

missing

Education of business students

How do we accelerate education about materials innovation (GI) in business schools as part of the Clean Commerce agenda?

“Our questionnaires are very rigorous and include issues about manufacturing, production and use,” Antle said. “The questions go deep into chemistry and deep into the issues of the content of the carpet fiber and the backings as well as worker safety, recycled content, emissions, energy, waste disposal and end-of-life disposition. One of our carpet vendors, with whom we had had a long relationship, didn’t take our environmental query seriously either in the questionnaire or in the follow-up interview process, and so we changed providers and awarded our contract to a more responsive vendor. They weren’t happy about it, but the process reinforced that there was a total disconnect between where we were going versus where they thought we were going.”

**Carol Antle
Director National Facilities Services
Kaiser Permanente**

Green Chemistry & Commerce Council Innovators Roundtable: Opportunities and Challenges in a New Era

May 4-6, 2009

Staples

Broomfield, Colorado



Professor Andrea Larson
Darden School of Business
University of Virginia

AGENDA

- GC3 and Clean Commerce
- Drivers of Clean Commerce
- Innovation & Sustainable Business

**DARDEN SCHOOL OF BUSINESS
UNIVERSITY OF VIRGINIA**

**TEACHING, RESEARCH on
INNOVATION AND ENTREPRENEURSHIP**

**Drivers & processes of
entrepreneurial innovation**

**ECONOMIC DEVELOPMENT
AND LIMITS OF NATURAL SYSTEMS**

**MBA COURSE : “SUSTAINABILITY, INNOVATION AND
ENTREPRENEURSHIP”**

**EXECUTIVE MBA COURSE:
“CLEAN COMMERCE”**



ANDREA LARSON

BUSINESS CASES/RESEARCH

- Coastwide
- East West Partners
- Shaw Industries
- Method
- Bank of America
- SC Johnson
- Walden Paddlers
- Frito Lay
- United Technologies
- IKEA
- AT&T
- Atlantic Energy
- Hermes Microtech
- Husk Energy
- ProjectFROG
- Calera
- FHC
- Kaiser Permanente

Clean Commerce
& Sustainability by
Design



**A WAVE OF
ENTREPRENEURIAL
INNOVATION**

- **Climate Change/CO2 reduction/Energy**
- **Economic Crisis**

Clean commerce



Efficiencies

Renewable Energy

Materials

**The most
important arena
for innovation is
clean commerce:**

**ENERGY
MATERIALS**

TARGETS:

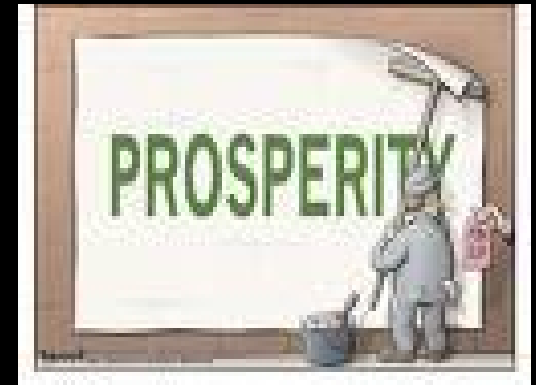
Renewable /clean energy

Benign/Clean materials

Radical efficiency

- energy
- materials

The industrial revolution



Common Wealth, Economics for a Crowded Planet (2008)

by economist Jeffrey Sachs

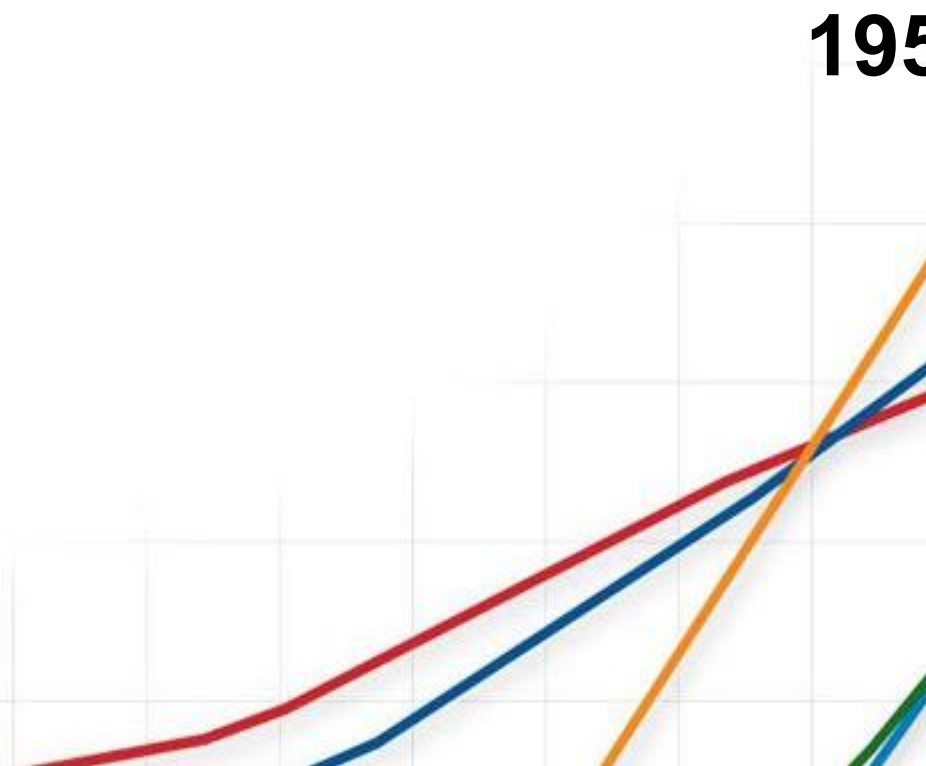
... describes the world's ability to combine long-term economic growth and environmental health

