SUSTAINABLE BUSINESS AND SAFER CHEMISTRY THROUGH THE SUPPLY CHAIN:
AN INNOVATORS ROUNDTABLE
NOVEMBER 14-16, 2005
CHARLOTTESVILLE, VA
CO-SPONSORED BY UMASS LOWELL AND THE DARDEN SCHOOL OF BUSINESS

INTRODUCTION

Chemicals – alone or in compounds - are the platform on which key elements of the global economy stand. These chemicals are incorporated into millions of products we use every day. However, as currently designed, many chemical compounds have inherently dangerous or environmentally damaging characteristics. As a consequence their use needs to be controlled or minimized to avoid harm to people who work with them throughout the supply chain, to the public exposed to the materials or products in use, and to ecological systems that cannot safely absorb or adapt to their toxins at end of life. Furthermore, for many chemicals now in the marketplace, we simply don't know enough to determine whether they are safe in the manner they are designed or in their use, nor do we know what alternatives might be safer.

The United States is a leader in chemicals management and innovative applications. However, U.S. chemicals strategy – in the private and public sectors – is falling behind the times. The primary federal chemicals management statute, TSCA, has not been revised since it was enacted more than 25 years ago. Newer information on chemicals, such as knowledge on low dose effects and vulnerable subpopulations (and the challenges of acting on the basis of uncertain knowledge) adds new challenges to federal chemicals management systems. Additionally, new solutions such as pollution prevention, design for environment, and green chemistry have, for the most part, not formed a central part of federal policy, receiving only minimal funding and policy attention.

The good news is that a growing number of companies are discovering on their own the benefits of green chemistry and Design for Environment, and are moving forward in transitioning to safer alternatives. This activity is being driven by a reduction in costs associated with the avoided management of toxic chemicals; labor and consumers' concerns about the potential impacts of chemicals on health and ecosystems; personal commitment from corporate executives; competition from other companies; and the need to comply with upcoming European chemicals regulations.

These drivers have created exciting opportunities for innovation, as well as competitive advantage for firms. In some cases companies are developing their own chemicals management tools and policies – however their efforts are limited by difficulties in determining which chemicals function as safer alternatives, finding suppliers who can supply safer alternatives, and by concerns about implying to consumers (whether true of not) that their former product was dangerous or that their safer product is lower quality.

How can innovation in green chemistry and design for environment be promoted and supported? How can businesses work with their suppliers and their end-users to promote the availability and demand for safer products and processes? How do we determine and prioritize the criteria on which to base the design and choice of safer alternatives? How can we more effectively address the continuing lack of available safety information on some chemicals, missing information on supply chain uses, and lack of understanding on material flows?

INNOVATORS ROUNDTABLE

From November 14-November 16, 2005, The Lowell Center for Sustainable Production at the University of Massachusetts, Lowell, and the Batten Institute at the Darden School of Business at the University of Virginia, brought together representatives from 50 forward-thinking companies, government agencies, academia and NGO's to talk about barriers and opportunities in the application of Green Chemistry design principles and safer chemicals selection by the private sector. Close to 70 people spent two and a half days discussing how they work within their companies, supply chains and with their customers to move away from suspect chemicals and toxicity and expand the demand for safer chemicals; the potential impacts of European chemicals policies; tools for choosing safer chemicals drivers of and barriers to innovation; and more. The Roundtable used presentations, panel discussions, and case studies to jump start discussions on these issues. While many questions were presented to participants, even more were raised during the discussions. The result was a lively conversation among leaders in the transition to safer chemical choices.

The objectives of the Roundtable were to:

- Discuss and recommend innovative practices and approaches to improve supply chain management of chemicals toward safer alternatives (and therefore safer products and less hazardous waste);
- Explore the ways companies currently manage chemical use within their supply chain, and the opportunities and barriers to the development and application of Green Chemistry and safer chemicals management throughout supply chains;
- Discuss and understand the forthcoming EU REACH regulation and the new Globally Harmonized System for classification and labeling of chemicals, and the impacts they are likely to have, particularly as incentives for innovation; and
- Identify opportunities and needs created by new chemical policies (state and country) and other core market drivers.

ENTREPRENEURSHIP, INNOVATION, AND SUSTAINABLE BUSINESS PRACTICES

Dr. Andrea Larson, co-organizer of the Roundtable and professor at the Darden School, discussed the relationship between innovation in chemicals design and use and capitalism's ability to adapt through entrepreneurial change. Drivers of innovation in sustainable business practices were discussed. These drivers include growing pressure from investors; the availability of practical guiding science-based frameworks such as green chemistry, industrial ecology and green engineering; expanding statutory requirements on the state, federal, or international level; heightened customer concern about product safety; pressure from employee and environmental health and safety groups; market shifts and resulting market opportunities; and new science knowledge about toxicity hazards. Acknowledging the companies present, she highlighted a key driver of change: innovative companies that view chemicals challenges as opportunities and are setting new standards by demonstrating operating and strategy gains through new practices.

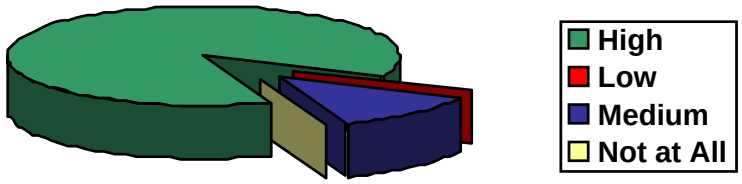
Dr. Larson discussed a useful way to view the economy and innovation - viewing the entrepreneurial sector as the innovation subset of the larger economy. Environmental and sustainable business activities happen within this entrepreneurial subset, representing an even smaller subset. Innovation is the tool by which entrepreneurs (individuals or firms, start-ups or within large corporations) exploit change as an opportunity for new products, processes, services, technologies, markets, and ways of organizing. Innovation centers on the causes, mechanisms, and effects of economic change; is a creative destruction of existing industrial and commercial patterns; and is a creative and adaptive response that leads to new products, services, technologies, markets, and organizational forms. Entrepreneurial ventures – whether within a company or between supply chain partners or between research, academic, or government institutions or others – move an idea through the steps it takes to test and prove the economic viability of that new idea.

Roundtable attendees, representing companies already making progress in green chemistry and safer alternatives, were described as being on the innovation edge of the economy, where break-through change is occurring around sustainability, and as entrepreneurs in a larger process of change. It is from this set of innovators who set new standards and demonstrate the business case that new processes and products are emerging to transition the market.

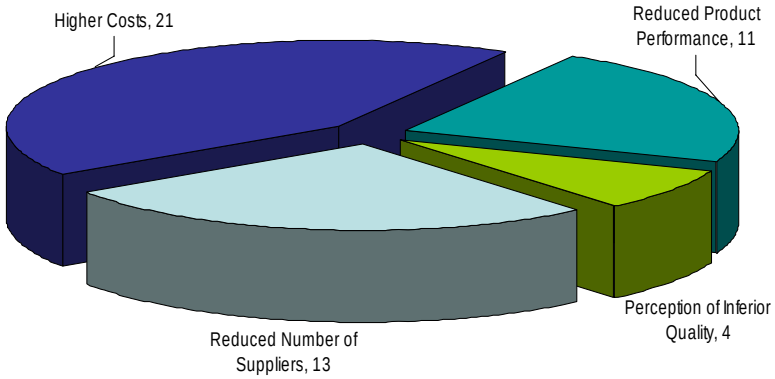
FRAMING THE ISSUES: DRIVERS OF CORPORATE CHANGE

Attendees were asked in advance of the Roundtable several questions about green chemistry considerations in their companies. Most placed green design as high in their company's corporate strategy. Drawbacks mentioned included higher costs, reduced number of suppliers, and reduced product performance. The major benefits from clean/green supply chain efforts were reported as being toxicity reduction or elimination, hazard reduction or elimination, customer retention or satisfaction, increased sales, cost and risk reduction, new customers, and new markets. Full responses are shown in the charts below.

