFOA was unregulated and was not tested before went on the market. It was dumped down drains, spread on farmland, put in drums and disposed in landfills where it then leaked. It has an odd fate and transport pattern. It is key to pass laws at state and federal levels (such as TSCA reform) that might keep these kinds of problems from happening. .

In 2014, Vermont passed the Kids Safe Products Act. It lists 66 chemicals of concern that must be disclosed by Vermont companies that use them. In the future, the State of Vermont will decide whether to ban these substances. In addition, a new committee on emerging chemicals of concern has been. Among other things, this committee will look at the impacts of new TSCA regulations. Commissioner Schuren noted that government typically acts in reaction to crises, but the Emerging Chemicals work group will help the State to be more proactive before crises arise.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- Industry must see green chemistry, engineering, and design as smart business strategy.
- Educators must teach about green chemistry.
- Funders must support green chemistry efforts.

Key Drivers for Safer Chemicals and Products:

- Liability from exposure to toxic chemicals in the environment.
- Potential for tarnished reputation.

Role for the GC3 in Helping to Advance Green Chemistry in This Area:

- Bring all stakeholders to the table – including policy makers, government, businesses, and NGOS—to resolve issues.

May 26th, 2016

KEYNOTE IV

John Replogle, Seventh Generation

Mr. Replogle opened his keynote address by summarizing challenges facing society in the 21st century such as growing population, dwindling resources, and skyrocketing pollution. Seven-hundred pounds of chemicals are released into the environment every second, and out of the 80,000 chemicals currently in commercial use, only a few hundred have been fully investigated for their toxicity. Mr. Replogle mentioned the "dark side" of capitalism, linking GDP growth with increased fossil fuel usage. Yet the solution to all of this lies in business – one of the most powerful forces on warth. Encouragingly, more and more businesses are shifting their thinking to the triple bottom line of people, profit, planet as opposed to profit alone. Benefit (B) Corporations such as Seventh Generation are now looking to maximize long term shareholder value and not only short term profitability. Mr. Replogle discussed Seventh Generation's four aspirations: 1. Nurture Nature 2. Enhance Health 3. Transform Commerce 4. Build Communities. Seventh Generation hopes to head a new push for "conscious capitalism" and a better way to do business. Going forward, Seventh Generation will be following five key points for growth: 1. Do no harm (use benign chemicals and formulations) 2. Start with nature in mind (Biomimicry) 3. Practice science led by the heart 4. Do more with less (recycled components) 5. Forge coalitions of the willing (to collaborate and share information).

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- Companies should be competing not only to be the best *in* the world, but the best *for* the world.

GC3 PROJECT BREAKOUT SESSIONS:

Mainstreaming, Communication, Education, and Innovation

1) Mainstreaming Green Chemistry

Facilitator: Joel Tickner

This discussion group focused on concrete government and market policy activities that would serve to accelerate adoption of strategies outlined in the GC3 Agenda to Mainstream Green Chemistry.

Joel Tickner presented a summary of the Sustainable Chemistry R&D Act that was not successfully included in the TSCA reform language. These provisions could become a set of government support elements that GC3 could advocate for moving forward:

- **Support for sustainable chemistry research, development, demonstration, technology transfer, commercialization, education, and training** through grants, partnerships, loans, prizes and interagency collaboration
- **Developing methods for federal government to create incentives for sustainable chemistry**, including funding technical support, etc.
- **Expanding the education and training** of students and professionals
- **Collecting and disseminating information on sustainable chemistry research, development, and technology transfer -- barriers and opportunities**
- Supporting (including through technical assistance, participation, financial support, or other forms of support) **venues for outreach and dissemination of sustainable chemistry advances**
- **Developing metrics** to track the outputs and outcomes of the Program

The core question that guided the discussion was what actions are needed that GC3 could support to advance the cause of green/sustainable chemistry, particularly on the policy front.

Discussion revolved around the following ideas:

Engage with Federal Agencies/Congress:

- Compile a list of federally available funding opportunities and incentives (such as tax incentives, international tariff support) for GC3 members, including non-traditional green chemistry funders such as USDA and Department of Energy. Use this list to publicize green chemistry within federal agencies that may have money for adjacent efforts and educate them on the potential linkages.