“One thing is certain: *The current trajectory of human activity is not sustainable.*”



In the business as usual scenario, with human population projected to grow by 40 percent by 2050, and average per capita income growing fourfold over that timeframe, we can expect the current \$67 trillion global economy to grow approximately sixfold to over \$400 trillion by mid century. When there is growing evidence that we have already overshoot the biosphere's carrying capacity, even contemplating a sixfold increase is absurd. Yet this is exactly the path we are on. It is time to pause and reflect on the so-called "inevitability" of our growth-driven, increasingly "efficient" global economy. We must concentrate our minds on how to understand the implications, and where to turn for the wisdom to guide the evolution of our economic models and our public policy choices.

DOMESTIC PRODUCT
HABITAT LOSS
WATER USE
SPECIES EXTINCTIONS
R VEHICLES
R CONSUMPTION
SHERIES
REIGN INVESTMENT
ZONE DEPLETION



A Global Perspective



life supporting
resources

declining

consumption of
life supporting
resources

rising

COMMON SENSE

“Anyone who believes that exponential growth can go on forever in a finite world is either a madman or an economist.”

Kenneth Boulding
Economist
1910-1993

Economic growth and its influence on natural systems has crossed a threshold of scale, intensity, and complexity that we can now talk about observed changes being **different in kind** not just in degree

Anthropogenic Earth

Human activity is changing the *dynamics* of natural systems

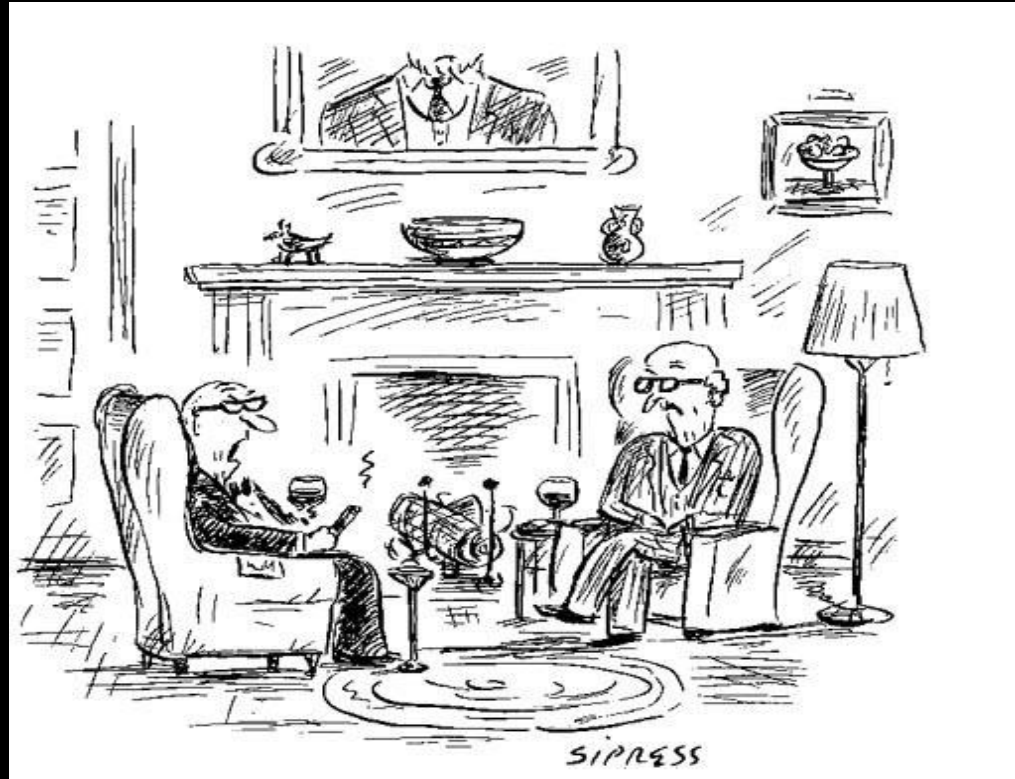
WHAT HAS CHANGED?

HUMAN ACTIVITY NOW INFLUENCES THE DYNAMICS OF NATURAL SYSTEMS:

- ATMOSPHERE
- HYDROLOGIC SYSTEMS
- SOIL COMPOSITION & SOIL EROSION
- OCEAN FISHERIES, CORAL REEFS
- HUMAN IMMUNE SYSTEM
- CHILDREN'S PHYSIOLOGY: ASTHMA AND CANCERS, ENDOCRINE DISRUPTION
- ANIMAL, INCLUDING HUMAN, REPRODUCTIVE SYSTEMS, FERTILITY

“...in ecological terms, the current situation is an extreme deviation from any of the durable, more “normal,” states of the world over the span of human history, indeed over the span of earth history.”

Source: Something New Under the Sun: An Environmental History of the Twentieth-Century World, J.R. McNeil, W.W. Norton & Company, 2000, pg. 362.