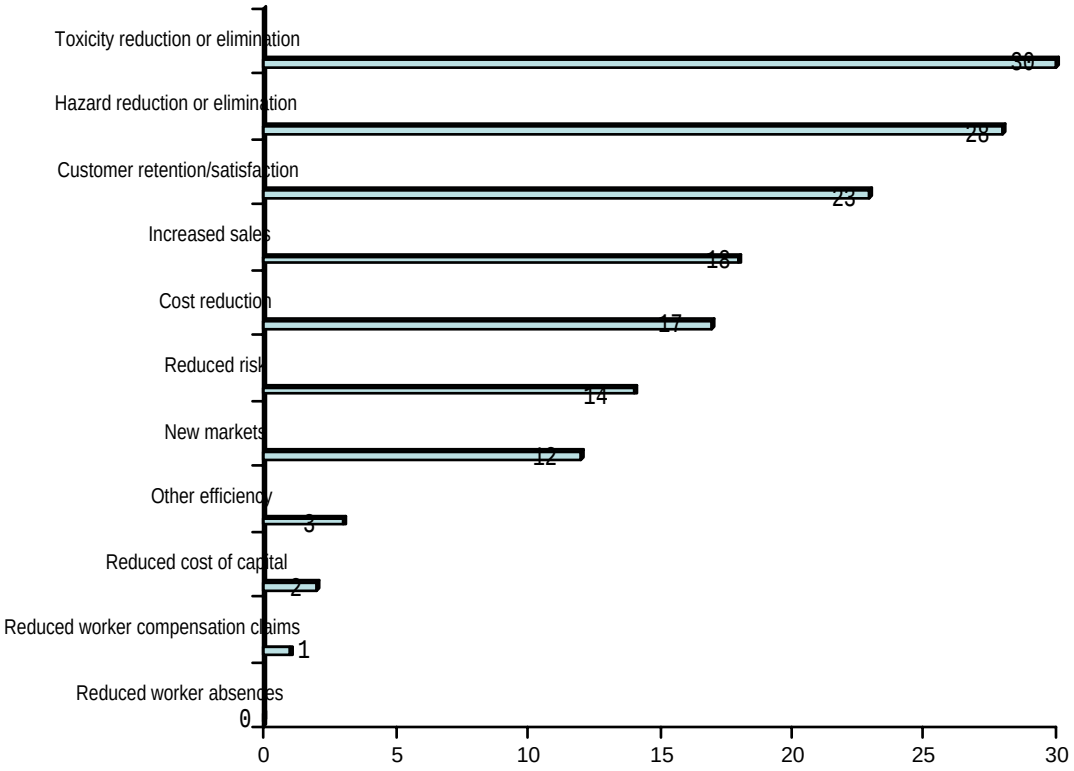
Importance of Green Design Topics in Your Company's Corporate Strategy



Drawbacks Related to Green Chemistry Innovations



Benefits from Clean/Green Supply Chain Efforts



Representatives from three companies were asked to reflect on their company's perspectives on innovation, drivers, barriers, and how and why their companies are approaching safer chemistry. Dr. Phil Lewis from Rohm and Haas, a chemical manufacturing company, provided a public health perspective and said there is no existing societally accepted framework to understand in a quantitative way what "safe" is, what level of risk we're willing to accept, or what the actual impact is of very low levels of chemical exposure. Consequently, we may not be regulating chemicals in the best way, and may be putting our money in the wrong places. Rohm and Haas has made a commitment to sustainability due to the personal values of their Board and management group more than the marketplace; it is not being driven by customer or investor demand. They would like to find a way to have the average person ask the right questions and think about sustainability when they purchase products and make investment decisions.

Roger McFadden of Coastwide Laboratories, makers of institutional and industrial cleaning chemicals, said, "When we innovate, we've got to be prepared to be called nuts." His company has made a corporate commitment to safer chemistry, in part because of increasing demand for safer products, but they are also finding cost savings due to lower insurance rates, lower risk and liability, and reduced costs for employee training and administrative management of hazardous substances and wastes. Within 5 years, all Coastwide products will meet specific sustainability guidelines. His perception is that market drivers have changed over time and that businesses are starting to embrace sustainability as a business strategy. He said many companies are "looking for a way to be more competitive and sustainable practices can help you build your reputation with customers." Mandates and the increased costs of raw materials and energy are helping businesses to make that change. He noted that businesses with sustainability principles are competing well in the Dow Jones Sustainability Indexes. What gets in the way of more innovation is

confusion about what is 'green'; the perception that 'green' products are too expensive and don't perform; lack of easy and affordable access to credible environmental, health and safety information about chemicals; claims from various companies about the real or imagined environmental aspects of their products that confuse consumers; and typical resistance by everyone to change of any kind. He concluded by saying that the process of change takes patience: "First they ignore the innovators and hope they'll go away; then they laugh at you and hope the humiliation will drive you away; then they fight and attempt to stop the new idea; and then they join together and change happens. We all need to join together to drive change."

Mary Ellen Mika from Steelcase, Inc., a designer and manufacturer of office furniture, pointed out her business is the opposite of the other examples: Steelcase's *customers* are demanding greener products. More than 80% of the requests for proposals from customers require environmental information about their products. Environmental issues have the ear of Steelcase's CEO and Board of Directors. And, in the last few years, the people working with suppliers at Steelcase, rather than just the environmental professionals, have started asking about issues relating to environmental properties. Steelcase is taking a closer look at the raw materials going into their components, which will allow them to do lifecycle analyses for various product lines. Getting information from their suppliers is somewhat of a barrier in this endeavor.

Roundtable participants raised a host of questions and discussed related issues: Who is the end-user: a retailer, the manufacturer who puts together the components, the person using the product? Who is asking or should be asking for design changes? Whose responsibility is it to educate consumers and suppliers? Why do internal forces in some industries, and external ones in others drive safer chemistry? How does timing affect the marketing of a product? How do you make something with the same performance characteristics and make it safer? Is it justified in some cases to sacrifice quality and performance for better environmental attributes? How do you get your suppliers to learn about safer chemistry and provide what you need? How should we define sustainability? How do you make designers feel excited about what they've achieved, but not disappointed because there's still further to go?

Companies want the consumer to ask for more sustainable products (which they do not generally do), but aren't sure they are the ones to educate them to do so. On the other hand, being better for the environment than a competitor's product can help a company differentiate themselves in the marketplace, while raising customers' awareness about environmental issues. Regulations will help push innovation, but companies will have to stay a step ahead of the regulations to keep themselves differentiated and competitive. Companies can lead or wait for regulations (which may be more constraining) or for the market to change. In the case of carpet, it took one company, Interface, taking the first step to change the way the industry competes and to raise awareness among suppliers, consumers, and the industry regarding environmental issues. In what other cases has being green helped a company become mainstream? What happened in those cases that made that transformation?

In terms of external drivers, if consumers and investors called for companies to focus on safer alternatives, then CEO's and company lawyers would certainly get behind the issues. Wall Street is starting to move in the direction of classifying environmental risk within certain industries. Sustainability and social responsibility are becoming part of the explicit fiduciary responsibility of boards. European and international banks, and recently leading U.S. banks, have incorporated environmental criteria into risk assessment for credit. There was agreement that companies that build this sensitivity into their business model and make it a competitive differentiation will have an advantage given current trends.

