Green Chemistry and the Competitive Edge

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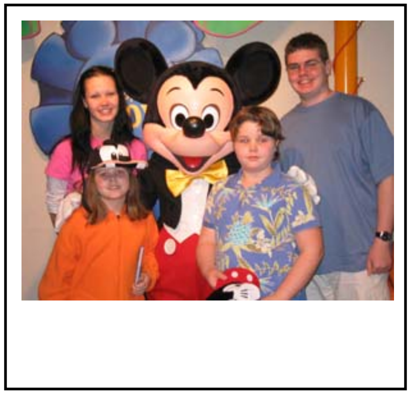

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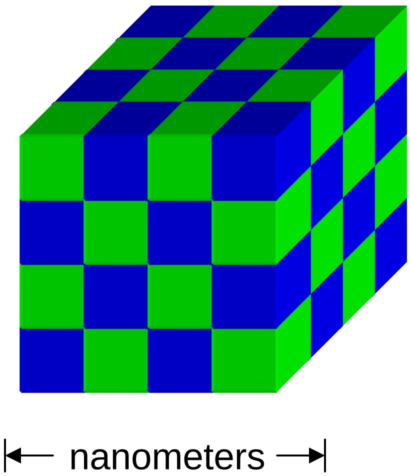
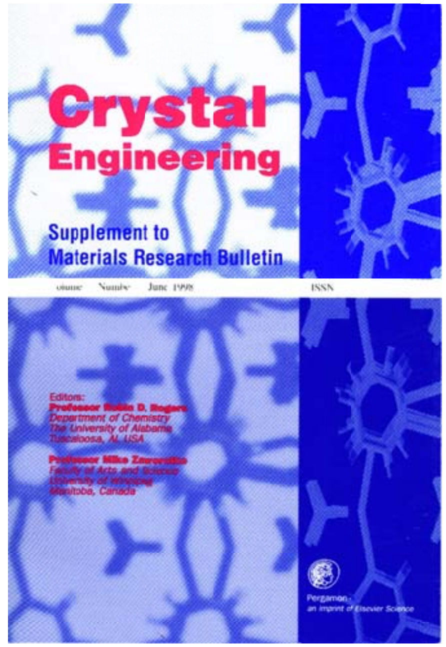
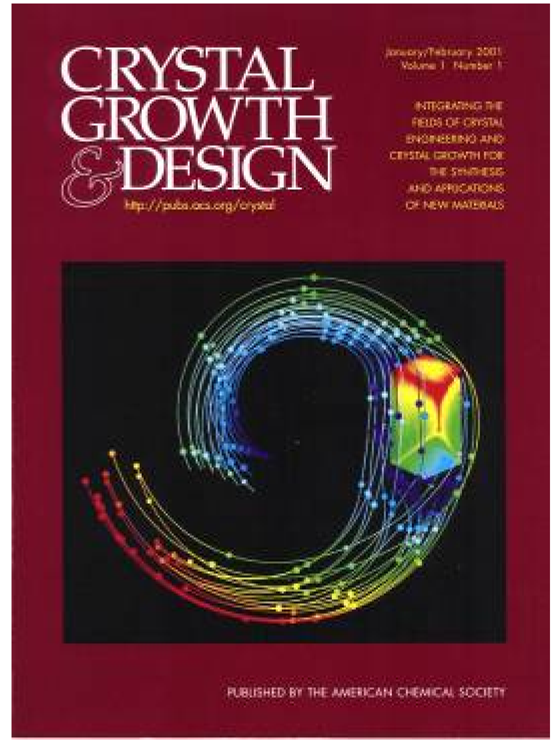
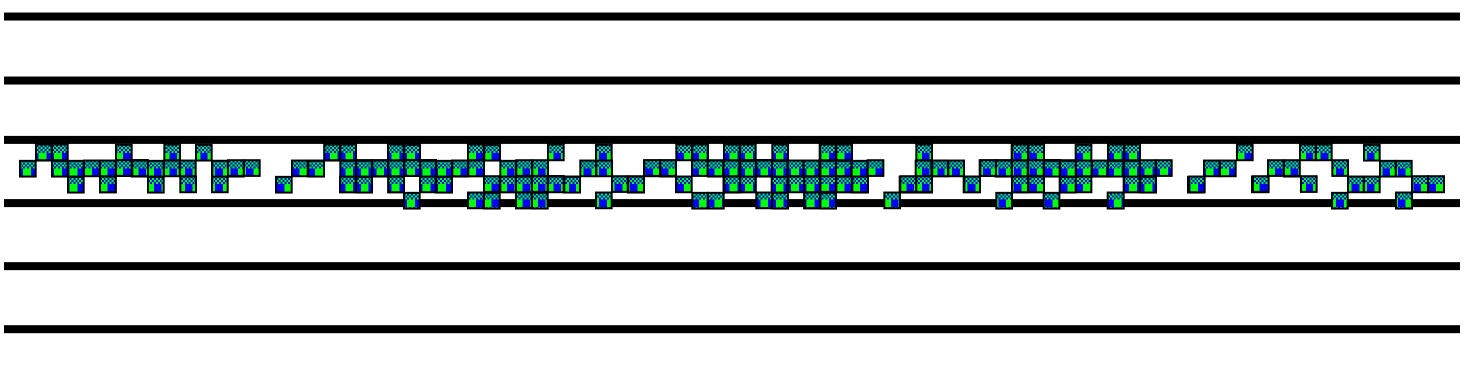
Noncovalent Derivatization