- Organize a Green Chemistry 101 training for key policy-makers and their staff on the federal, state and local levels. This should involve Small and Medium Enterprises (SMEs) to tell powerful green chemistry business stories.

Engage More Effectively with Business Leaders to Build Support for Green Chemistry Actions and Policies:

- Engage C-suite leaders in a discussion about green chemistry, with a focus on long-term investment in research, development and adoption (a model could be business leaders convening internationally around climate change).
- Engage investment community leaders in discussions about the need for long-term investments in green chemistry solutions and the business case.

Engage New Constituencies in the GC3 to Accelerate Green Chemistry:

- Bring more value-chain players to GC3 discussions, perhaps through sector side-meetings along the lines of the Retail Leadership Council, and including new sectors such as the Auto sector.
- Find creative ways to educate supplier networks more effectively without changing the intimacy of the GC3 Innovators Roundtable.
- Expand usage of the Chemical Footprint Project to the same level as the Carbon Disclosure Project, increasing the environmental and sustainability interest of the investment community.
- Reach out to non-chemistry academic partners in engineering, architecture, business, etc., to identify champions.
- Think broadly about potential partners that can help leverage green chemistry's message to new audiences (similar to the climate movement's partners in the religious community). Suggestions include the American Sustainable Business Council, the B Corp Community, etc.

2) Communication

Facilitator: Amy Perlmutter

One of the GC3's five strategies for mainstreaming green chemistry is to Inform the Marketplace. This group discussed:

- communication-related actions that the GC3 could take to address any of the barriers described in its Agenda to Mainstream Green Chemistry;
- topics that members might like to know more about regarding communicating within firms, B:B, and B:C;
- research or experts that could be featured on a GC3 webinar or considered as part of a panel for next years' Roundtable.

Communication-Related Actions That The GC3 Could Take:

- Create incentives (cash reward, recognition, etc.) for GC3 partner organizations that work together to launch a new product based on green chemistry. This could be used to create case studies, and also provide evidence that the GC3 network is working.
- Collaborate with search engine sites such as SpecialChem, UL Prospector, and CleanGredients to include a special note for chemicals and materials that are green chemistry. This would be helpful for chemists and material scientists to search for materials based on desired properties.
- Automotive and healthcare represent the largest segment of the U.S. economy, however, they are not represented at the GC3 Roundtable. It is important to include them to have more purchasing power over the supply chain to adopt green chemistry products.
- Help consumers to understand the difference between "acute" and "chronic" health effects, as well as the difference between "exposure" and "risk."
- The "Dr. Oz effect" can be huge- when he says something, people listen. What trusted expert(s) can the GC3 approach to talk about green chemistry?
- Educate journalists and other media experts about green chemistry issues and messages.

Topics You Would Like to Learn More About Regarding Communicating Within Firms:

- There are numerous labels and it generates a lot of confusion to firms and their consumers. Labels such as Safer Choice are not green chemistry, but are a step in the right direction. What are the positive or negative perceptions of the various labels and certifications in the green/sustainability space?
- Which terms have the most positive resonance with consumers: chemical-free, safer, sustainable, green chemistry, wellness, etc.
- Methods to communicate and spread sustainability and green chemistry concepts and awareness within a company.
- How to educate merchants and buyers about green chemistry within a company.
- How retailers and other companies can better communicate to the scientific/engineering community to highlight the product needs in the area of green chemistry, i.e. safer water repellants, safer wrinkle free chemicals, etc.
- How to inform people about the hazards of chemicals without scaring them.

Research or Experts That Could Be Featured by GC3:

- Research on consumer trends/preferences by the Natural Marketing Institute.

- Communicating about science, perhaps combining scientists and journalists/marketers on a webinar to explore the best methods to communicate technical and scientific results.
- A Roundtable session or webinar focused on effective communication strategies for green chemistry-related messages.

3) Education

Facilitator: Saskia Van Bergen

The education work group discussed its two major projects: Safer Chemistry Training, and the internship program.