Companies also agreed that a product has to perform, it has to be of high quality, it has to be competitive in the marketplace, and it should protect public health and the environment. These parameters are not

mutually exclusive, but do need balancing. Roger McFadden said that for his company there are "Four Ps: Performance, People, Planet and Price. If you can balance these four, you can move the discussion away from green vs. non-green and towards a holistic approach around sustainability." From his perspective, "You can't innovate if you can't stay in business." In addition, while we need a common definition of what sustainability is, each industry must determine what sustainability means for them; one paradigm does not fit all companies or industries. However, while each industry has different issues, there are common themes among them. Studies have shown that sustainability adds to the bottom line if approached properly, but there is still a perception that the opposite is true. More study is needed about what happens to companies that don't act more sustainably.

A participant from Germany was surprised at the lack of discussion about the public sector role. He gave an example of Japan, where the Ministry of International Trade and Industry, MITI, said that cadmium could no longer be used by industry. MITI developed alternatives and gave companies money for research. It is an example of how non-regulatory public support can help move innovation.

GREEN CHEMISTRY AS A STRATEGY FOR THE FUTURE

Paul Anastas, Director of the Green Chemistry Institute, described green chemistry and its status. Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Green chemistry, as a framework for thinking about material choices, acts as a driver of innovation. It focuses on intrinsic (e.g., molecular design to reduce toxicity, safety from accidents or terrorism) rather than circumstantial (e.g., exposure, handling, treatment) factors in chemical design and processing. Green chemistry is solutions oriented and innovative—it redefines the problem and re-engineers systems; it allows for infinite adaptations to individual circumstances, and focuses on the goal, not on making the same mechanism work differently. Green chemistry has a high return on capital--it can return as much as 53% on capital, compared with a negative 16% when these changes are required by law. Recognized in the Nobel prizes in 2005, it is being practiced by top chemists in the world, and is on the agenda of the G-8 Ministers of Science. There is strong agreement among all sectors of society on the need to advance green chemistry.

There are twelve Principles of Green Chemistry:

1. *Prevention*: it is better to prevent waste than to treat or clean up waste after it has been created.
2. *Atom Economy*: Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. *Less Hazardous Chemical Syntheses*: Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. *Designing Safer Chemicals*: Chemical products should be designed to affect their desired function while minimizing their toxicity.
5. *Safer Solvents and Auxiliaries*: The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
6. *Design for Energy Efficiency*: Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
7. *Use of Renewable Feedstocks*: A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.
8. *Reduce Derivatives*: Unnecessary derivatization (use of blocking groups, protection/de-protection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.
9. *Catalysis*: Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. *Design for Degradation*: Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

11. *Real-time Analysis for Pollution Prevention*: Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. *Inherently Safer Chemistry for Accident Prevention*: Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

David Bott, Co-chair of the Steering Group for the UK's Crystal Faraday Partnership on Green Chemistry, followed by discussing the United Kingdom's cross government department approach to sustainability, Securing the Future. The government funded, through the Department of Trade and Industry and the Engineering and Physical Sciences Research Center (EPSRC), twenty-four Faraday partnerships, four of which focus on different aspects of sustainability: waste reduction, land remediation, biocatalysis, and green chemical technologies. The purpose of the Faradays is to:

- Promote active flows of people, science, industrial technology and innovative business concepts to and from the science & engineering base and industry.
- Promote the partnership ethic in industrially-relevant research organizations, business and the innovation knowledge base.
- Promote core research that will underpin business opportunities.
- Promote business-relevant post-graduate training, leading to life-long learning.

The green chemical technologies Faraday is called Crystal Faraday. Crystal Faraday is a partnership of the Chemicals Industry Association, the Royal Society of Chemistry, and the Institution of Chemical Engineers. Its purpose is to facilitate the uptake of green chemical technologies. Crystal Faraday has created a roadmap for green technologies and green product design, has held workshops and seminars, and worked with the EPSRC to secure further grant funding.

The results of these efforts have been mixed: The government's goals are good, and it has made an effort to stop "initiative overload." However, it needs a more delivery-oriented approach. The various trade associations and societies that represent the chemicals and chemistry-using industries are trying to work together, but, of over 3,000 chemical companies and the larger number that use chemistry, it is difficult to judge how many are engaged.

He analyzed the reasons for the mixed results using basic marketing principles about the diffusion of innovation: there are Innovators who will try new ideas; Early Adopters who are opinion leaders; the Early Majority who adopt new ideas just before the average people do; the Late Majority who approach innovation with caution and scepticism; and the Laggards, who are resistant to change. There is a gap between the Innovators and Early Adopters, who are likely to pick up new technologies, and everyone else. But there also appears to be a gap between the Early and Late Majorities. The Late Majorities need more of a push, and the Laggards need an even bigger one.

A phased approach should be used to deal with the different groups. Innovators will supply the new ideas and technologies; Early Adopters just need to be communicated with as to what is out there; the Early Majority needs standards from the government or their supply chain to be persuaded to make a change; The Late Majority needs legislation; and the Laggards will go out of business.

Bott indicated several lessons to learn from these efforts:

- This takes time
- Too many initiatives confuse everyone
- Consistency is really important
- You need to tell people what they want to know, not what you want to tell them

- You need to listen to every stakeholder you can imagine and then be prepared to discover there are more that you didn't
- The Force is with us!!

Roundtable attendees commented that there is a competitive advantage to those who think differently, and in bringing together sciences that don't traditionally work together. For example, biomimicry, or learning from and imitating how nature designs things—such as the way peacock feathers refract light to create color or the strength of abalone shells— provides stimulus for innovation. Innovation by accident must be replaced with innovation by design. Alternatives have to be thought of broadly. We can look to non-chemical as well as chemical solutions, such as lasers for cleaning applications. People don't buy "chemicals," they buy what the chemicals do, and there may be non-chemical ways to accomplish things. There is no reason to sacrifice quality for safer products—people still want performance and are willing to pay for it.

Making products that are safer takes a lot of work, and will have implications throughout all stages of manufacturing—the whole production system will be impacted. How can companies develop business strategies around green chemistry? They need to know what is possible, and what they can demand from their supply chain. Companies have to drive their supply chain so that both are less vulnerable, and the end-users are provided with new performance they may not have previously known was possible. Customers will also be exposed to less risk, which also reduces risk to the company. Innovations can be shared with other sectors. Good PR can be a by-product of this. One issue that was noted was the lack of technical (and "moral") support from government to companies that want to innovate. While the Department of Trade and Industry has undertaken the Faraday partnerships in England, no similar effort in the U.S. Department of Commerce exists. The US EPA's Design for Environment program has been seen as an inspiration to companies, but its efforts are necessarily limited by resources. Public sector involvement and investment is critical for research and development of safer products. While funding is necessary to develop new safer chemistries, it is equally important to how to process them. New chemistries will not be successful if they cannot be processed into products. Support is needed in both areas.

Companies have a big investment in the old way of doing things—how can the investment be driven towards green chemistry? This is particularly a challenge when thinking about resistance from within companies, such as legal affairs departments worried about liability. Further, getting these issues to resonate at the CEO/board levels is a challenge, though beginning to occur.

Change has to start with product developers. There is a need for strong research and development (which will vary from firm to firm and product to product) and collaborations inside of and across firms to move towards safer products. Champions need to defend that new technologies are more robust and reliable, cause less of a regulatory burden, won't cause product quality or supply problems, and won't lead to long-term liabilities (i.e., how much the real cost is of building "brown"). As old technologies reach their end of life, and as petroleum based products get more expensive, there will be more opportunity and incentive to move towards more sustainable technologies. But education is needed to get the next generation thinking about these issues. Innovation will happen. It is the only tool to beat commoditization. We are in competition with the developing world, where there is less embedded capital invested in old technologies. But there will be consequences to our economy if we don't push forward on innovation—there will be costs of lost business opportunities, as well as continued costs of cleaning up pollution.