EPA Approval

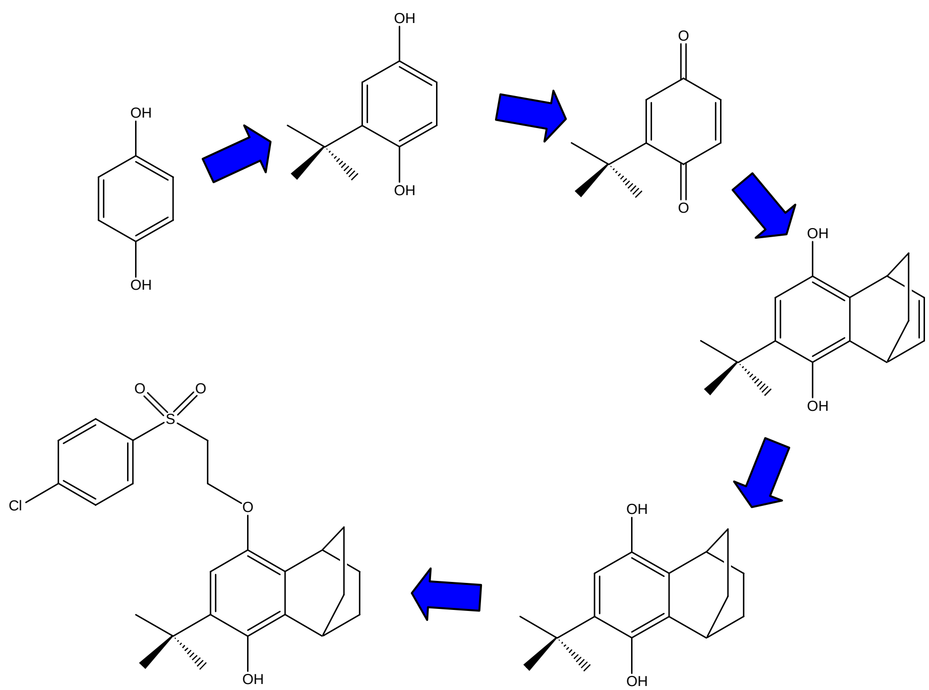
Low **V**olume **E**xemption
Pre**M**anufacturing **N**otification

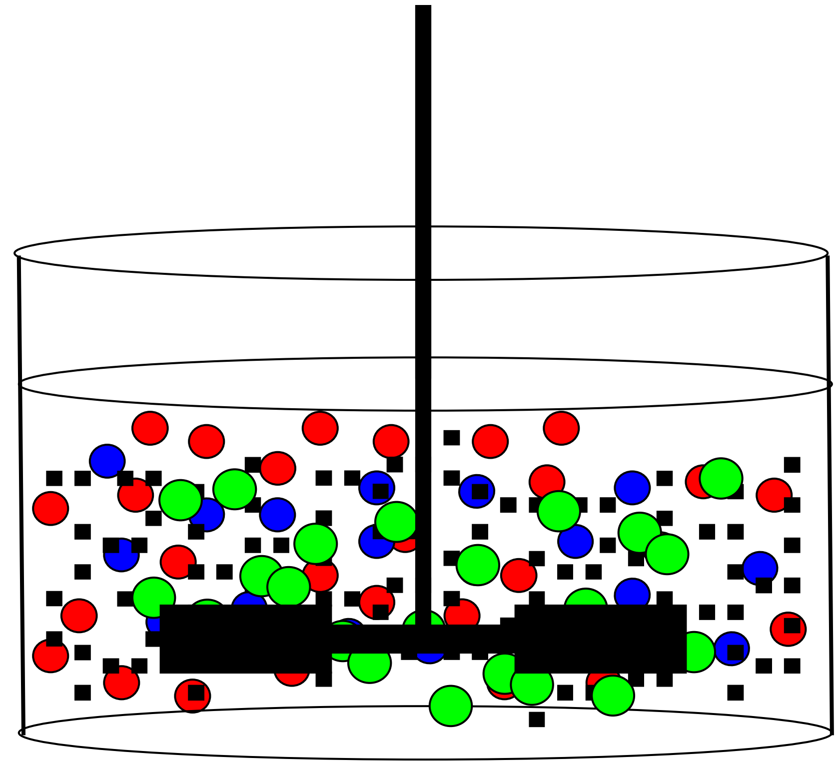
Small particles?

Molecular Complexes?

Paul Anastas

Office of Pollution
Prevention and Toxics





Old Technology
Several Solvents
High Energies
Hazardous Reagents

New Technology
Aqueous Conditions
Low Energies
Non-hazardous Reagents

“Reinventing Government”

$75,000.00

EPA United States Environmental Protection Agency

Presidential Green Chemistry Challenge

The Presidential Green Chemistry Challenge

Awards Opportunities

The Pollution Prevention Act of 1990 established a national policy to prevent or reduce pollution at its source whenever feasible. The Pollution Prevention Act also provided an opportunity to expand beyond traditional EPA programs and devise creative strategies to protect human health and the environment. Green chemistry, or the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances, is a highly effective approach to pollution prevention. Green Chemistry applies innovative scientific solutions to real-world environmental situations, all through voluntary partnership programs. In order to successfully effect the technical and behavioral changes necessary to accomplish wide-spread pollution prevention through green chemistry, the benefits of the approach must be clearly demonstrated and communicated.

Objective:

The Presidential Green Chemistry Challenge seeks to recognize outstanding accomplishments in green chemistry through an annual awards program in order to demonstrate the scientific, environmental, and economic benefits that green chemistry technologies offer.

Background:

The Presidential Green Chemistry Challenge was implemented as a voluntary EPA Design for the Environment (DfE) partnership with the chemical community. DfE partnerships encourage changes that both promote economic development and benefit industry by identifying cost-effective ways to prevent pollution.

Description:

The Presidential Green Chemistry Challenge Awards Program is an opportunity for individuals, groups, and organizations to compete for annual awards in recognition of innovations in cleaner, cheaper, smarter chemistry. The Challenge Awards Program provides national recognition for outstanding chemical technologies that incorporate the principles of green chemistry into chemical design, manufacture, and use, and that have been or can be utilized by industry to achieve its pollution prevention goals.

Nominations received for the awards are judged by an independent panel of technical experts convened by the American Chemical Society. Typically, five awards are given annually to industry and government sponsors, an academic investigator, and a small business. for this program. Individual projects selected for support may be funded by EPA, NSF, or jointly by both agencies. This is at the option of the agencies, not the grantee.