Safer Chemistry Training:

The training has been edited so that viewers can watch the whole presentation or jump to individual speakers. Each talk also is ranked by the level of chemistry involved. Discussion focused on how to get more people using it, including those outside the sustainability field:

- Sections have been added to the UW professional and continuing education Green Chemistry and Chemical Stewardship certificate program.
- The training has been added to a few websites and mentioned in the GC3 innovation portal when people ask for an education resource.
- A blast email was sent to Mrs. Meyer's Clean Day group.
- Could be referenced in an email when trying to educate others
- It should be pushed to new employees/interns.
- Highlight specific material to certain people.
- Link certain parts of the material to certain topics.
- Mark Mason (University Professor) hopes to link some of the webinars in the Fall to some of his courses).
- Are there any follow-up webinars that can be added?
- Push it through industry associations.
- Offer something to entice people to watch them.
- Send out emails as a campaign rather than just one.
- Tie the webinar/training to the innovation Portal so you can "ask the expert."
- People have the most time to do this kind of thing when they first start a job. How can we get to the new employees? A check-list might engage people more.
- Can the training become accredited for continuing education for LEED AP, Architects, Designers, occupational safety, etc.?
- Build collaborations with partners like Beauty Brains, UL Prospector, etc.
- Offer a certificate of completion to people who finish the training.

- Conduct proactive marketing for one or two webinars that can be used to remind attendees of other webinars.
- Continue the careers webinars of the past two years.

Internship:

Four internships are available for this summer. The number of student applicants went down from last year, though. How can this be promoted to students, especially outside of chemistry departments, and is this something that GC3 companies are interested in continuing?

- Many companies are looking for someone who is interested in being hired on full time after internships.
- Talk to companies to define what kinds of projects they do with an intern for a limited amount of time.
- Many graduate students in chemistry can't even take a summer internship. Would targeting the internships towards undergraduates make it easier to find applicants?
- Certain universities do allow summer internships for their traditional research-based graduate students (University of Toledo).
- It might be more beneficial to offer options for time frames.
- Send continued reminders to GC3 companies for next year's interns, especially late summer/fall.
- Offer externships.
- More understanding is needed for how the program works:
    - Integrating with current internships programs
    - What is expected
    - Logistics
- Use the Innovation Portal to promote internships.
- There will be more students in the pipeline over the next few years that have a green chemistry interest.
- The universities also tend to have corporate networks where they can place students for internships.
- Consider putting the focus on creating a network between universities and companies, rather than committing to an actual GC3 internship program.
    - Companies said they can find interns fairly easily but don't know what school can offer internships
    - Universities would list when the common hiring season is for their students' summer internships
    - GC3 as a passive participant rather than active
    - Need a metric and way to collect it.
    - Parameters for companies:
        - How many interns are usually hired
        - Pay range for internships

        - Skills sought
        - Date range(s) for internships
    - Parameters for universities:
        - Types of students looking for internships
        - Hiring season
        - Links to department websites
    - Parameters for students:
        - Availability (dates, hours, etc.)
        - LinkedIn profile link
        - Interests
        - Skills
- Use the matchmaking portal for full time jobs, not just internships.
- Send out a survey every year to all participants re: matches, hiring of interns, stories, etc.
- Better leverage LinkedIn?
- Create a community of practice—highlight interns each year, even if they are not technically GC3 interns.
- Show that internships help with a path to employment, especially if students have a diverse background (business, engineering, GC, etc.).

Additional Thoughts:

- Include green chemistry in ACS standard exams- its impossible to create green chemistry innovation without more people with green chemistry backgrounds.
- A stand-alone certificate might be a better option than making green chemistry part of the curriculum.
- Get a Khan Academy course in Green Chemistry.