How does green chemistry fit in where we don't have the information we need about hazards or risk? Green chemistry is a goal of perfection, but we won't reach it and shouldn't wait to do so. We should think about continuous improvement, and about design of new chemistries, processes, and materials, not

just substitutes. And how do we define safer without having the criteria or data to evaluate chemicals and exposure? All we can do is work with the best available science we have, and continue to drive the science.

OPPORTUNITIES FOR BUSINESS—THE ROLE OF REGULATION

Andrew Fasey, one of the lead authors of Europe's REACH—Registration, Evaluation, and Authorization of Chemicals—proposal, discussed the goals and details of REACH. The purpose of REACH is not as much to tell companies how to do things, which is typical of the way regulations have worked in the past, but to ensure adequate data is available to make reasoned decisions and spur innovation in safer technologies. While REACH will impose duties on companies, it has been designed to encourage substitution of dangerous by less dangerous substances and the use of safer substances and processes; this should act as a spur to innovation in safer substances and technologies.

REACH came about because the current chemicals management system is inefficient. There is a lack of hazard data for most substances on the market (only about 35% have adequate information available), the volumes & uses of most substances on the market are unknown and it is difficult to identify and address risks.

The objectives of REACH are to:

- Protect human health and the environment
- Maintain/enhance innovation/competitiveness
- Maintain the Internal Market
- Increase transparency and consumer awareness
- Integrate with international efforts
- Promote non-animal testing
- Conform to WTO obligations

It will provide a high level of health and environmental protection while achieving sustainable development.

REACH focuses first on high volume chemicals, and chemicals of greatest concern. It requires registration of substances greater than or equal to 1 tonne/year, evaluation of some substances by EU Authorities (the new EU Chemicals Agency supported by Member States), and Authorization for substances of very high concern. REACH is not a testing program; information required for registration of substances can be met in various types of ways. Under REACH, the system will say that a registration is complete; it won't say whether the information is adequate. Industry is responsible for providing and updating the information required.

The substance manufacturer or importer (on its own, in a preparation or in an article) is required to collect the required information, assess risk(s), implement/recommend relevant control measures, and send information to the new European Chemicals Agency by given deadlines, (depending largely on tonnage), and to provide certain of this information to clients. Consortia are encouraged to work together to supply information. It is likely that a shared data set will be required for all registrants of the same substance – 'one substance one registration' (OSOR).

Currently, manufacturers don't always know how their chemicals are being used. REACH will stimulate discussion on hazards and risks up and down the supply chain. Development of supply chain relationships and dialogues is key to the success of REACH. If a downstream user sees effects of a substance they were not told about by a supplier, they are required to pass that information up the supply

chain. If a manufacturer knows how their chemicals are being used, they can work with user companies to tell them how to do it safely. Industry is responsible for safe management of their materials. Downstream users may however keep information on their uses confidential if they wish to do so e.g., for business reasons.

There are several elements of REACH that are designed to stimulate innovation. Currently, regulations require higher levels of information for newer chemicals than older ones, which is a disincentive to create or use newer chemicals that might be safer. REACH treats all substances the same way, which will take away a barrier to development of new substances. Other regulatory drivers are exemptions on registration for product and process oriented R&D, higher volume thresholds for registration of new substances, lower costs of registering new substances, quicker registration than currently exists, and authorization being required for Substances of Very High Concern (SVHC's). The costs, time and uncertainty associated with Authorization will encourage the development and use of safer substances and/or processes that won't need to go through the Authorization process.

REACH's structural drivers make it more onerous to work with Carcinogenic, Mutagenic, and Reprotoxic (CMR) substances, persistent and bioaccumulative substances and other SVHC's. CMR's are prioritized for registration, and authorization is required for uses of SVHC's. Registration requires a data set (depending on production volume), risk assessment of uses, and identification of appropriate risk management measures (RMM). Industry will be required to demonstrate 'adequate control' of the substances for the uses in question through the use of appropriate RMM. These requirements, particularly the stricter requirements for SVHC's, will likely encourage the development and use of safer substances and processes and may lead to reclassification of substances/mixtures when better data is collected. Evaluation of particular substances is also less likely if they are less harmful than others. Better communication and information through the supply chain on properties, uses, and needs of customers will also encourage innovation, as well as efficiencies in data flow and chemical use.

REACH is not going to go away—it is moving through the European Parliament and Council and is expected to be in force by late 2006 or early 2007. Companies are already looking at their chemicals and making decisions about which they will register and which they will remove from the market. Companies need to start thinking about this now: EU importers of substances (on their own or in preparations or articles) produced by US companies will have to register substances they import, and ensure that SVHCs in products are authorized. Some substances that manufacturers use may no longer be available if the producers take them off the market as a result of REACH, so companies should start talking to their supply chains and consider alternative processes, substances, or suppliers.

Uwe Lahl, General Director of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety in Germany, added three points:

1) While REACH is a proposal from regulators, it is a modern, flexible instrument. Industry is responsible for policing themselves, but there will be repercussions if they don't comply.
2) Most of the data required by REACH for most chemicals should already be available and part of the dataset any responsible company would collect. However, REACH will help move that data to the user of the substances.
3) REACH is for today, and is useful for the future. It will be a driver of green chemistry. For example the collection of data on chemical properties will be very useful for designing more effective prediction tools that can be used in designing safer chemistries.

REACH'S OPPORTUNITIES FOR BUSINESS

Prior to discussion, two panellists provided their perspectives on opportunities provided by REACH and other state/country laws and proposals.

Jack Linard, from Unilever, said that Unilever's brands sell the promise to the consumer that they will deliver benefits in an ecologically and human health-friendly manner. They look at safety and environmental risk of products as they are being developed. If they do have to use a toxic substance, they use it in the smallest quantity possible. Unilever also performs environmental forecasts and views environmental protection as making strategic sense for their company. For example, the majority of Unilever's income is from food. They partnered with the World Wildlife Fund on marine stewardship, and are looking at sustainable tomato and palm oil farming that doesn't tear down rainforest. Unilever also has outside auditors monitoring what they do.

Unilever has gone on record in support of REACH, as well as a strong European chemicals agency that can understand the data and any gaps. They feel it will reassure the public that their products are safe, and will help them communicate with their customers. It will also simplify compliance by having one European standard. They have created downstream users groups to look at chemicals. They are also holding workshops in Europe to understand how to communicate with consumers and learn what consumers want to know. Various forms and parts of REACH are being proposed in the US, and Unilever may not support those if the essence of what REACH is gets lost.

Lothar Lissner of Kooperationsstelle Hamburg in the Department of Science and Health in the state of Hamburg, Germany said that REACH is overdue. Existing European regulations require the use of the least hazardous chemical, but this can't be done without adequate information. Small and medium sized companies need REACH to get information on substances. REACH will create more trust that safer chemicals are being used, and more knowledge by chemical suppliers and manufacturers about how their chemicals are being used. His group has undertaken numerous case studies and discussions on chemical substitution and found that there is a need for information tools and technical support.

Tod Arbogast from Dell noted his company's efforts to remove problem chemicals from their products, driven in part by NGO pressure and by regulatory demands. He noted that given the overlapping supply chains in the computer industry, one of Dell's goals is to distinguish itself from other competitors through innovation in cleaner and safer products. If that innovation can be achieved through supply chain efficiency and design changes, all the better.