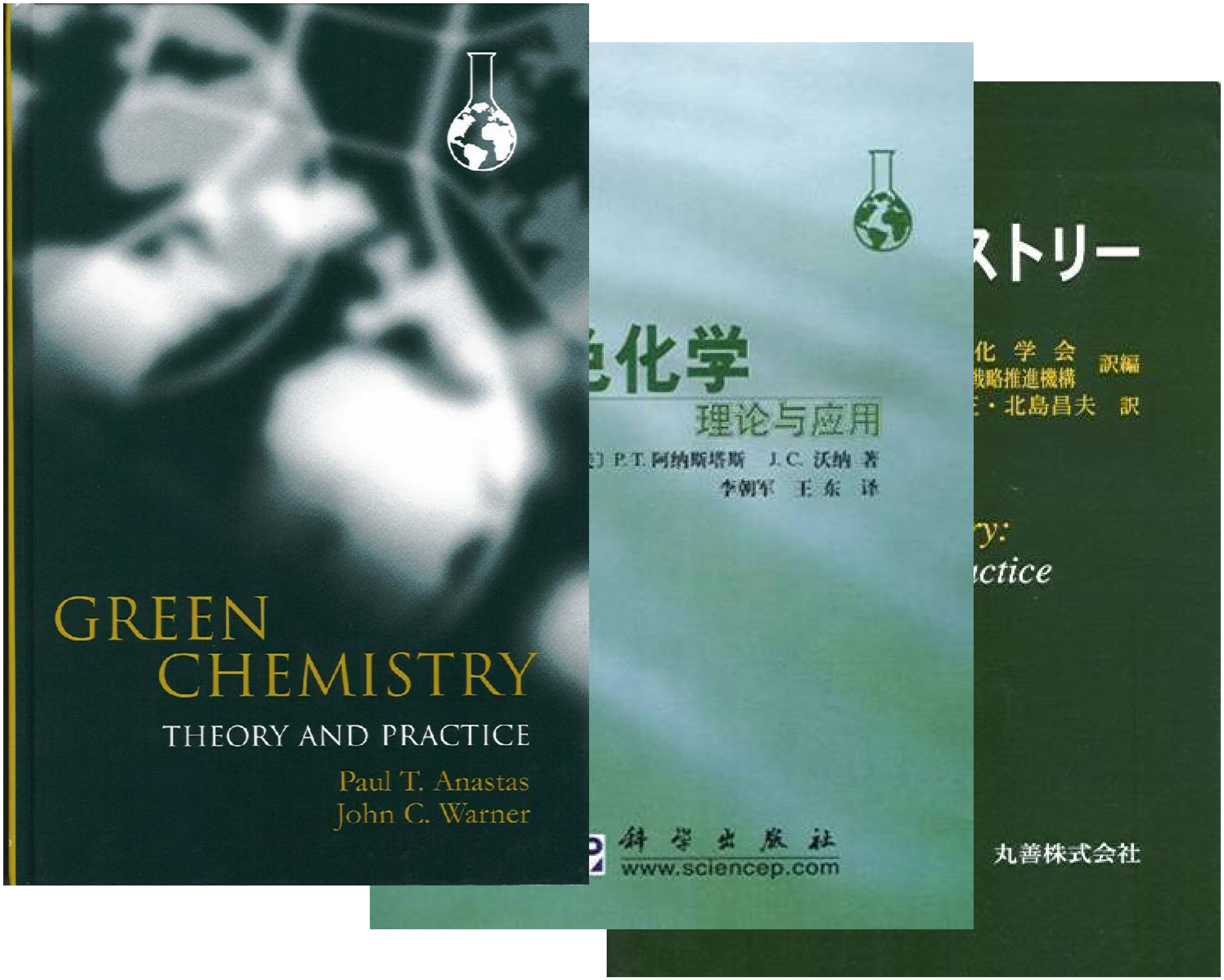
United States Environmental Protection Agency

Printed on paper that contains at least 50 percent postconsumer fiber

Green Chemistry Challenge

	1996	1997	1998	1999	2000	
Academic	Mark Holzapple	Joseph DeSimone	Barry Trost Karen Draths John Frost	Terry Collins	Chi Hue Wong	
Small Business	Donlar Corporation	Legacy Systems	PYROCOOL Technologies	Biofine	RevTech	Ede
Alternative Synthetic Pathway	Pharmacia	BHC Company	Flexsys America	Lilly Research Laboratories	Roche Colorado	C
Alternative Solvents and Reaction Conditions	Dow	Imation	Argonne National Labs	Nalco Chemical Company	Bayer Corporation	N
Designing Safer Chemicals	Rohm and Haas	Albright and Wilson Associates	Rohm and Haas	Dow AgroSciences	Dow AgroSciences	

Green Chemistry is the *design* of chemical products and processes that reduce or eliminate the *use and/or generation* of hazardous substances.



The Twelve Principles of Green Chemistry

1. Prevention. It is better to prevent waste than to treat or clean up waste after it is formed.

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 Synthesis. Whenever practicable, synthetic methodologies 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 preserve efficacy of the function while reducing toxicity.

5. Safer Solvents and Auxiliaries. The use of auxiliary substances (solvents, separation agents, etc.) should be made unnecessary whenever possible and, when used, innocuous.

6. Design for Energy Efficiency. Energy requirements should be recognized for their environmental and economic impacts and should be minimized. 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 practical.

8. Reduce Derivatives. Unnecessary derivatization (blocking group, protection/deprotection, temporary modification of physical/chemical processes) should be avoided whenever possible .

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 do not persist in the environment and instead break down into innocuous degradation products.

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. Substance and the form of a substance used in a chemical process should be chosen so as to minimize the potential for chemical accidents, including releases, explosions, and fires.