I remember when there was no damn environment

Sustainability vs Environment

parks
trees
extinctions
spotted owls
frogs
pollution
“back to nature”
tree-huggers
radicals
“save the planet”

costs
overhead
environ mgt
higher prices
job losses
competitive
disadvantage

= problem

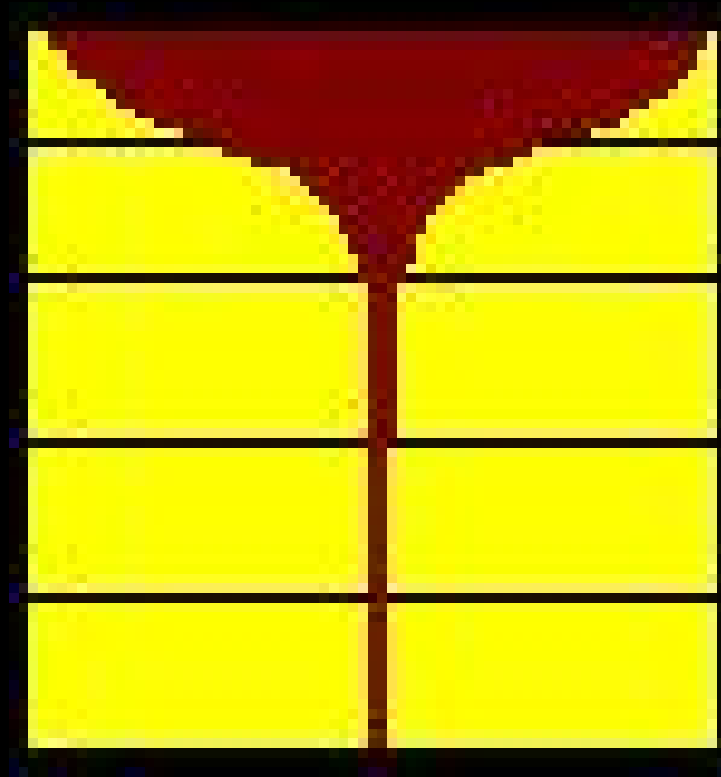
regulation
public policy
compliance
fines/penalties
liabilities
activists
lawsuits
boycotts

corporate social
responsibility
ethics
stakeholders

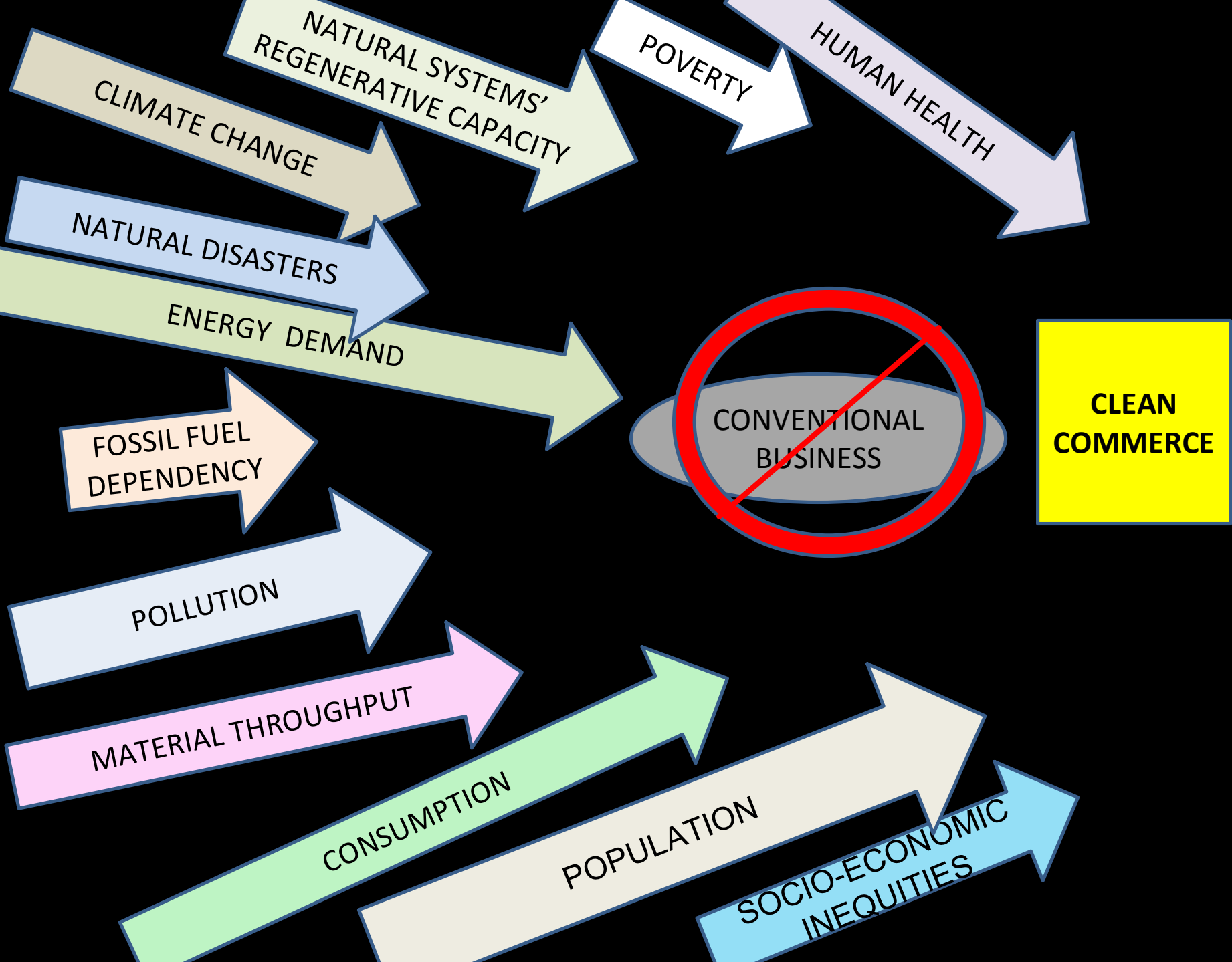
Sustainability:

- clean air
- clean drinking water
- healthy food
- environmental justice
- green buildings
- zero waste, zero emissions
- positive footprint
- clean energy
- benign materials
- renewable energy
- stable communities
- healthy ecosystems

A Global Perspective: The Champagne Glass Reality



The richest 1%
of the world's
people receive as
much income as
the poorest 57%



NATURAL SYSTEMS'
REGENERATIVE CAPACITY

POVERTY

HUMAN HEALTH

CLIMATE CHANGE

NATURAL DISASTERS

ENERGY DEMAND

FOSSIL FUEL
DEPENDENCY

POLLUTION

MATERIAL THROUGHPUT

CONSUMPTION

POPULATION

SOCIO-ECONOMIC
INEQUITIES

~~CONVENTIONAL
BUSINESS~~

**CLEAN
COMMERCE**



THE FUTURE

Clean
Commerce



Innovation
- product, process,
technology, org form

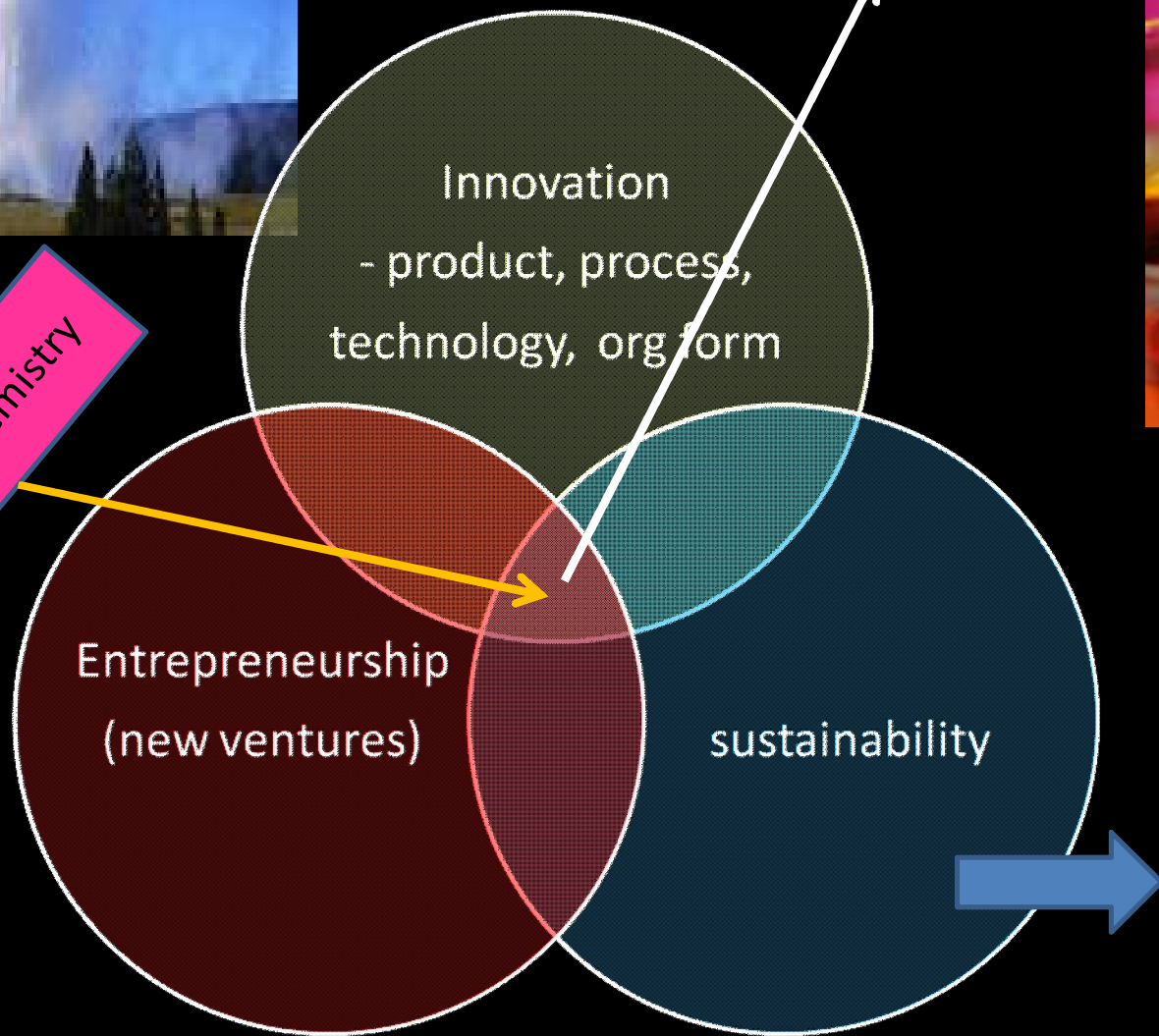
Green Chemistry

Entrepreneurship
(new ventures)

sustainability

Performance

- Economic
- Ecological
- Human health
- Community prosperity



What is “sustainability” in
business?

Sustainability embraces a spectrum of company performance characteristics

Profitability alone is inadequate as a measure of strategic success and fiduciary responsibility

Shareholder value is increasingly determined by a deliberate strategy that results in high performance across 3 areas:

1. ecological integrity/restoration
2. community and individual health
3. economic return

Sustainable Development:

“Meeting the needs of a stabilizing future world population while reducing hunger and poverty and maintaining the planet's life-support systems.”

National Research Council

“Characterizing a Sustainability Transition: Goals, Targets, Trends, and Driving Forces”

Proceedings of the National Academy of Sciences of the United States of America 100(14)(8 July): 8068-8073.

