



# Green Chemistry & Commerce Council

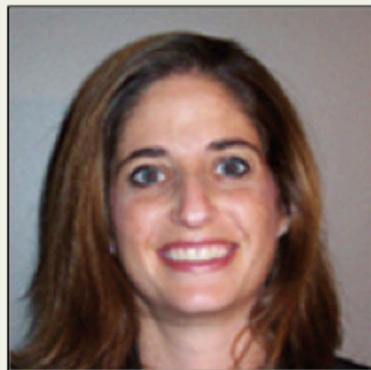
Moving Business Toward Safer Alternatives

## *GC3 Green Chemistry Innovation Webinar Series*



December 12, 2013

### **Advancing Green Chemistry Innovation in the Pharmaceutical Industry: The GCI Pharmaceutical Roundtable's Research Grant Program**



Julie Manley, Guiding Green LLC & Coordinator of the ACS,  
Green Chemistry Institute's Pharmaceutical Roundtable

# Webinar Discussion Instructions



- Due to the number of participants on the Webinar, all lines will be muted.
- If you wish to ask a question, please type your question in the Q&A box located in the drop down control panel at the top of the screen
- All questions will be answered at the end of the presentation.



**Advancing Green Chemistry Innovation in  
the Pharmaceutical Industry:  
*The ACS GCI Pharmaceutical  
Roundtable's Research Grant Program***

**Julie B. Manley  
Guiding Green LLC**

**Contracted by the ACS Green Chemistry Institute®  
Green Chemistry & Commerce Council  
Webinar**

**December 12, 2013**

# Additional Webinar Participants



Michael Kopach, Principal Research Scientist, Eli Lilly and Company



Daniel Richter, Principal Scientist and Green Chemistry Lead, Pfizer La Jolla



Robert E. Maleczka, Professor and Chair of the Department of Chemistry, Michigan State University



Neil K. Garg, Professor and Vice Chair for the Department of Chemistry and Biochemistry, UCLA



Wei Zhang, Professor and Director of the Center for Green Chemistry, University of Massachusetts Boston



Asha Kadam, PhD Candidate, University of Massachusetts Boston

# Objectives

Demonstrate how the ACS GCI Pharmaceutical Roundtable catalyzes Green Chemistry innovation through the ACS GCI Pharmaceutical Roundtable Research Grant Program.

- Background
- Aspects of the Program
- Accomplishments
- Learnings

Share experience from the stakeholder perspective

- Representatives from member pharmaceutical companies
- Grant recipients
- Students

# ACS Green Chemistry Institute®



*To catalyze and enable the implementation of green chemistry and engineering throughout the global chemical enterprise.*

- **Science**

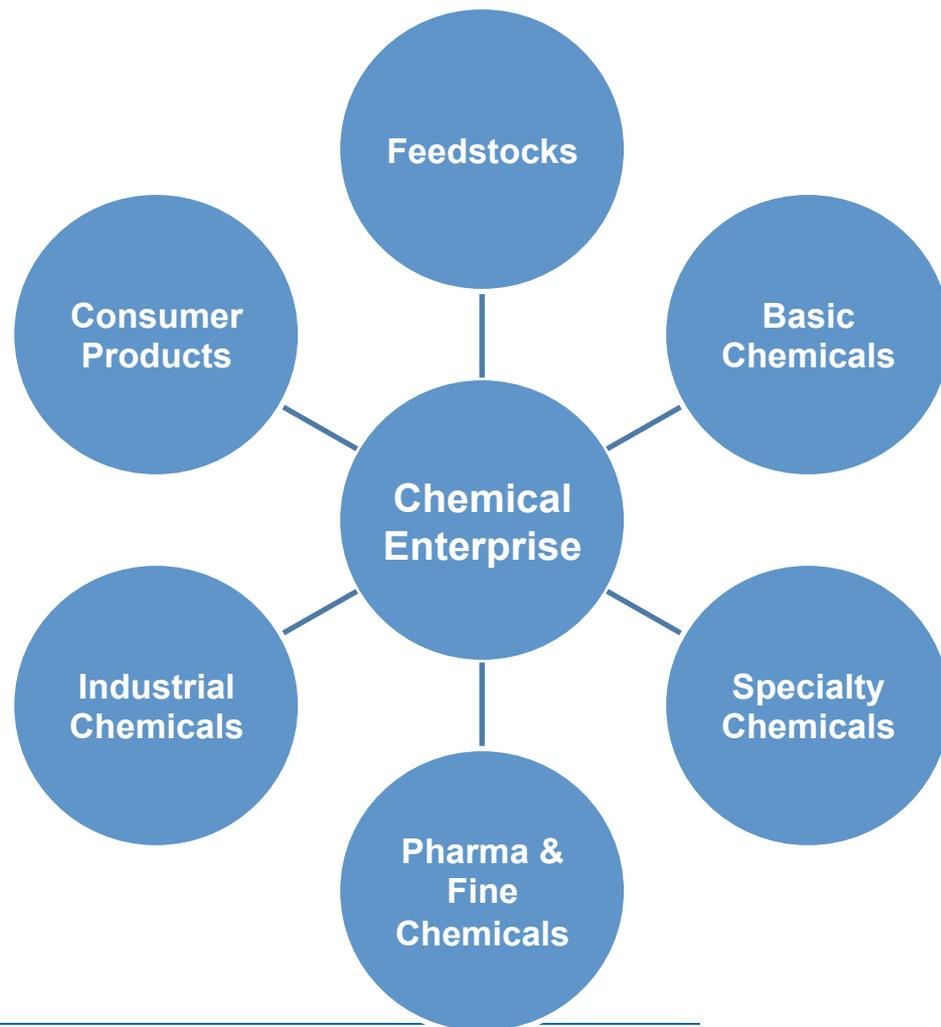
Advance research & innovation for global challenges