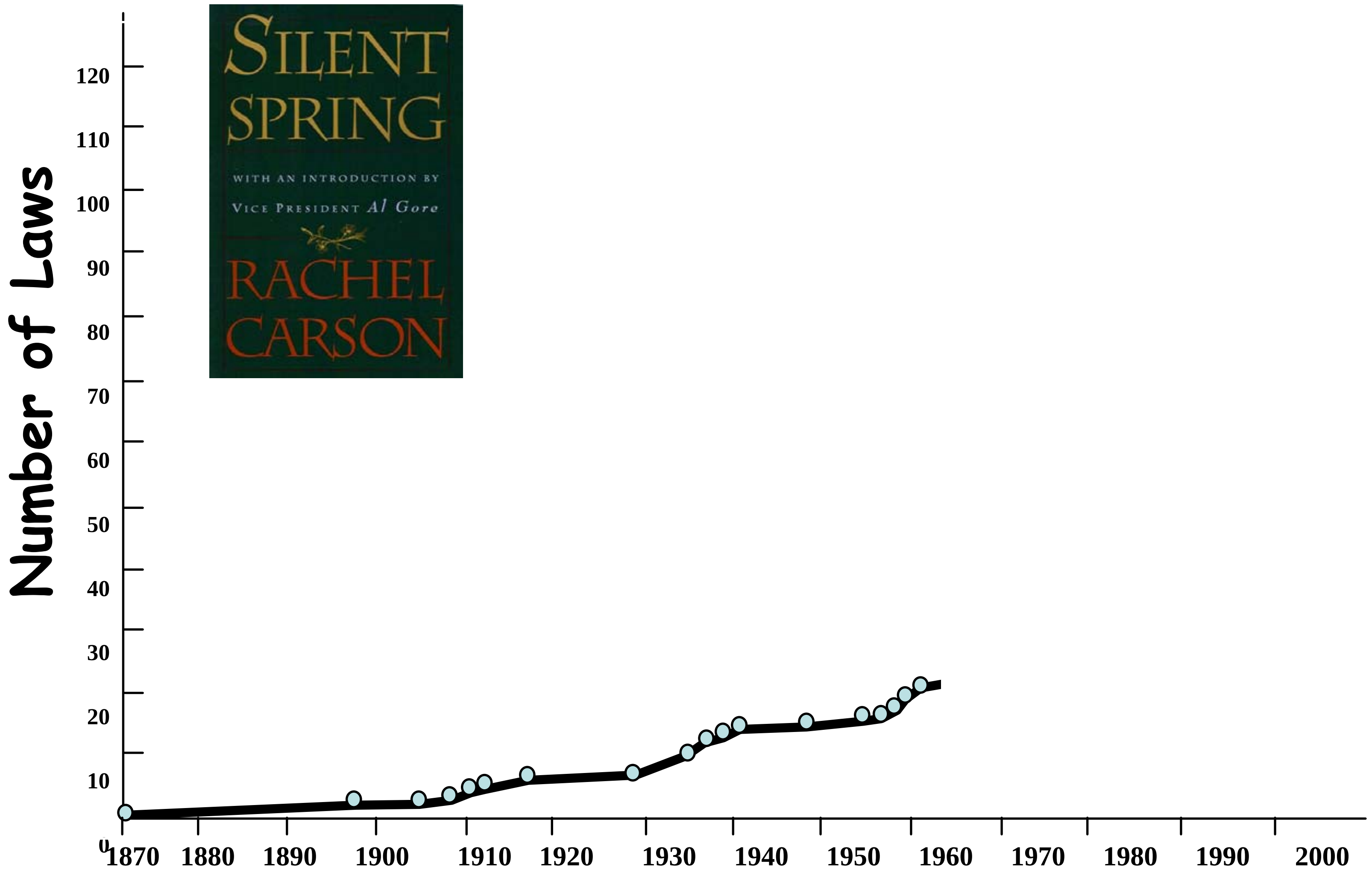



Risk = Exposure x Hazard

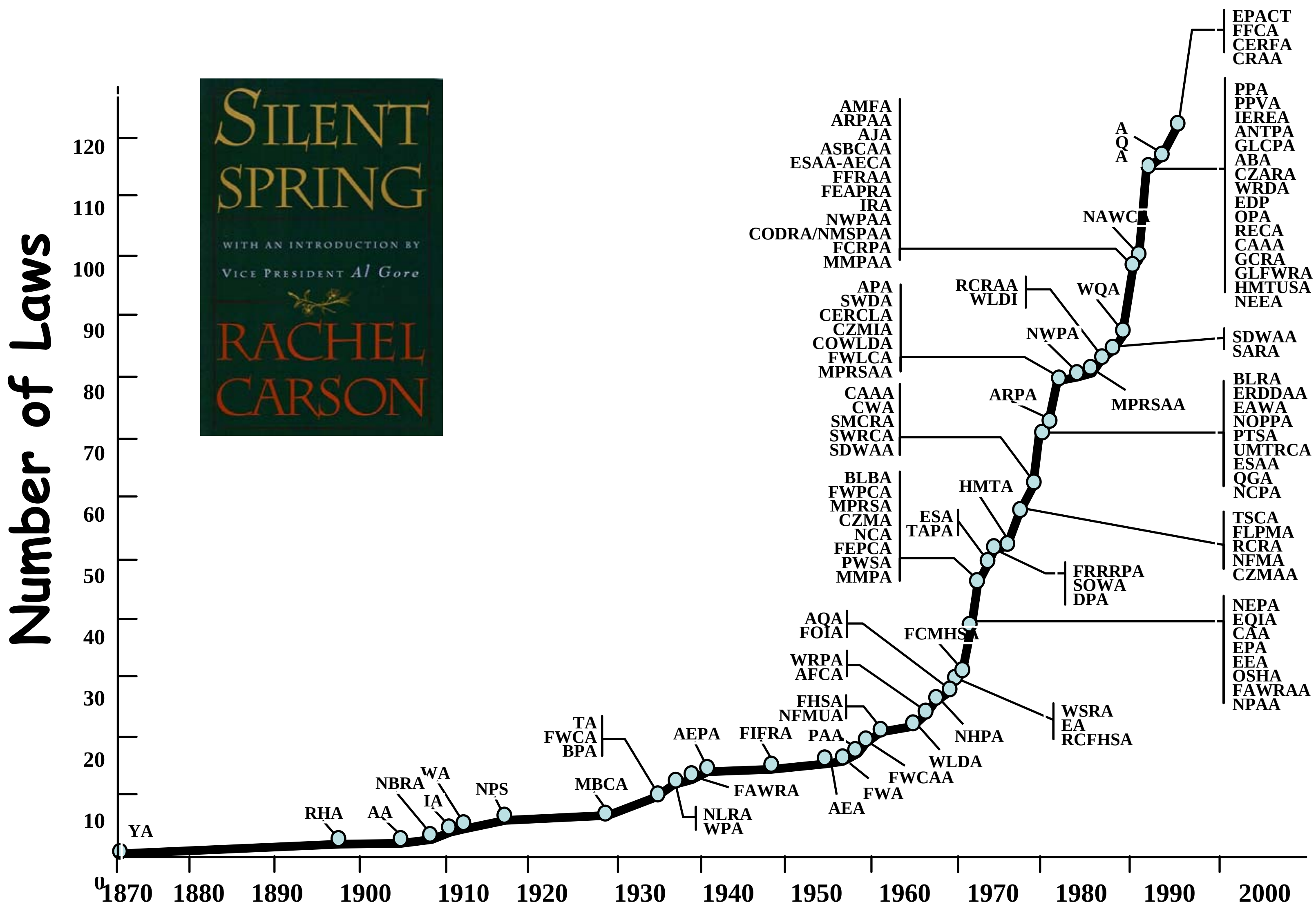
The cost of using hazardous materials:

- Storage
- Transportation
- Treatment
- Disposal
- Regulatory Costs
- Liability
- Worker Health and Safety
- Corporate Reputation
- Community Relations
- New Employee Recruitment

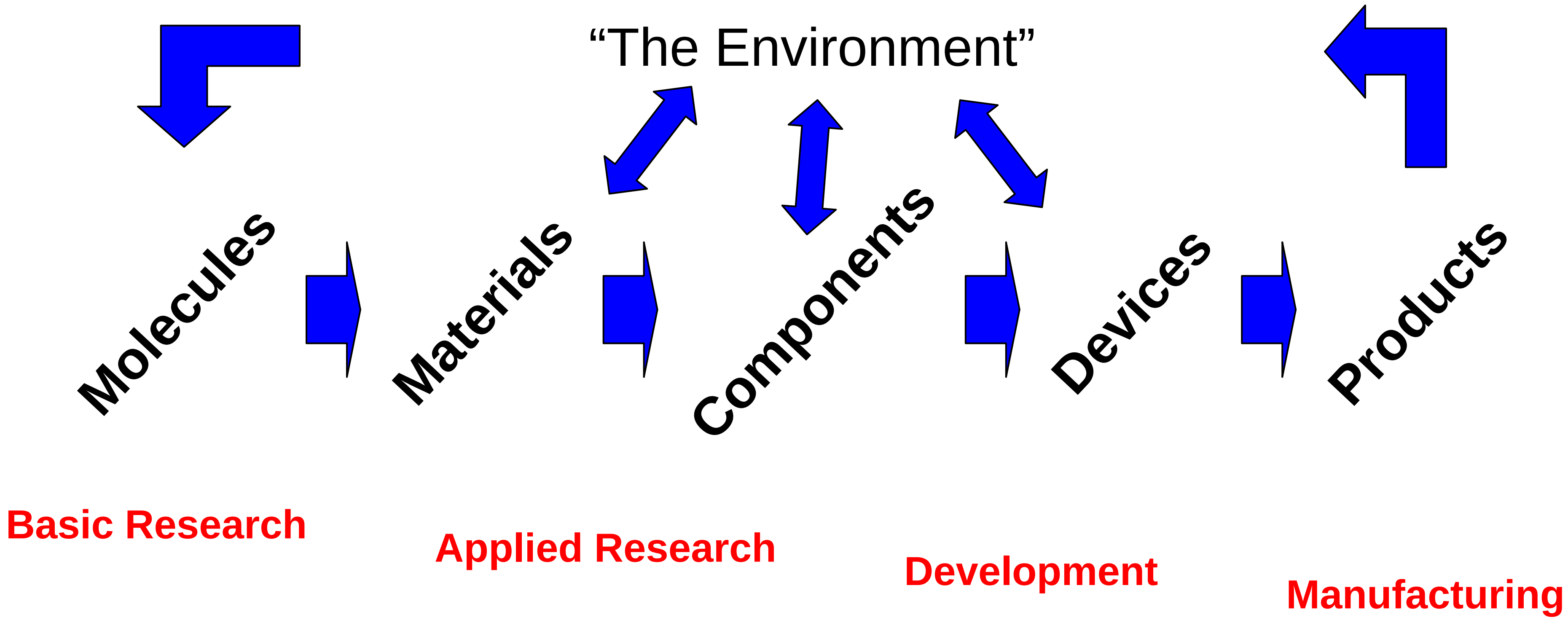
Environmental Regulations



Environmental Regulations



Where do products come from?