4) Innovation

Facilitator: Monica Becker

This session largely focused on the Collaborative Innovation Project on Preservatives. The goals of the project (expanding the palette of safe and effective preservatives for personal care and household products, and creating an accelerated model of pre-commercial collaboration) were reviewed. Initial efforts resulted in the release of a need statement and development criteria by the companies involved in the project. This is being utilized by preservative suppliers to guide their preservative development efforts, and is serving as the foundation of the soon-to-be-launched open innovation competition organized by the GC3. Acting as the catalyst for this competition, GC3 is looking to bring brands, suppliers, and retailers together in a crowd-sourced open innovation challenge. Individuals and organizations in academia and industry will be asked to submit ideas for new preservative technologies, which

will be evaluated by a panel of judges, tested for efficacy and screened for safety by contract labs and risk assessors, respectively. GC3 is looking to cast a wide net, and not looking for a specific technology, so submissions in skincare, detergents, etc. are acceptable. InnoCentive will run the competition and make sure that participants' IP is not threatened. Suppliers will get access to the submissions after finalists are selected.

The new GC3 Green & Bio-Based Chemistry Startup Network was also briefly discussed. An inaugural event was held prior to the 2016 GC3 Roundtable with the goal of connecting bio-based startups to large companies, brands, and retailers to enable faster market adoption of green technologies. Each of the 10 participating startups gave a 5-minute presentation on their technology followed by networking. Suggestions to expand the event and evaluate its effectiveness were discussed, including asking the participating chemical and product manufacturers and retailers to present their needs at the meeting (a deeper look at the demand side), in addition to having start-ups present their companies, technologies and products.

SESSION VII

Safer and Better: High Performing Green Chemistry Solutions

Nick Brown, Nikwax
Michael Greene, Sappi
Ramaswamy Nagarajan, University of Massachusetts Lowell
Pam Eliason, TURI, University of Massachusetts Lowell *(moderator)*

This panel showcased three green chemistry innovations born out of entrepreneurship, industry, and academia. Mr. Brown, of Nikwax, demonstrated his company's hydrophobic down material for use in high performance outdoor water-repellent insulating gear. Traditionally, water-repellency has been achieved by using perfluorinated compounds, such as perfluorooctanoic acid, which are toxic and bio-accumulate when released into the environment.

Mr. Greene, with Sappi, discussed his company, a traditional paper manufacturer, and its collaboration with Sharklet Technologies, a company that has developed a new microbial resistant surface patterning technique. Based on shark skins, Sharklet is a patented microstructure to inhibit bacterial attachment and growth. By making use of Sappi's printing expertise, the microstructure is printed onto casting and release paper, which can be used to impart this microstructure to surfaces used in environments where bacterial growth should be minimized, such as hospitals.

Dr. Nagarajan of UMass Lowell showcased his research into bio-inspired flame-retardants. Many of the current flame retardants consist of either brominated or chlorinated molecules, which are environmentally persistent, toxic and often prone to bioaccumulation. His team found that extracting tannic acid from sequoia trees and coating it on nylon fibers provides safer, more environmentally friendly flame retardant properties.

KEY TAKEAWAYS

Opportunities for Safer Chemicals and Products:

- Opportunities for greener, more sustainable technologies can be found in areas as disparate as textiles, flame retardants, and hydrophobic coatings.
- Look at the whole lifecycle of a particular product and not just a single stage in order to make significant improvements.
- Nature often has a green solution that can be adapted.

Challenges for Implementation/Lessons Learned:

- Breaking into saturated, established markets can be difficult.

- New technology may require new standards and testing protocols to move it into the marketplace. For example, a primary challenge for Sharklet is the lack of approved testing protocols. Traditional tests for anti-microbial surfaces focus on killing the bacteria, vs. Sharklet technology, which resists bacterial growth.
- Market leaders attempting to extend the lifetime of their products keep greener alternatives out of the marketplace (ex. polymeric brominated fire retardants).
- Solving an environmental/safety challenge without sacrificing performance is key to bringing a new product to market.
- A new technology should simultaneously solve both a technical and an environmental problem.

Helpful Actions to Advance Green Chemistry (E.G. Policies, Education, Partnerships):

- Partnerships between academia and industry give early-scale academic research a much better chance to become commercial.
- Collaborations between unrelated companies, as in the case of Sappi and Sharklet, can lead to innovative solutions.

Role for The GC3 in Helping to Advance Green Chemistry in This Area:

- Connect start-ups and inventors to organizations farther down in the value chain.
- Consult with inventors in order to appraise the viability of their technology at an early stage.