- **Education**

Advocate progress and communication of the principles of GC&E

- **Industry**

Accelerate the industrial adoption of GC&E



ACS Green Chemist

*Not an actual depiction of the ACS GCI Roundtables*

# Co-opetition enables the greening of the supply chain

- Companies in the same market work collaboratively;
- they explore new ideas to advance scientific knowledge and research new products;
- they simultaneously compete for market-share;
- and exploit the new knowledge in different ways.



# The Foundation of a Roundtable

**Non-Competitive**

**Consensus  
Driven**

**Member Governed**

**Value Oriented**



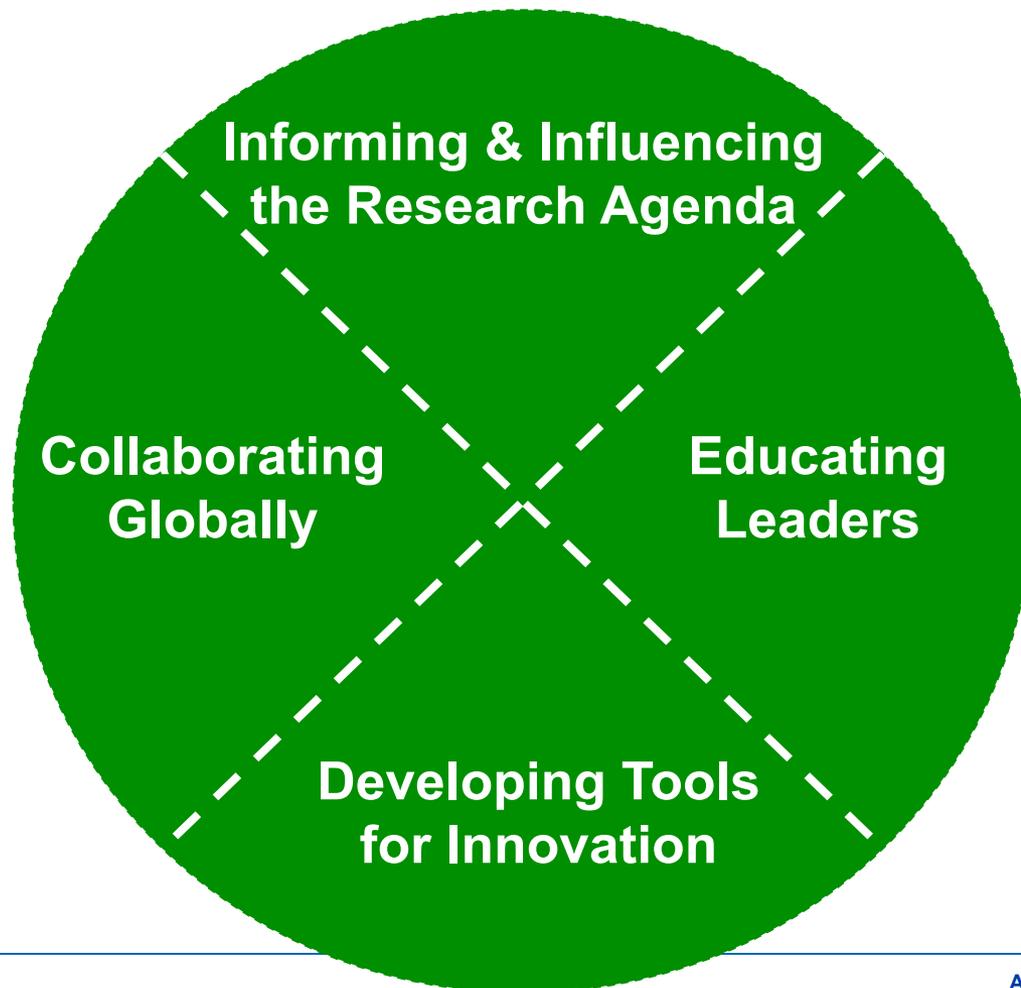
# ACS GCI Pharmaceutical Roundtable



# ACS GCI Pharmaceutical Roundtable



To catalyze the implementation of green chemistry and engineering in the pharmaceutical industry globally



# Quantifying the value of the ACS GCI Pharmaceutical Roundtable

Annual membership contributions range from \$10,000 to \$25,000 depending on the membership category and global sales. The example presented here illustrates the benefits associated with the ACS GCI Pharmaceutical Roundtable, and demonstrates a benefit of more than 1000%.

## On-Going *Tangible* Benefits

Benefit Category	Benefit Description / Strategic Alignment	Business Areas Realizing Benefit	Annual Benefits Value			Total
			Year 1	Year 2	Year 3	
Research Grant	Influence research agenda; Access to research in key areas; Engagement with researchers; Authorship	R&D	\$150k	\$150k	\$150k	\$450k
Lecture Tours	Research lectures to company sites	R&D	\$10k	\$10k	\$10k	\$30k
Articles of Interest	Literature review available to company scientists, 0.3 FTE resource	R&D	\$45k	\$45k	\$45k	\$135k
Solvent Selection Guide	Tool available to company scientists, 0.2 FTE resource	R&D, EHS	\$30k	\$30k	\$30k	\$90k