A sustainable product or process is one that constrains resource consumption and waste generation to an acceptable level, makes a positive contribution to the satisfaction of human needs, and provides enduring economic value to the business enterprise.



Bakshi & Fiksel

American Institute of Chemical Engineers (AIChE)

Journal, Vol 49, No 6, June 2003, p 1350

Resource utilization should not deplete existing capital, that is, resources should not be used at a rate faster than the rate of replenishment, and waste generation should not exceed the carrying capacity of the surrounding ecosystem

Dr. Karl-Henrik Robèrt, 1977

Entrepreneurial Innovation

- Explains the production of future goods and services
- Introduces significant changes in products, services, technology, markets, and organizing forms
- Departs from, disrupts, existing industrial and commercial patterns
- Explains the emergence of new processes and products, and new ways of meeting human needs

The Impact of the Entrepreneurial Sector

**The force of one period's
entrepreneurs becomes the next
generation's business paradigm**

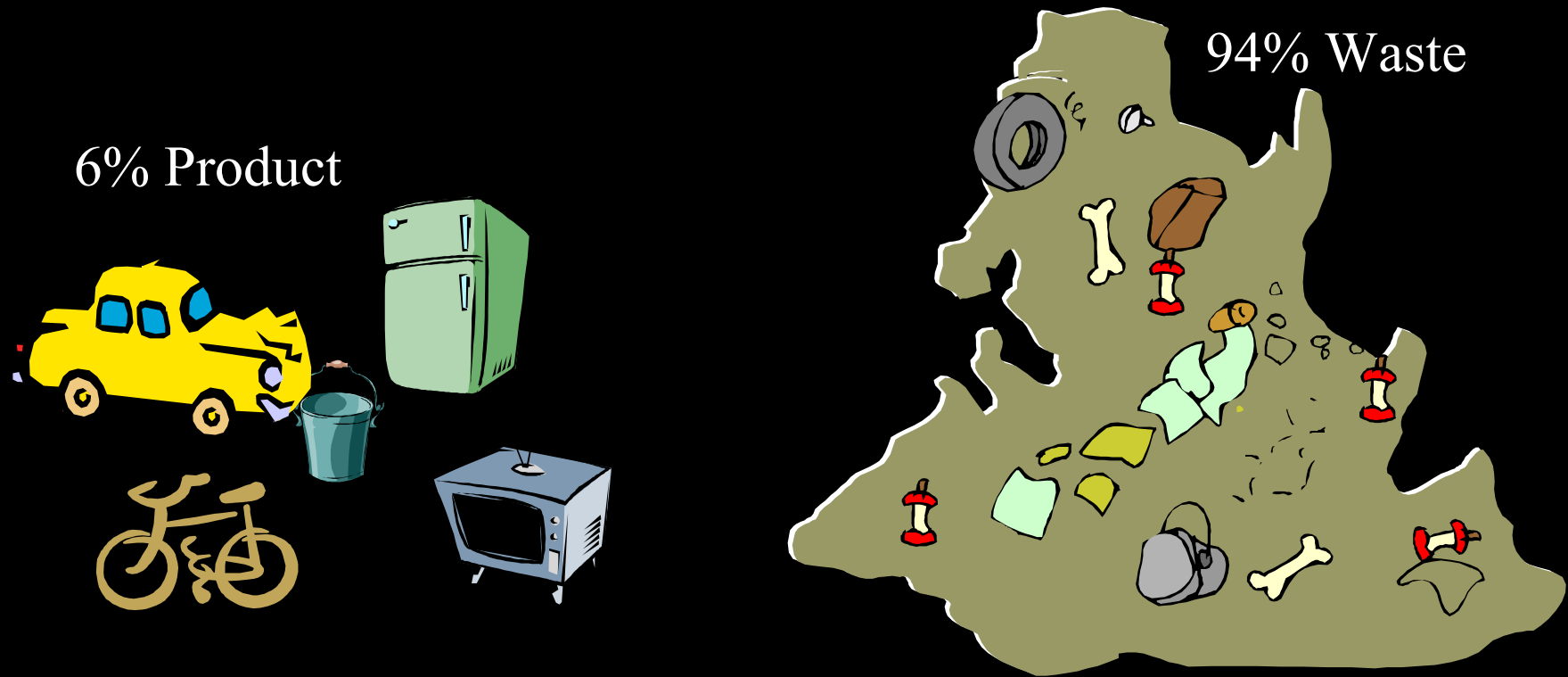
**... entrepreneurship trends are a
leading indicator of business and
social change**

Entrepreneurship/Innovation



- ENTREPRENEURSHIP HAPPENS IN A VARIETY OF SETTINGS, NOT JUST NEW VENTURES
- INNOVATION INCLUDES BREAKTHROUGH DESIGN CHANGES IN PRODUCTS, PROCESSES TECHNOLOGIES, NEW MARKETS, AND NEW ORGANIZATIONAL FORMS
- ENTREPRENEURIAL INNOVATION HAPPENS WHEN OPPORTUNITIES ARE DISCOVERED

Unlike natural systems, modern human societies process resources in a linear fashion, creating wastes faster than they can be reconstituted into usable resources.