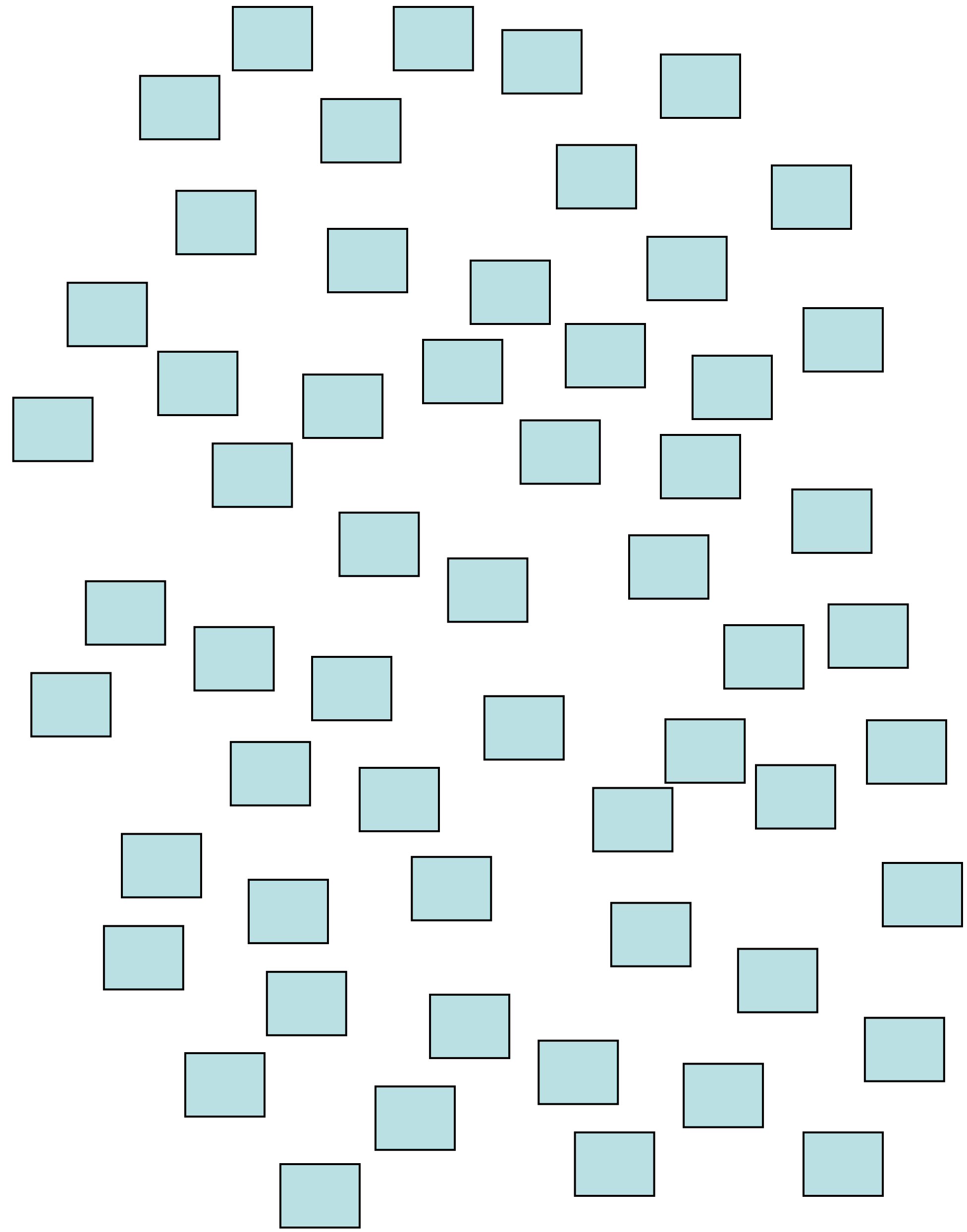
Performance

Economics

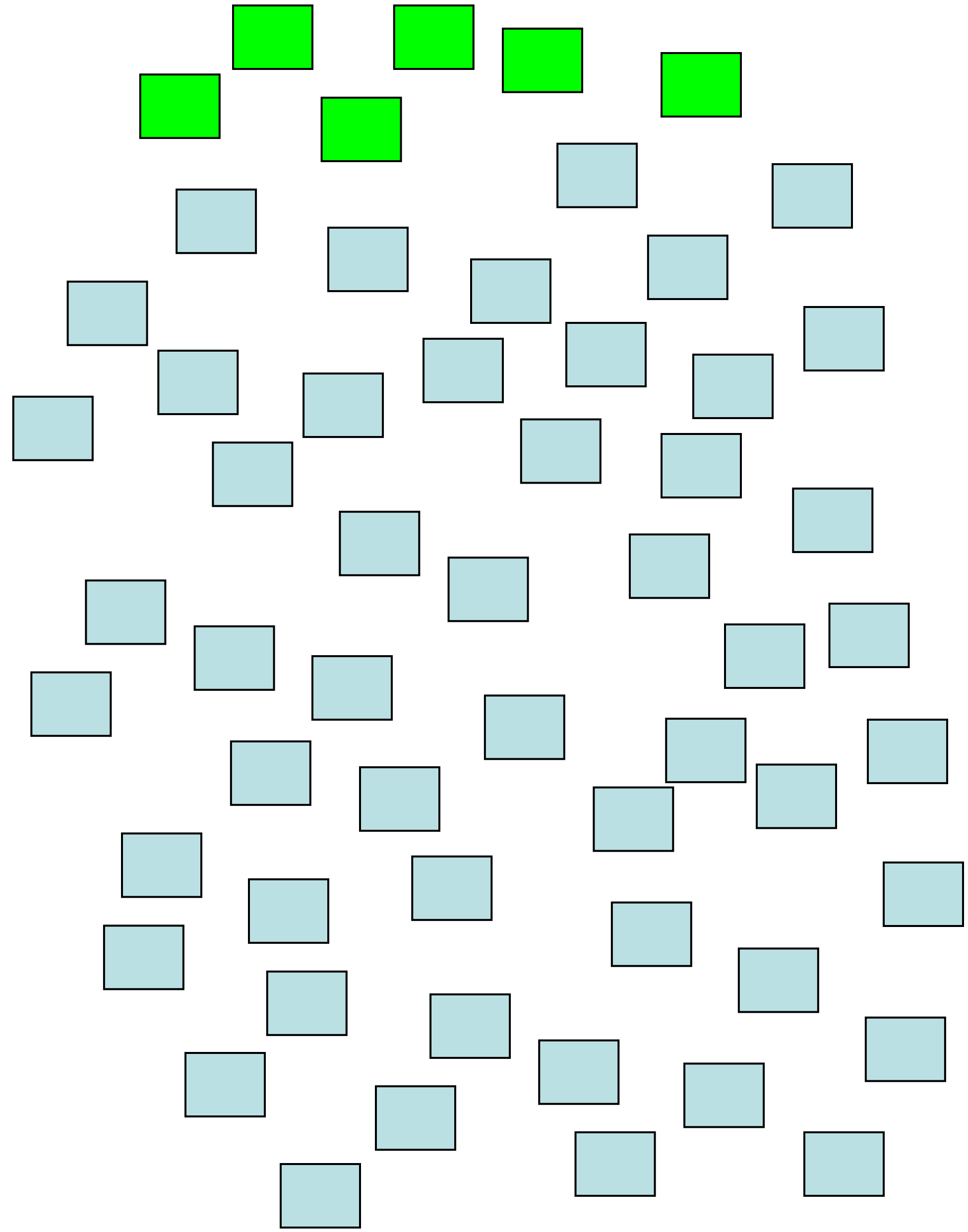
Social Implications

Of all the products and processes…

Maybe 10% are benign…



Of all the products and processes…



Maybe 10% are benign…