Reagent Selection Guide	Tool available to company scientists, 0.2 FTE resource	R&D, EHS	\$30k	\$30k	\$30k	\$90k
Commercial Tool Guidance	GC becomes standard feature rather than customization in some electronic lab notebooks.	R&D, EHS	\$10k	\$10k	\$10k	\$30k
Annual Total			\$275k	\$275k	\$275k	\$825k

## On-Going *Intangible* Benefits

Benefit Category	Benefit Description / Strategic Alignment	Business Areas Realizing Benefit
Benchmarking	Process Mass Intensity benchmarking, regular snapshot of performance against peer group	R&D, EHS
Calculation Tools	Process Mass Intensity calculator with LCA estimation	R&D, EHS
Green BioPharma	Development of relevant metric and alignment of company with EHS Strategy for Product Environment	R&D, EHS
Student Summer Schools	Positive reputation benefit, employer of choice to attract top talent	R&D
Medicinal Chemistry	Greener processes transition through the development process	R&D
Editorial Policy	Encouraging green chemistry through influencing editorial policy for journals read by company scientists	R&D
Involving suppliers	Collaboratively engaging suppliers to enable green chemistry through use of Roundtable-developed tools	R&D, EHS
Continuous Processing	Benchmarking, best practice sharing, developing the business case	R&D
Corporate Stewardship	Visibility of company commitment and engagement; Supportive of corporate mission	EHS
Commercial Tool Development	Industry recommendations for green chemistry implementation into external tools like Electronic Lab Notebooks; Encouragement to become standard rather than customized features	R&D, EHS

# ACS GCI Pharmaceutical Roundtable



To catalyze the implementation of green chemistry and engineering in the pharmaceutical industry globally