On average 94% of the raw materials used in creating a product ends up as waste; only 6% ends up in the final product

Solid Waste, Molecular Waste



Scientific American



DEAD ZONES -
with little or no
oxygen continue
to form in coastal
areas worldwide
due to fertilizer
run-off from
agriculture and
fossil fuel burning

August 15, 2008

The Gazette

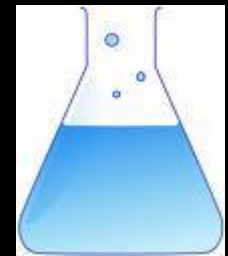
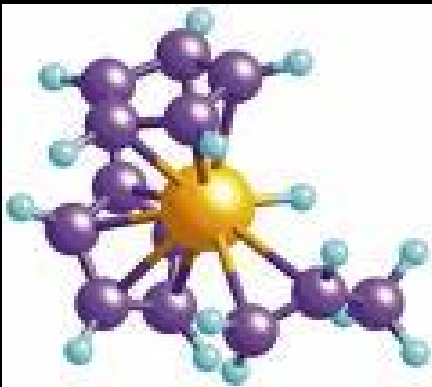
Montreal Gazette, May 25, 2004

"Infertility used to be a female problem," said Serge Belisle, a professor of obstetrics and gynecology at the University of Montreal's Centre Hospitalier. But now scientists are grappling with a worldwide trend.

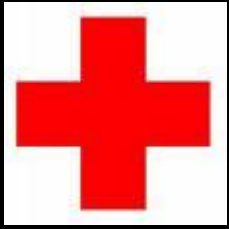
"Over the past 50 years, sperm counts have been declining in humans, in animals, even fish," he said. "It's a reality we have difficulty grasping because it's a new reality for us. Now, 50 per cent of the problem [fertility] is male. "(But) we know more about the biological prerequisites of conception from the female standpoint than the male."

The drop in male potency is believed to be related to environmental toxins and drugs in the drinking water that are responsible for the "feminization" seen in animals and fish.

Pesticides, heavy metals, other industrial chemicals now known to cross the placenta and enter the brain of the developing fetus with subsequent learning and behavioral disabilities



**National Academy of Sciences
Mount Sinai School of Medicine**



RED CROSS STUDY OF UMBILICAL CORD BLOOD
- 10 BABIES BORN IN AUGUST & SEPTEMBER 2004

- Tests revealed a total of 287 chemicals
- Found an average of 200 industrial chemicals and pollutants in cord blood
- = Waste materials from burning coal, gasoline, & garbage; pesticides; chemicals from consumer products

CHILDREN'S VULNERABILITY

- **Children's enhanced vulnerability to toxins:** lead, methyl mercury, polychlorinated biphenyls (PCBs), and tobacco (heavy metals generally)
- Developing **fetus and young child particularly vulnerable** – consume far more water and food per unit of weight compared to adults
- Researchers have found “**remarkably low level exposures**” linked with **toxicity symptoms:** intellectual impairments, behavioral problems, spontaneous abortions, & preterm births

CHILDREN'S VULNERABILITY - 2

- **Toxins enter transplacentally before birth and through breast milk** and direct ingestion of dust, soil and foods
- Development **neurotoxicity and reproductive toxicity testing rare**
- Estimated **1 in 6 US children with developmental disabilities** from subtle learning problems to overt behavioral/emotional disorders
- **“Dose makes the poison” no longer a reliable assumption**

Vol 2, Issue 3 March 29, 2005
PLOS Medicine <http://medicine.plosjournals.org>

Dr. Bruce Lanphear, Professor of Pediatrics & Environmental Health; Dir Environmental Health Ctr, Cincinnati Children's Hospital Medical Center

Dr. Charles Vorhees, Professor of Pediatrics, Cincinnati Children's Hospital

Prof David Bellinger, Dept of Neurology, Harvard Medical School

ASTHMA



Nearly 11% of children headed back to school this fall have asthma. Annually, school aged children with asthma miss just under 13 million days in the classroom making asthma related illness one of the most common reasons kids are absent from school.



American Lung Association
2008 <http://www.lungusa.org/site/c.dvLUK900E/b.22542/k.CA6A/Home.htm?aid=3934809> 2008

source: Science News, August 2,
2003, Vol 164 (p72))



Studies “now accepted by most researchers” have shown that community death rates rise and fall nearly in lock-step with local changes in concentrations of tiny dust particles – even when concentrations of those particulates are just one-quarter of the federal limit for indoor air. Research since 2001 links the greatest harm to the *tiniest* dust: particulate matter no more than 2.5 micrometers in diameter, called the PM-2.5 fraction. Ultrafines, particles less than 0.1 micrometer across, may be the most dangerous. They represent a class of dust that environmental studies and regulations have generally ignored.

– Joel Schwartz
Harvard School of Public Health
2003

Body Burden

Centers for Disease Control (CDC)

Rowan Holland

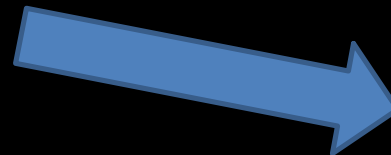
20 months old - In his blood:

- DDT
- PCBs
- Mercury
- Cadmium
- Plasticizers
- Flame retardants (PBDEs)



PBDEs:

**behavioral changes are
observed in rats at
300ppb**



Rowan's

**PBDEs:
838ppb**

The release of thousands of industrial chemicals into the environment is “an uncontrolled experiment on six billion people.”

Leo Trasande
Pediatrician and mercury expert
Mount Sinai School of Medicine
New York City

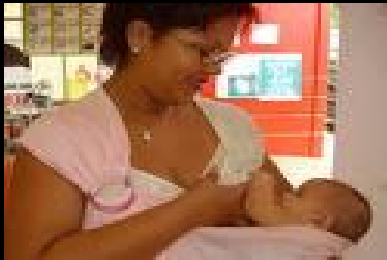


TEFLON



Chemicals used to make nonstick (teflon) cookware and stain-resistant (scotchgard) fabrics are spreading around the world and turning up in surprising places, everywhere from wildlife and drinking water supplies to human blood. Now, a team of researchers including Kathleen Arcaro of the University of Massachusetts Amherst has found these suspected carcinogens in samples of human milk from nursing mothers in Massachusetts.