The group discussed the pros and cons of legislation. There was some surprise that Unilver is so outspoken about policy change—many said their company restricted them from speaking out publicly on legislation. Some agreed that customer confidence is important, but that if the registration dossiers required under REACH are bad, then the law will not give consumers confidence. It was also mentioned that legislation can drive partnerships that may not have happened otherwise. In addition, the benefits of legislation have a broader impact than just where the legislation is in effect: companies will manufacture a product for a broader market, not just the region where it is legislated. Some companies felt that legislation like RoHS, Restriction of Hazardous Substances, which mandates changes, (as opposed to REACH, which is not a mandate) has an important role as well. Yet some companies felt that legislation may make it difficult to differentiate their products since all manufacturers would be required to comply. Others noted that legislation can set a minimum baseline for compliance and companies can go beyond this to differentiate their products.

Regardless of legislation, it is important that companies constantly look at how to optimize their supply chain and manufacturing processes. One company said that they changed their way of connecting parts and moved to a snap design in order to get rid of screws that were treated with hexavalent chromium. Companies also discussed that getting rid of toxins before being legislated helps differentiate them in the marketplace.

One key driver of legislation is the development and broader availability of data on chemical properties. There is likely already much data available through different sources, though distribution throughout supply chains and society has been a challenge. Thus newly available data will allow greater understanding of safety and an ability to distinguish products.

The discussion moved to what companies need to support them in their efforts towards green chemistry. Partnerships with state and federal programs and agencies were mentioned, as was the need to have allies on the outside pushing the issues to help company advocates convince upper management, and educated customers to drive demand. Legislative change, particularly in Europe, is inevitable so the question is how best to prepare and innovate in safer products.

CASE EXAMPLES

Beth Rosenberg and Wendy Porter presented a case study of Interface Carpet and Fabric Company's efforts to reduce their environmental footprint in all aspects of manufacturing their products. After an epiphany about the environmental damage his company was causing, Interface's CEO, Ray Anderson, challenged his employees to make Interface a sustainable business. His vision of a sustainable business means not using or producing toxins, and not adding to the waste stream though either their production process or their end product. Interface's goal is to first do no harm, and then to actually be restorative to the earth. By changing the way they do business, Interface not only created change in their own products, but changed the way the carpet industry does business, and created competition around sustainability.

Interface has designed a system of Eco-metrics that allows them to measure the energy inputs and the waste outputs per yard of finished product so they can track their progress and see which areas to prioritize. From 1999 to 2005, in the Maine and Massachusetts plants, solid waste in pounds per yards decreased by 60%, and green house gas emissions were reduced by 78%. By their own calculations, savings through their waste minimization efforts in the 5 US plants in 2005 were 40 million dollars.

Interface's sustainability efforts fall into 3 categories: conservation/waste minimization, process changes, and product and chemical changes. Every employee receives sustainability training, emphasizing humans' negative impact on the biosphere and the range of things that individuals can do to make a difference. The training also encourages employees to be creative in problem-solving, stresses that anyone can make a contribution, and notes that even small changes have large impacts over time.

Conservation/Waste Minimization Conservation efforts include motion activated lighting, water conserving toilets, and removing bulbs from vending machines. They have also decreased their electrical lighting needs by painting walls bright white, which required looking for the white paint that reflected the most light. Everything that can be reused or recycled is, including wooden palettes, cardboard, bale straps, plastic bags and sheets, fiber waste, all metal, oils, newspapers and magazines. Tubes are reused and recycled. Paper towels from the rest rooms are burned as fuel. Waste wood chips from a nearby factory and yarn cones are also burned for fuel. They adjusted some of their machines to run more slowly, which made no change to production rates but saved electricity.

Process Redesign: Two examples of process design are reconfiguring of looms to produce less waste fabric, and redesigning the flow pattern of the water used in fiber dying. The latter reduced water use by over a million gallons per year, and saved $10,000 in water and steam costs.

Product Changes: Using polyester made from recycled soda bottles was an early initiative. It is more expensive than using virgin material, and the material has different properties from new plastic. Both the fiber making process and the dyeing process were redesigned to adjust to this. Another design initiative underway is engineering carpet tiles so that the backing can be separated from the front of the carpet and

then both can be recycled. The ultimate goal is not to be making material that needs to be recycled, but rather, to make materials that will behave like nature, and eventually degrade. Interface is pioneering a fiber from corn that will do that.

Finding safer chemicals is a challenge for Interface. They will not use ingredients that are considered toxic and/or harmful to human health, other organisms, and the environment, including carcinogens, mutagens, SARA313 toxic chemicals, clean water act priority pollutants, clean air act hazardous air pollutants, those that have aquatic or oral toxicity, etc. They not only screen ingredients against certain lists, but obtain scientific information about the ingredients and/or mixtures that address the criteria they have established. They feel this process allows them to make decisions based upon affirmative information about chemicals based on the best science available today. It also severely limits the chemicals that they can use, and there are both good and bad consequences to that.

In order to ensure a supply of safer chemicals, Interface has developed a close working relationship with their suppliers. They have made internal changes so that suppliers can grow their business knowing that Interface will work with them in the long term. Interface saved over $300,000/year because of streamlining and standardizing cheaper alternatives. They sacrificed on design (such as limiting the colors they use due to replacing toxic dyes), but not on performance. Interface is working on implementing these programs while competing on a price level. Yet, Interface has faced resistance from chemical trade organizations who are arguing that their efforts represent a dangerous precedent.

The program has had an impact on employees throughout the company, who, in general, are proud to be part of the program and have noted that the work environment is better.

Interface faces several challenges. One of them is getting more information about chemicals (data collection systems), even with confidentiality agreements. Chemical suppliers do not always know what's in the dyes they use, and tests can be expensive. They need useful MSDS's and that means minimum standards for the people who prepare them. Another challenge is the lack of a coherent US chemicals policy that ranks toxicity so they know what to prioritize to phase out. Companies don't know whether a SARA 313 chemical is worse than a CA Prop 65 or a PBT is worse than an endocrine disrupter.

There are other policies that would facilitate Interface's sustainability goals:

1. Take Back Policy – will change the way products are made
2. Overhaul electricity generation and distribution so that there are incentives to produce energy from renewables.
3. Educate the public about sustainability – make it part of a core curriculum in schools, and have a certification on products that reflects the product's environmental footprint.
4. Give tax incentives to use cleaner production methods and renewables.
5. Recognize companies that are taking risks and doing the right thing.
6. End enormous subsidies for the oil industry – have a pollution tax.

Mark Rossi provided case studies of Herman Miller and Health Care without Harm's efforts in creating change in supply chains.

Herman Miller, a designer and manufacturer of office furniture, feels that designers can design better with more constraints—environmental concerns are not a barrier, but a design opportunity. According to Gary Miller, Herman Miller's Chief Development Officer, "Only by incorporating environment into design can we create value rather than cost."

Herman Miller has three components to their Design for Environment Program:

- Material Chemistry

- Disassembly
- Recyclability

The barriers they have faced in these efforts include:

- Collecting chemical constituent data for plastics, colorants and coating finishes
- Evaluating the hazards of a chemical.
- Eliminating materials that lack an easily identifiable and cost competitive alternative
- Integrating significant design changes into existing products

The company wanted to know what chemicals were in the materials they purchase, down to the parts per million, and turned to the McDonough Braumgart Design Chemistry company, MBDC, to help them evaluate their chemicals. They looked at the constituents in their product, and the toxicity, and make changes before a product gets to market. They also use this information in working with the supply chain.

Opportunities they see are:

- Investing in high quality design-- this pays off in the long run
- Addressing shareholder concerns
- Meeting customer demand

Health Care Without Harm is a non-profit that works collaboratively to make changes in the health care industry, and provides an example how a non-profit can help to make shifts in the supply chain. They create markets through

- Driving change in health care sector:
    - Chemicals & material selection, including PBTs, BFRs, mercury, phthalates, PVC
    - Chemicals policy
    - Waste disposal
- Targeting the supply chain
    - Manufacturers
    - Group Purchasing Organizations
    - Health care systems, e.g., Kaiser
    - Hospitals
    - Waste disposal
- Working with stakeholders
    - Nurses, doctors, purchasers, EHS staff, architects, designers, patient groups

Health Care Without Harm creates collaborative partnerships with major health care systems, GPO's, shareholders, and hospitals. They provide technical support, education, and confront market laggards.