# Key Green Chemistry Research Areas

- Current Reactions
  - Amide Formation
  - OH Activation
  - Amide Reduction
  - Greener Mitsunobu Reactions
  - Oxidation/Epoxidations
- More Aspirational Reactions
  - C-H Activation or Aromatics
  - Chiral Amine Synthesis
  - Asymmetric Hydrogenation
  - Greener Fluorination Methods
  - *N*-Centered Chemistry
- Key Ideas outside the reaction theme
  - Solventless Reactor Cleaning
  - Greener alternatives to polar aprotic solvents

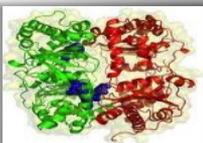
Key green chemistry research areas—a perspective from pharmaceutical manufacturers, *Green Chemistry*, 9 (5), 411-420, 2007

# Key Green Engineering Research Areas

## 1. Continuous Processing



## 2. Bio-Processes



## 3. Separation & Reaction Techs.



## 4. Solvent Selection, & Optimization



## 5. Process Intensification



## 6. Life Cycle Assessment



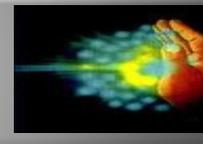
## 7. Integration of Chemistry & Eng.



## 8. Scale up Aspects



## 9. Process Energy Intensity

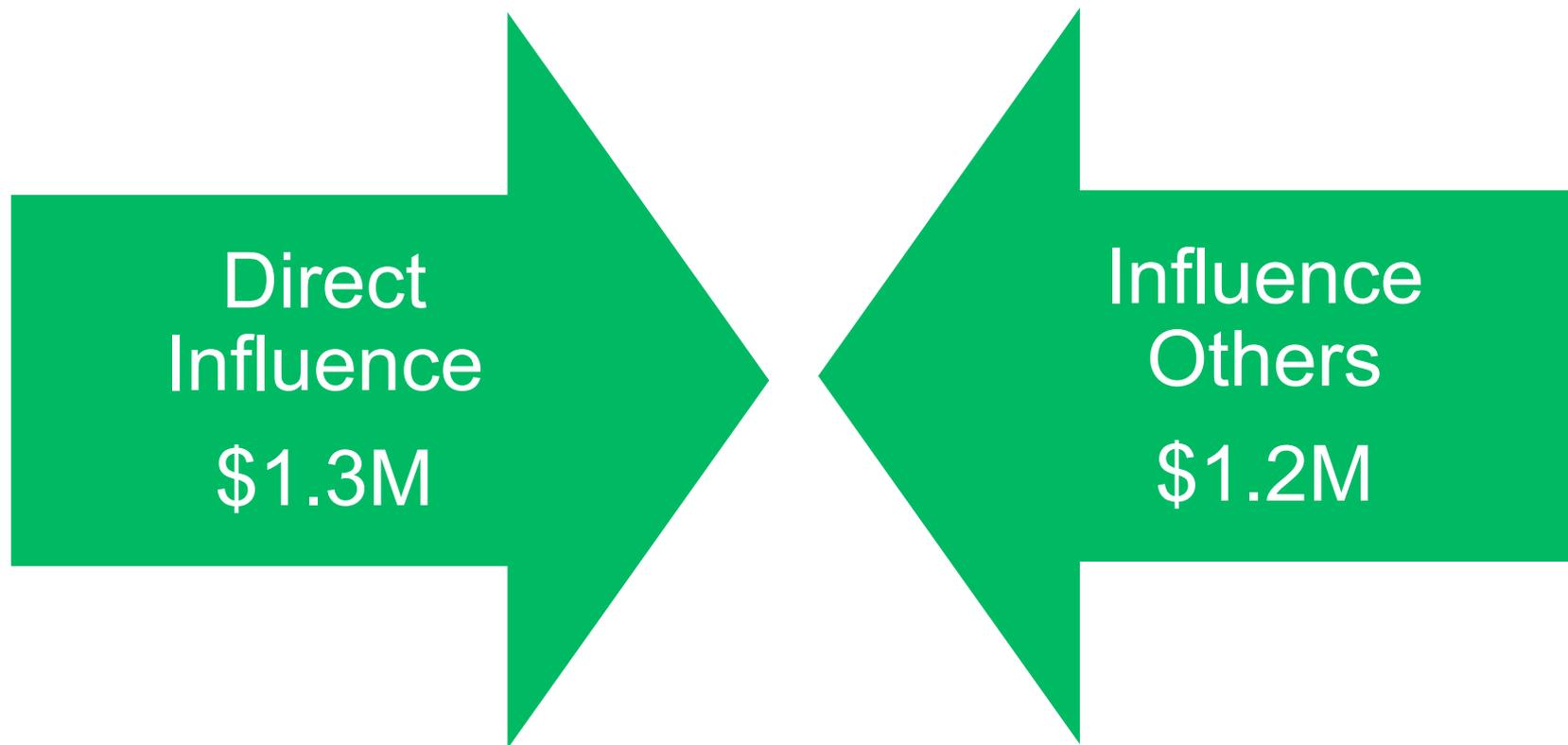


## 10. Mass & Energy Integration



Key green engineering research areas for sustainable manufacturing: a perspective from pharmaceutical and fine chemicals manufacturers, *Organic Process Research & Development*, 15 (4), 900-911, 2011.

# Influencing the Research Agenda



# Influencing the Research Agenda



NSF

Grant Opportunities for Academic Liaison  
with Industry

R. Maleczka & M. Smith, MSU

Co-PI – Merck

C-H Bond Activation and Functionalization

\$484,000

NIH Challenge Grant

S. Stahl,

University of Wisconsin-Madison

Aerobic oxidation methods for  
pharmaceutical synthesis

\$747,166

Influence  
Others

\$1.2M

# ACS GCIPR Research Grant Program

Recipient	University	Year
J. Xiao	University of Liverpool	2007
R. Maleczka & M. Smith	Michigan State University	2007
C.J. Li	McGill University	2008
M. Krische	University of Texas- Austin	2008
R. Crabtree	Yale University	2009
D. Cole-Hamilton	University of St. Andrews	2010
S. Stahl	University of Wisconsin-Madison	2011
R. Maleczka (GOALI)	MSU	2011
W. Zhang	UMass-Boston	2011
C. Liotta	Georgia Institute of Technology	2012
N. Garg	UCLA	2012
J. Scott	University of Bath	2013

# Aspects of the Grant Program

- Prioritizing research & defining scope