PFCs



“Perfluorinated compounds, or PFCs, are found in human blood around the world, including the blood of newborns, but this is the first study in the United States to document their occurrence in human milk,” says Arcaro, a professor in the department of veterinary and animal sciences and a member of the environmental sciences program.



“While nursing does not expose infants to a dose that exceeds recommended limits, breast milk should be considered as an additional source of PFCs when determining a child’s total exposure.”

WHO DRUGGED MY DRINK?

A recent study found that drinking water in the United States is full of prescription drugs. That's not to say they don't appear in a concentration great enough to hurt you, you are drinking them, and they paint an interesting picture of what we're putting into our bodies—and then into our water supply.

HERE'S HOW IT HAPPENS.

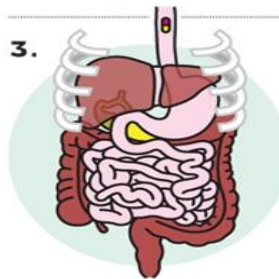
1.



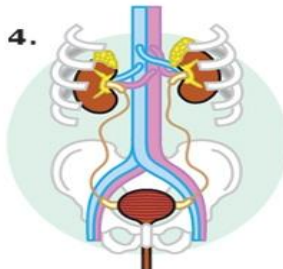
2.



3.



4.



5.



1. A glass of water is filled. 2. A pill is consumed. 3. The pill enters the esophagus. From there it passes through the stomach and into the small intestine. There the drug is absorbed into the bloodstream. Once in the bloodstream it makes its way to the liver where it is metabolized. Any unabsorbed drug gets passed to the colon and is excreted in the feces. 4. The liver converts the drug into a water-soluble form which then enters the kidneys via the bloodstream. The kidneys then excrete the drug in the urine. 5. Our waste then enters the sewage system.

6.



6. Most of our waste water ends up in municipal sewage treatment plants, where it is heavily processed to remove physical, chemical, and biological contaminants. The water is then suitable for discharge back into the environment, but can also be sent off for further filtration to convert it into drinkable water. While efforts are made to remove all impurities from our water, the system is not perfect and trace amounts of chemicals can remain.

DRUGS AND OTHER STUFF IN OUR WATER

ATENOLOL:

A beta-blocker used in treating heart disease.

CARBAMAZEPINE:

A drug used mainly for the treatment of epilepsy and bipolar disorder. It reduces alcohol tolerance and can counteract oral contraceptives.

ESTRONE:

A hormone—which causes gender mutation in fish—that occurs naturally, but also in birth control pills.

GEMFIBROZIL:

A drug used to lower cholesterol.

MEPROBAMATE:

A popular sedative.

NAPROXEN:

A painkiller.

PHENYTOIN:

An anti-seizure medication.

SULFAMETHOXAZOLE:

An antibiotic used in the treatment of strep throat, among other infections.

TRIMETHOPRIM:

An antibiotic used to treat urinary tract infections.

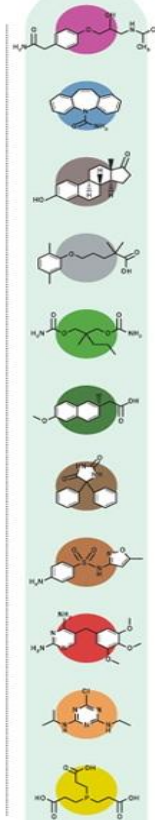
OTHER STUFF

ATRAZINE:

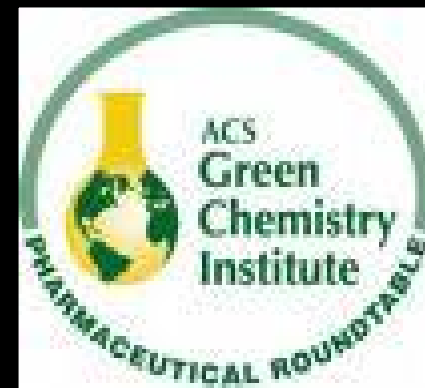
A weed killer banned by the European Union; The United States uses 76 million pounds of it annually.

TCEP:

A reducing agent used in molecular biology experiments to break disulfide bonds.



PIE



GOOD

SOURCES: *The Works: Anatomy of a City* by Kate Ascher; Australasian Biosolids Partnership; The New York City Department of Environmental Protection; *Principles of Anatomy and Physiology*, Seventh Edition by Gerard J. Tortora and Sandra Reynolds Grabowski; Southern Nevada Water Authority

good.is/
Transparency

SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

Source: Science News, May 23, 2004

Virtually all of America's fresh water is tainted with low concentrations of chemical contaminants, according to the new report of an ambitious nationwide study of streams and groundwater conducted by the U.S. Geological Survey (2004)



December 2007 Headline: “Human Pollution Knocks Out 42% of Natural Streams in the United States”



**42% POLLUTED OR IN “POOR”
CONDITION**

25% CONSIDERED FAIR

**Only 1 in 4 streams in the US are in
“good” condition**



Clean Commerce Paradigm

A Foundation of 21st Century Development

**THE PROBLEMS ARE NOT
GOING AWAY**

Climate change, energy security, fuel price uncertainty, fossil fuel pollution, ecosystem impairment, environmental health concerns, poverty, social injustice, resource scarcity/competition

**The problems are basic: AIR, WATER, FOOD, HEALTH, SHELTER,
ENERGY, TRANSPORTATION**

We need answers to our current economic woes that also embrace the larger picture of a global collision among population growth, economic development needs and the limits of natural systems