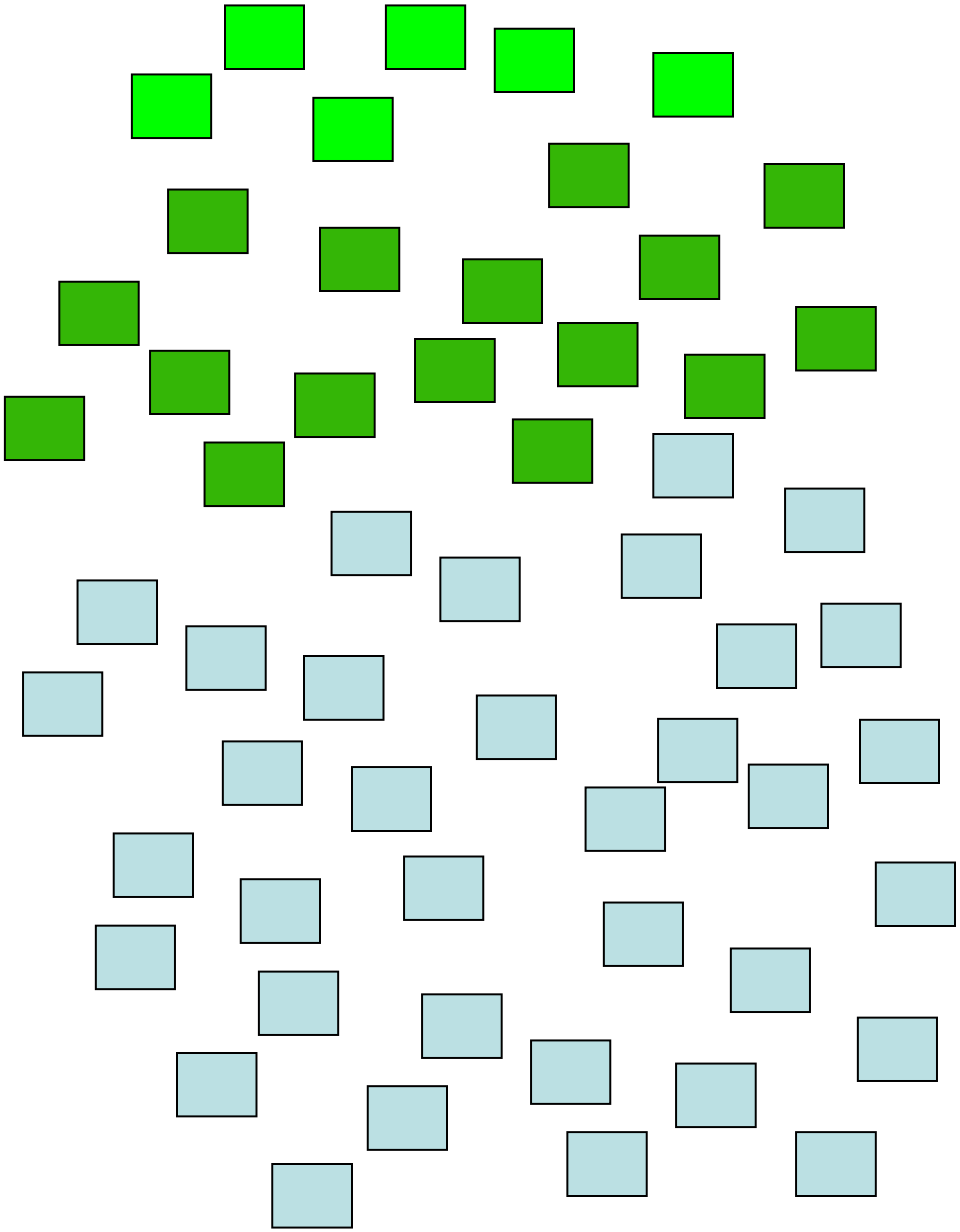
Maybe 25% more are relatively easy to do…

Of all the products and processes…

Maybe 10% are benign…

Maybe 25% more are relatively easy to do…

Who is going to invent the other 65%?