- Eligibility
- Proposal process
  - Full proposal vs. 2 phase proposal process
  - Length of proposals
- Proposal requirements
- Authorized submissions
- Review process

# Addressing Intellectual Property

**The Roundtables are designed  
to be non-competitive.**

- RFP requires listing of any existing background intellectual property and/or collaborations that might limit the freedom to operate.
- The primary purpose is to publish research to make information publicly available.
- Every patent, United States or foreign, that results from research funded (in part or in its entirety) by the grant shall be immediately dedicated to the public, royalty free.

# Learning & Adjusting



Funding amount



Collaboration



Report Structure

# Accomplishments

- Increased awareness of the needs
  - Key Green Chemistry Research Areas – 283 citations
  - Key Green Engineering Research Areas- 39 citations
- Research reports and publications
- Industrially relevant research
- Engaging and affecting students

## Coming in 2014

- Reviewing key green chemistry research areas
- Expect to award 2 grants early in 2014
- Anticipate issuing Requests for Proposals in 1-2Q 2014
  - Greener conditions for amide reduction
  - Iron-catalyzed couplings

# Acknowledgements

- ACS Green Chemistry Institute®

[www.acs.org/greenchemistry](http://www.acs.org/greenchemistry)

- ACS GCI Pharmaceutical Roundtable

[www.acs.org/gcipharmaroundtable](http://www.acs.org/gcipharmaroundtable)

- All member companies & grant recipients
- Especially Mike, Dan, Rob, Neil, Wei, and Asha

*Whatever we accomplish  
belongs to our entire group, a  
tribute to our combined effort.*

*- Walt Disney*

# Thank you!

Julie Manley

Guiding Green LLC

[juliemanley@GuidingGreen.com](mailto:juliemanley@GuidingGreen.com)

The audio recording and slides shown during this presentation will be available to GC3 Members on the GC3 Website:

<http://www.greenchemistryandcommerce.org>

Non- GC3 Member Attendees who would like to view these slides please contact Sarah Shields at [sarah\\_shields@uml.edu](mailto:sarah_shields@uml.edu)



## *Mark Your Calendars!*

9th Annual  
**GC<sup>3</sup>** Green Chemistry &  
Commerce Council  
Innovators  
Roundtable  
MAY 28-30 2014  
St. Paul, Minnesota  
Hosted by **3M**