HOW TO LIVE ON A CROWDED PLANET

**CLEAN
COMMERCE
AS A PATH
THROUGH THE
CURRENT
ECONOMIC
CIRCUMSTANCE
- and beyond**



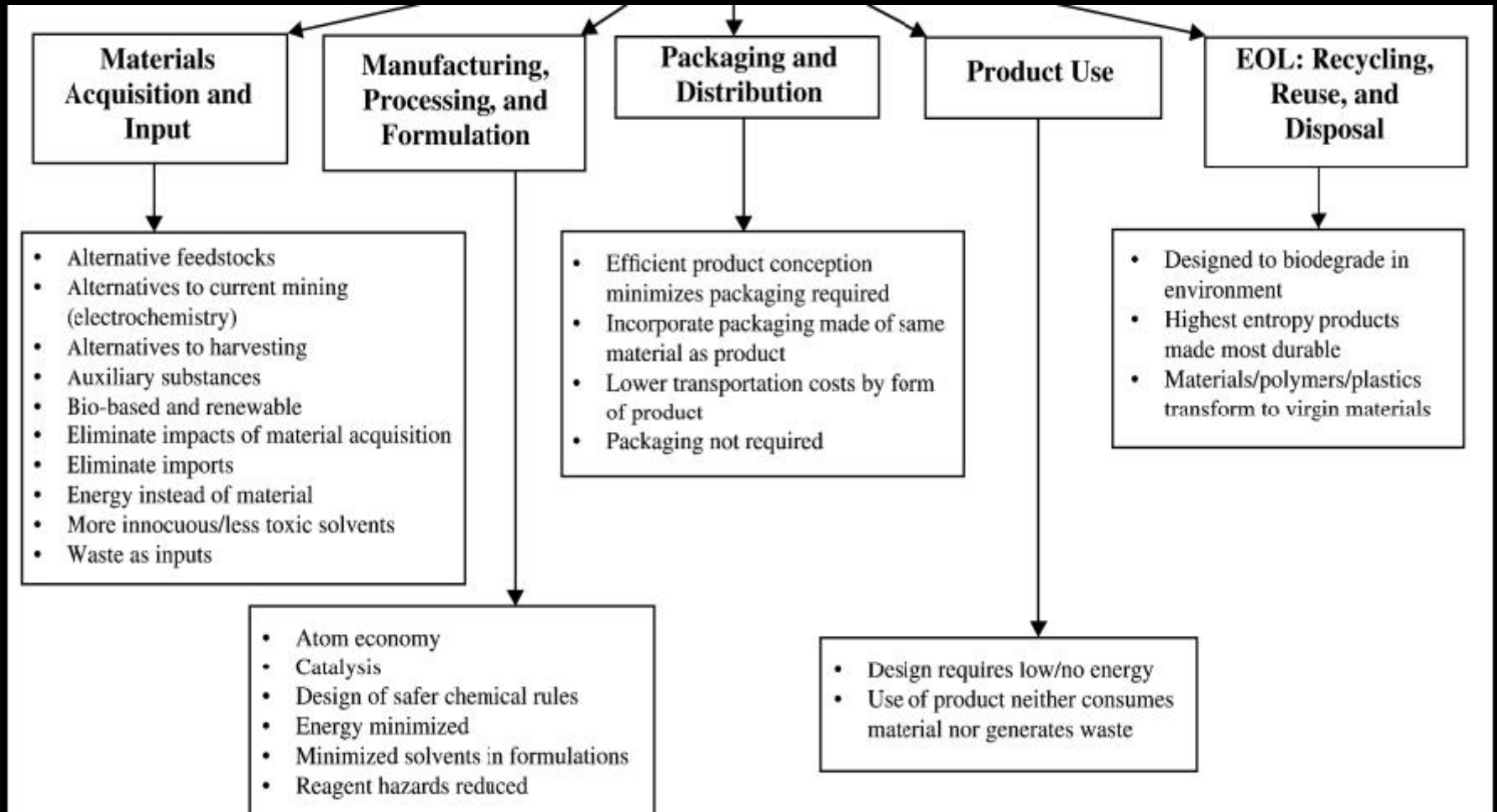
**A shift in
the U.S. and
global
economy
toward
Clean
Commerce**



**Trends are
accelerating
across industries**

- **Energy**
- **Financial**
- **Retail**
- **Consumer packaged goods**
- **Electronics**
- **Pharmaceuticals**
- **Materials**

Energy/Environment/Materials



SUPPLY CHAIN PERSPECTIVE



- Industrial manufacturing clients (clean rooms)
- Property management companies (office buildings, industrial parks)
- Education market (public school systems, university campuses)
- Municipalities (transportation agencies, libraries, office buildings)

Corporate Express/Coastwide “Sustainable Earth” product line

- Equal/better performance vs. category leaders (ASTM certified results – up to 63% improvement in some product categories)
- Market share growth to largest regional supplier (16%)
- Customer base growth – 35%
- Top quartile of industry in 2005 survey:
 - Profit margin
 - Return on assets
 - Return on equity
 - Operating profit
 - Sales per employee



- Reduced material inputs
- Lower input costs
- Lower insurance premiums
- Lower handling costs
- Reduced sick days
- No need for protective equipment (expensive)
- Lower training costs
- Reduced regulatory burdens – monitoring/reporting
- Lower waste disposal costs
- Elimination of training for hazardous waste handling
- Elimination of hazardous waste disposal fees

COST REDUCTIONS

– for the company and
their customers!



Revenue Growth

- Customer retention
- Longer contract commitments
- Market share growth
- Attracted new customers

- Attracted acquisition ----- capital for expansion