John Frazier of Nike commented on the case studies by noting the challenges of instituting safer chemistry in products. The reduction of risk does not necessarily equal return on investment – at least in the usual ways in which ROI is often calculated within a business. Legislation is useful in propagating chemical restrictions, but legislation cannot be expected to address all of the needs identified by industry. To encourage greater focus on environment and health in materials selection, Nike is developing closer partnerships within the supply chain, has redefined its exposure and hazard scenarios, and is training suppliers and encouraging competition between them. He noted a critical need is better collaboration with chemical suppliers and other manufacturers to harmonize lists of chemicals of concern and tools for assessing safer materials.

Troy Brantley from AlphaGary noted the utility of regulations to push management to innovate in safer materials. He also noted the need to ensure balance between environmental sustainability and other

properties such as fire retardancy. Training and awareness of customers is also important to ensuring that they demand safer materials.

Adam Lowry of Method Products noted the need for branding to develop markets for safer products and to ensure education of consumers about these products such as their "People Against Dirty" campaign. There are three parts of entry for their brand: design/aesthetic, performance, and environmental attributes. A challenge for the company is gathering and prioritizing data to make informed decisions – how to screen, prioritize chemicals. They, too, have developed a small list of suppliers to ensure better up and down supply chain communication.

The attendees discussed some of the lessons learned in working with their supply chains and designing products:

- Smaller suppliers can be more nimble
- Work with fewer suppliers and establish collaborative relationships with them
- Bring in lawyers, designers, etc., early on
- Know what your values are to help prioritize efforts
- Educate up and down and within companies in the supply chain
- Create more constraints for suppliers
- Work with standards organizations
- Regulations can be a pain, but they can also help
- Look at the product lifecycle
- Position your product to get the interest of environmentalist ***AND*** those that don't think about environmental issues

TOOLS AND INFORMATION

People expressed frustration with how few chemicals are fully characterized and how little information there is. They don't know the best way to prioritize and make decisions on chemicals, and don't even know what a full characterization would be, or what the best format would be to present the information. Doing their own tests, especially for small and medium sized companies is expensive. REACH and GHS will be tools that will help, and EPA has some information on high production volume materials on the web. MBDC is building a database that will help companies evaluate risk in various uses. EPA has created a partnership with the furniture industry to look at health attributes of the materials they use, and this could be a model for other industries. EPA also has links on their Sustainable Futures website to websites with toxicology data. The Small Business Administration and department of commerce should also be involved in these discussions, to provide a focus on making industry successful and innovative. One question is how can EPA better accommodate the demand for action. Another suggestion was to work together to create a watch list of chemicals to share information on. There are some potentially interesting lists of chemical information out there – such as pharmaceutical studies for about 90,000 compounds. There is a question of whether that data is available for other companies.

The problem is bigger than government. Regulations alone will not change business culture. New business models are needed. State manufacturing partnerships and the EPA's Green Suppliers Networks represent some examples. The technology is there, but changes won't be made without a new way of doing business, without internalizing the cost of pollution that business as usual creates. Early successes are also needed to convince management to support change. And, an internal mechanism should exist within a company to make changes once those changes are identified. Yet, big change will not happen without CEO commitment, goals, and metrics and middle management support.

ADVANCING GREEN CHEMISTRY

Christine Murner talked about the Ecomagination program at General Electric, being driven by their CEO. The new corporate focus and tag line for the large conglomerate is "Imagination at Work" and Ecomagination is an example of this. Ecomagination's principle is that better technology is the answer to environmental challenges. GE has committed to double their research investment in environmental technologies, introduce more Ecomagination products and increase their revenue from these products to $20 million, reach a net 1% reduction in greenhouse gasses, make customers their true partners, and keep the public informed. To ensure implementation and measure achievement, GE is working to establish clear metrics to demonstrate progress, and salaries are tied in part to Ecomagination performance.

Tom Swarr discussed United Technologies environmental approach. Their efforts are also driven by their CEO, as well as a President's Council that sets goals. The objective is to drive corporate goals that lead regulatory requirements. They feel they do not need more information about toxicology to identify the priority needs for reducing usage of toxic materials in products. They have been able to minimize the impact of regulations, such as ROHs through good design practice, such as consolidating electronics into easily removed modules. In 2001 they created a goal to eliminate heavy metals and chlorinated solvents. Executive compensation is based in part on meeting that goal, but they haven't yet figured out how they are going to achieve complete elimination of the targeted materials. They start with the big items they use in large quantity and have enough information about, and then move to the things they know less about. They need both the discipline to use the information they already have to make things happen, and to continue to gather new information to answer new questions. It should be emphasized these goals are focused on uses that are not banned or restricted by regulations. Business managers are being pushed to voluntarily invest in replacements for perfectly legal materials with potential, but uncertain risks.

Ed Mongan, from Dupont, reported that DuPont has a top level commitment to sustainable growth, but is still working to establish metrics to track progress in this area. They have made a huge investment in compliance, recognize that going beyond compliance to demonstrate excellence in environmental stewardship is necessary to gain the public trust. Dupont is seeking to evolve their perspective from pollution prevention to product stewardship, incorporating a more holistic, life-cycle approach across the value chain. Their priorities are to deal with known hazards, exposure to those hazards and public perception around their actions. Much of their effort is now switching from facility based risks to product risks. A key is how to make management pay attention to avoid future problems. Having management teams with financial responsibility involved in sustainable chemicals issues is critical as well as metrics developed by a council of vice president's. Their global chemical management program has identified priorities and intra-company and stakeholder discussions have been important to staying ahead of the curve.

Buzz Cue, a former vice president of Pfizer Global R&D and founder of their green chemistry program, noted that his industry was driven primarily by making a product to enable people live longer and healthier lives. Now, with the recognition that many important human diseases have an environmental component, environmental concerns are quickly becoming important too. While the total amount of product produced is relatively low, the waste produced per unit of product produced may be the highest in the chemical industry. There are four key issues to consider in this business– speed to market, cost of R&D and manufacturing, quality of product, and balancing of risks. For every drug going to market as many as 50 are started and this yield is not sustainable as R&D costs continue to escalate. In the short term, while efforts continue to improve product candidate survival, some companies are delaying significant R&D investment until they have passed the point of most candidate attrition in their R&D timeline. This makes it imperative that a green chemistry mindset be adopted as early as possible in the product and process design R&D phase. Moreover, because of manufacturing and waste disposal cost issues, there has been a focus on integrating green chemistry concerns early in the R&D process along with other concerns such as product purity and yield. Senior leadership support in the firm is critical to

succeeding in this change process. He also noted that while there are environmental regulations for the pharmaceutical industry, the FDA is the main regulatory body for them. He expressed the belief that a quick route to change would be to have the FDA adopt Green Chemistry as an expectation.

A comparison was made between the product industry and the pharmaceutical industry. In the pharmaceutical industry, FDA sets standards, investments are high, and the perception is that making continuous improvement carries high risk because of the need to revalidate that the change has no negative impact on patient safety or product performance. Partnerships with suppliers are essential in developing products and to knowing how the supplier is making their raw material to ensure changes do not adversely impact product quality at very low analytical levels (<0.1%). Most pharmaceutical companies are adopting green chemistry as a partnership between environmental health and safety and R&D and manufacturing chemists and chemical engineers. Some of the opportunities include increasing bioavailability of drugs so that not as much is needed, and how to increase the degradability of the products once they enter the environment. They need more trained green chemists from academia, and an agreed upon set of metrics on what it means to be 'green.' And, they need to interact with people from other parts of the chemical industry to learn how they are approaching similar problems. This is especially true for technologies that are new to the pharmaceutical industry such as process analytical chemistry, flow reactors, catalysis and biocatalysis and separations. Many of these technologies are common practice in the rest of the chemical enterprise. Culture—corporate, public, or otherwise—can be used to facilitate change, or it can be a barrier.