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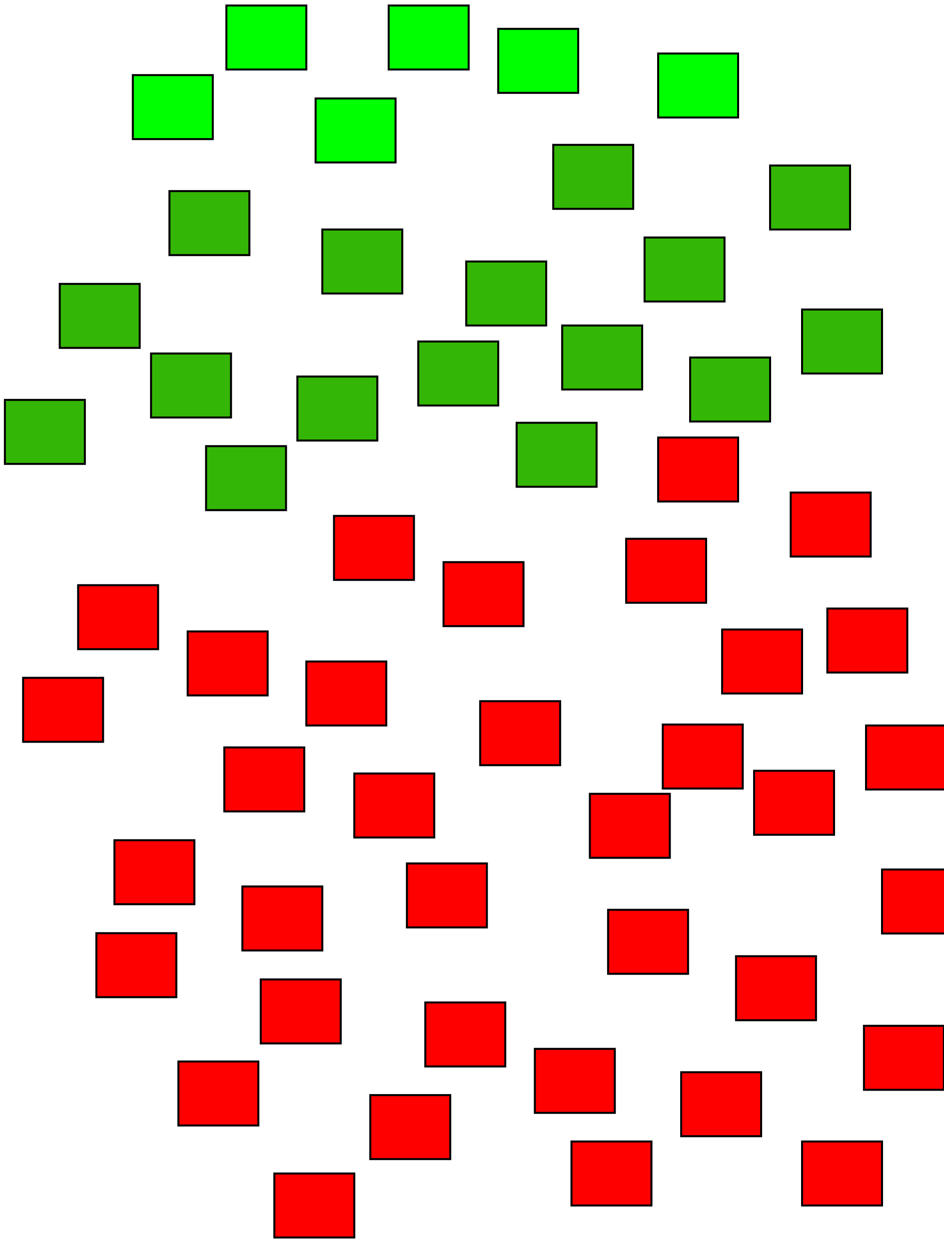
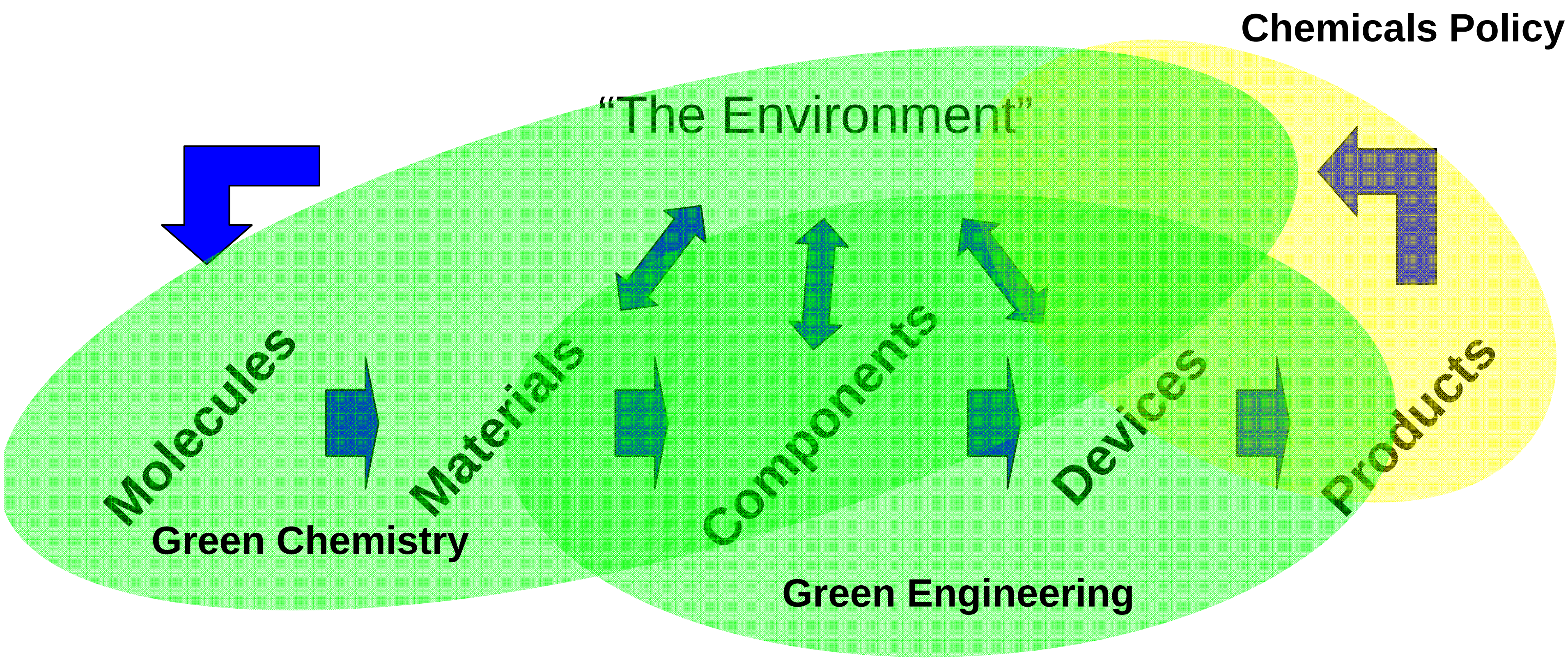


To get a PhD in Chemistry…

No universities in the United States require any demonstration of knowledge regarding toxicity or environmental impact!


Chemicals Policy
"The Environment"
Molecules
Materials
Components
Devices
Products
Green Chemistry
Green Engineering

Traditional Processes

Carbon-Carbon Bonds
Oxidations
Reductions
Hydroxylations
Polymer Syntheses

Traditional Processes

Green Alternatives

Green Chemistry Research and Development Act of 2005

Physical properties of a material

- State of Matter
- Color
- Melting Point
- Boiling Point
- Solubility
- Electrical Conductivity

Physical properties of a material

- State of Matter
- Color
- Melting Point
- Boiling Point
- Solubility
- Electrical Conductivity
- Toxicity
- Impact on the environment

Green Chemistry Research Group

www.greenchemistry.uml.edu

Thank You !

UMASS Lowell

College of Engineering

School of Health and the Environment