BETTER SUPPLY CHAIN MANAGEMENT THROUGH IMPROVED CHEMICAL KNOWLEDGE

Several tools and initiatives designed to compare and advance safer chemistries were presented and discussed in detail.

Globally Harmonized System of Classification (GHS)

Andrew Fasey discussed the GHS, a United Nations initiative, which is an approach to defining, classifying and communicating information on chemical hazards; it is not a testing system. The target audience for GHS includes consumers, workers, transport workers, and emergency responders. The benefits of harmonization include enhancing protection of humans and the environment, facilitating international trade in chemicals, reducing the need for duplicate testing and evaluation, and assisting countries and international organizations in the sound management of chemicals.

GHS covers all hazardous chemical substances and mixtures, excluding those in pharmaceuticals, food additives, cosmetics, and pesticide residues in food (except where workers may be exposed and in transport). It classifies information by health (toxicity, skin or eye irritation, carcinogenicity, etc.), environmental (such as aquatic hazards) and physical (explosivity, reactivity, corrosiveness, flammability, etc.) impacts, and communicates this through labels and safety data sheets. The labels include agreed upon terms, statements, and pictograms regarding the product, supplier, chemical identify, hazard, and precautionary information.

The UN Economic and Social Council (ECOSOC) has overall international responsibility and oversight of the GHS. The role of the UN Sub-Committee of Experts on GHS (UNSCEGHS) – an ECOSOC committee – is to

- Make the GHS available for worldwide use and application
- Make guidance available on the application & implementation of the GHS
- Prepare work programmes and submit recommendations to the committee
- Develop and improve the GHS

In the EU, GHS will be adopted at the same time as REACH. Canada is fast-tracking GHS and it will be enacted by the end of 2005. In the US, EPA, OSHA, DOT, the FDA, and the Consumer Products Safety Commission are all working on GHS, although no one is coordinating these efforts.

The link to GHS: http://www.unece.org/trans/danger/publi/ghs/ghs_rev00/00files_e.html

Greenlist

Dave Long from SC Johnson talked about his company's Greenlist. Greenlist is a process that they use to evaluate, from a biological and ecological standpoint, chemicals they typically use in products. It is a patented, flexible process. SC Johnson is considering licensing it to companies that could use it with their own criteria. Greenlist sets 4-7 unique criteria for 6 categories of their highest volume chemicals. They are given an EC—environmental criteria—score of 0-3 based on the above. A zero score means a materials use is restricted. Greenlist is embedded into the decision-making process for products. SJ Johnson also works closely with their suppliers to develop products with superior environmental health and safety (EH&S) profiles, and shares EC rankings with their suppliers. Dow chemical is one of their big suppliers, and they look at total solutions, not just substitution.

SJ Johnson is lucky to have extensive R&D and EH&S resources that allow them to evaluate performance of materials. They never change a product based strictly on environmental criteria; a product has to meet cost, performance, and environmental health and safety concerns as well. However, any use of a high priority substance in a product requires a senior vice president's approval and an exit plan for that substance. Thus, by involving research and development the entire company is bought in to the process.

Greenlist is a priority for upper management. SC Johnson's Chairman has made a commitment to reducing the footprint of the company. He sets goals with the company management, and pay is tied to the meeting of these goals.

Cradle to Cradle Materials Assessment Protocol

Jay Bolus from MBDC discussed the MBDC tool, which is used by numerous companies. The tool ranks various aspects of a chemical, and then gives it an overall profile and color ranking of red, yellow, or green. Lifecycle thinking goes into the tool—it takes into account who is exposed and where exposure happens, but it is not a lifecycle analysis. The tool considers mixtures and content of products as well.

Green Suppliers Network

Tom Murray from EPA discussed the Green Suppliers Network. They work with companies through manufacturing extension partnerships to assist small and medium sized manufacturers in working with their suppliers and open lines of communication. The Green Suppliers Network serves as a delivery system for EPA'S and other green tools.

EPA Sustainable Futures Program

Clive Davies summarized EPA's Sustainable Futures program. Sustainable Futures is intended to make the toxicological tools and models developed by the EPA to support implementation of the Toxic Substances and Control Act (TSCA) more broadly available. EPA provides training on how to use the models, and provides technical assistance to companies that use the tools. Sustainable Futures is housed in the Office of Pollution Prevention and Toxic Substances (OPPTS).

The EPA Design for the Environment Program (DfE) uses OPPTS tools in partnerships with a broad range of stakeholders. A major focus of DfE partnerships is the conducting of alternatives analysis.

The DfE Furniture Flame Retardant Partnership helped guide industry toward safer flame retardants for polyurethane furniture foam through an assessment of toxicity and performance of alternatives in a multi-stakeholder discussion. The industry used information from the partnership to move to safer alternative flame retardants.

The DfE Formulator Program, works with partners to reformulate products to be environmentally safer, cost competitive, and effective. By making chemical and toxicological information available in an understandable format and suggesting safer substitutes, the Formulator Program has been able to reduce an estimated 40 million pounds of chemicals of concern in 2005 through recognizing industry partners that take action to make more health and environment-friendly formulations through continuous improvement in product design.

As part of the DfE Formulator Program the Safer Detergents Stewardship Initiative will provide broad recognition for companies who move toward safer surfactants and eliminate use of nonylphenol ethoxalates (NPE's). NPEs are aquatically toxic and degrade slowly to increasingly toxic products.

DfE Green Formulators Initiative and CleanGredients

Lauren Heine and Tarek Rached from the GreenBlue Institute described this tool. The goal is to have a one-stop database of institutional and industrial cleaning products and their characteristics. Rather than saying what's 'green,' it will give companies information about properties of different substances—it will provide flexibility to company needs and interests. Suppliers are submitting physiochemical information and testing data into the database, and formulators can search for physical properties. The goal is to harmonize this with GHS. It will be a one-stop place for information that is provided in a consistent format, and a way for suppliers to communicate with formulators and access EPA DfE services.

COMMON THEMES

In addition to many questions, common themes came up throughout the meeting that fall into ten broad categories:

1) Green Chemistry is here to stay

- It is being practiced by leading scientists.
- It is on the agenda of G-8 ministers of science.
- Green/performance/quality must go hand in hand—i.e., zero and low-toxicity should be performance attributes.
- Green chemistry is happening, and it is passed the tipping point. The best ways must be found to advance its integration in education, funding, and agency priorities.

2) Innovation around green chemistry and safer alternatives are good for business

- These approaches protect corporate reputation.
- Innovation and green chemistry can expand market share.
- Competitive advantage can be established when business takes a fresh approach.
- Green chemistry practices reduce the high costs of regulatory compliance, insurance, haz mat management, administration, and workers comp.
- Use of safer substances offsets sometimes higher or unpredictable costs of energy intensive chemicals and processes.
- Innovation and use of green chemistry creates consumer confidence.
- Companies can either lead the market and differentiate themselves in the marketplace, or react to the market and follow.

- If companies wait for regulation, they can lose a competitive advantage. If companies are already doing it, regulation is not as burdensome as there is less to regulate.
- A combination of drivers is critical for stimulating and directing innovation.

3) Moving to safer alternatives is a continuum

- Continuous improvement occurs as more is learned.
- Change takes time and needs a high level commitment.
- It's not always possible to wait for completed information before making changes in processes or materials.
- When standards are set high, innovation is ongoing.
- Non-chemical alternatives (lasers, snap designs, reducing numbers and types of materials) can be equally effective. Businesses must assess their goals and look for total solutions, not just designing of substitutes.

4) Companies can't be environmentally sustainable if they are not economically sustainable

- People will pay for increased product performance, but not necessarily for a "green" product.
- Businesses must find the right balance of people, planet, performance, and price.
- Firms can't lead the way or change the market if they can't stay in business.
- Sacrifice of quality and performance for environmental attributes is not an option.

5) Change is happening due to a variety of drivers

- Some are internal while some are external, depending on the market.
- Regulation.
- Consumer demand.
- Investors.
- Stockholder petitions.
- CEO leadership.
- Fiduciary responsibility.
- Suppliers.
- An industry leader driving competition, such as Ray Andersen.
- Standards, such as LEED, which has changed the building business.
- There is a cost of being 'brown'.
- Good PR and brand enhancement opportunities.

6) Barriers still exist

- There is a lack of common agreement regarding the definition of safe/safer.
- There is a lack of agreement of how to weigh issues once they are defined.
- In some cases, there is a lack of sufficient demand by shareholders, the company itself, consumers, or retailers.
- There may be internal corporate resistance to these ideas.
- A general resistance to change may exist from suppliers through manufacturers and end-users.
- Information on chemicals and their environmental, health and safety impacts and risks from different types of exposure (air, water, etc) is lacking, while available information is not always in useful formats or consolidated. There is a need for better tools.
- The range of possibilities in a situation is not always known.
- Historic green-washing has confused consumers and made them skeptical.
- There is a lack of suppliers with know-how in these areas.
- Companies and consumers are unwilling to pay more for a product or service.
- Firms have a fear of liability after a history of making products later found to be toxic.

- Negative perceptions exist about the merit of "green" products, materials, or processes.
- There's no broad agreement of interpretation of scientific data, and there needs to be a standardized approach to avoid differences of judgment.
- Data and tools to gather data on toxicology and unintended consequences is frequently missing.

7) Partnerships and collaborations are key

- There needs to be cooperation within supply chains. Producers need to find suppliers who are nimble and work with them to develop products, identify product composition, and create market for their product.
- Supply chains need to work together to drive change.
- Cross-sector partnerships will help drive solutions and disseminate innovation.
- Sharing information will reduce costs for individual firms.
- Businesses must develop common tools, approaches, and criteria by which to measure.
- Companies should set goals and be accountable to the public.
- Businesses could partner with a leading customer and develop synergies.

8) Education is needed on all fronts

- Investors, corporate leaders, consumers, suppliers, retailers, regulators, environmental advocates, etc all should learn about the issues.
- Discussion is needed about whose job is it to educate whom, and how that education should be done.

9) Government is a resource

- State and federal agency programs can help to define standards, create and disseminate tools, assess alternatives, and stimulate dialogue and new ways of thinking about problems.
- Regulation will move lagging businesses forward in innovating toward green chemistry.
- EPA, Department of Commerce, Department of Justice, and others are potential resources that should be more fully explored.
- Government is currently under-utilized as source of support.

10) Actions are needed

- More data and information about chemicals and alternatives, risks, and hazards is needed in a usable format.
- More information about the business case for safer chemistry, including implications and costs of inaction, is necessary.
- Barriers can be overcome with more information to and from all players.
- Science is critical to define data on hazards and risk of exposure, and to provide new information on alternatives and green chemistry advances.
- Results need to be presented in a standardized way.
- Data should be presented as is, and companies should decide on this data based on their values.

MOVING FORWARD—CRITICAL ISSUES AND NEEDS

Roundtable participants broke into small groups to discuss key issues more in depth and identify next steps in addressing them. Recommendations from the groups include:

Partnerships

- Find a champion/facilitator/owner
- Develop an inventory/model

- Perform a needs assessment
- Identify gaps/roles
- Create tools/guidance for engaging
- Work with industry sustainability sub-committees.

Tools
- Develop Idiot's Guide to Life Cycle (LC)
- Define LC thinking
- Create a Tool Department/Tool Boxes
    - List tools
    - Purpose
    - Users
- Involve Decision-makers
- Develop process flow chart to direct user to appropriate tools
- Get grad students involved
- Assess if identified needs are being met
- Develop a consistent transparent toxicity screening tool
- Develop a database populated with toxicological and environmental data (GreenBlue project)
- Compile list of modeling tools and evaluate them
- Implement GHS
- Develop list of performance criteria by industry sector—example: standards of performance testing for cleaning hard surfaces
- Develop guide on assessing alternatives- hazards, risks, process; flow chart element
- Assess tools for evaluating bio-based materials

Stimulating Innovation
- Link safer chemicals/green initiatives to profitability—make it real to business leaders
- Create opportunity for innovation
    - Publicizing and recognizing innovators- formally or informally
    - Networks across organization
    - Diversify (functions, customers, etc)—working groups that include customers, departments don't normally include; recruit people that think differently
    - Engage unconventional stakeholders—NGO's, government, industry groups
    - Forward looking customers,
- Base consumer awareness on performance, with green aspects secondary
- Use Green Tools to drive business cause (ROI)
- Define/discuss implications of inaction

NEXT STEPS

This meeting was seen as a starting point and, as the discussions unfolded, it became clear that the majority of participants wanted to keep the conversation going beyond this event and focus on next steps. The next steps suggested include:

Create a website that:
- Lists tools/databases of chemicals
- Lists company chemical restrictions
- Has information from the Roundtable
- Links information and tools, intern and job opportunities, resources, etc.

Increase the use of DfE
- Show and continue support for DfE programs

- Strengthen relationship with DfE/Chemical manufacturers
- Leverage DfE with other environmentally friendly programs
- Standardize green criteria

Hold a follow up meeting
- Set up work groups for specific problems—refine ideas
- Form ongoing discussion group
- Bring one or more suppliers to the next event
- Compare notes in 9-12 months and see if we've made any progress
- Organize a follow up meeting to have more discussion time
- Bring in company non-believers
- Involve more students
- Keep diverse group
- Get more in depth into certain subjects
- Identify cross-industry issues that can be worked on as a group
- Get a work group together with EPA to pull together all tools and demonstrate them at the next meeting.

Expand Education
- Keep the Darden/UMass link between business and chemistry
- Identify student internship opportunities
- Integrate green chemistry in business classes
- Convert unbelievers to believers

Support Government
- Voice support for EPA's efforts to create and promote tools to support green chemistry and DfE efforts by businesses

UMass Lowell agreed to put information about Tools, the Roundtable, and other links on their website, www.chemicalspolicy.org, and to facilitate follow up calls and conversations. A group of participants agreed to participate on a committee to plan a follow up meeting and some of the next steps. Based on evaluations from the Roundtable, a next meeting should consider:

- Topics: transparency vs. confidential business information, more detailed case studies and examples of innovation, focus more on actions and moving forward rather than barriers, more 'how to's' on the value added of environmental benefits, more about supply chains, more discussion on strategic innovation, more about tools—identifying needs and filling them.
- Structure: have more small group discussion
- Discussion: should take into account the diversity of the audience's industries, have discussion more action oriented around next steps.
- Participants: include more NGO's, manufacturers, or EU industries. Bring more marketing people into the group whose job it is to promote ideas

CONCLUSION

There is a strong interest by these innovative companies in working together within and across sectors, products and materials to move forward and expand the market and tools for green chemistry and design for environment. These companies are on the cutting edge of innovation around safer alternatives, and are not afraid of upcoming legislation like REACH. In fact, they are ahead of legislation in moving towards safer products and processes.