

Reflections on Green Chemistry and California

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DuPont “Green Chemistry” Award

- ☞ Presidential Green Chemistry Challenge
 - Microbial production of 1,3-propanediol
 - ◆ High-volume conversion of renewable resource into chemical
 - ◆ Substitution for petroleum-based feedstock
 - Melding chemistry/biology
 - ◆ More sustainable economically and **environmentally**
- ☞ Many companies are sensing opportunity in societal transition to sustainability

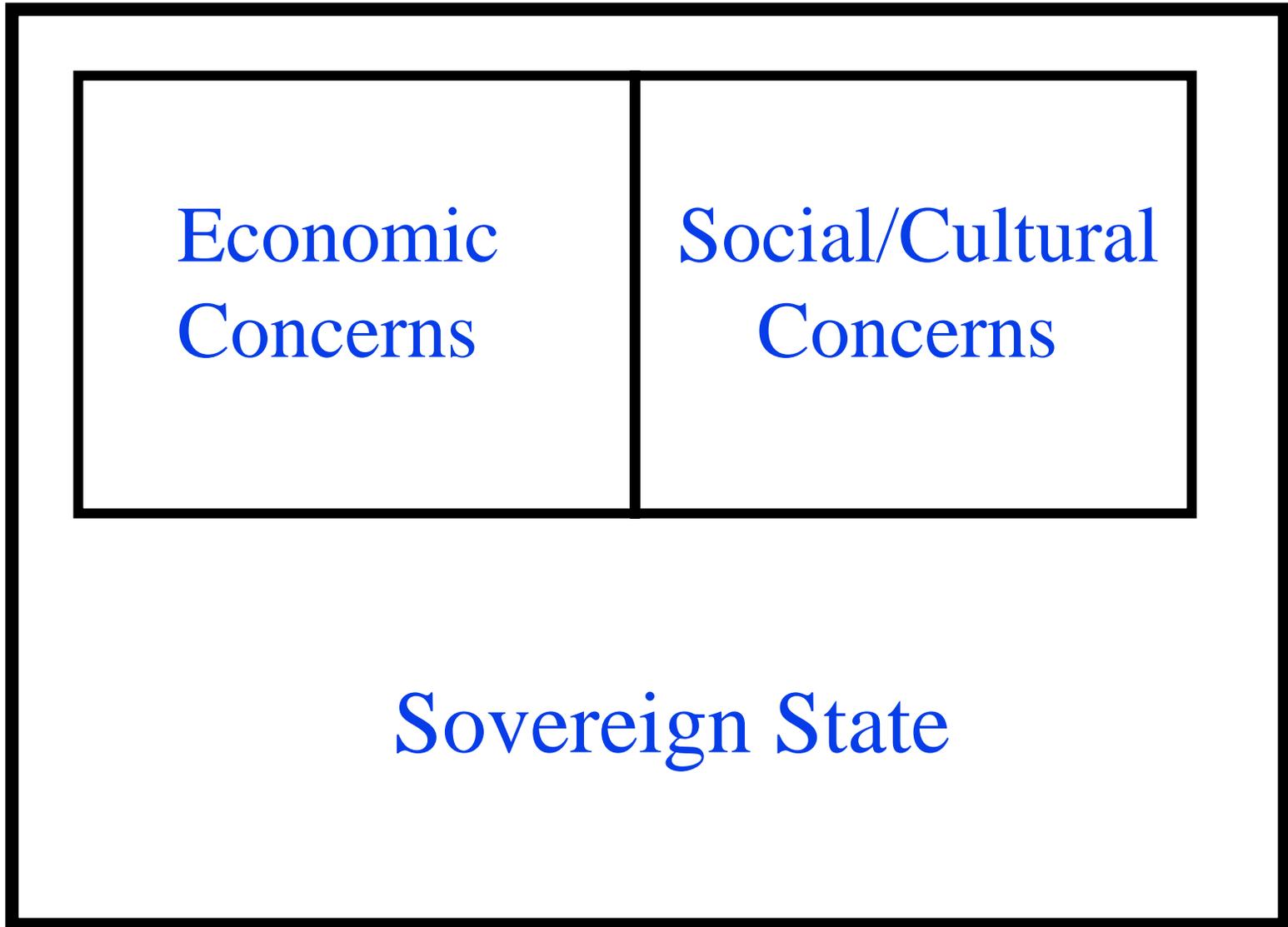


An Era of Transition

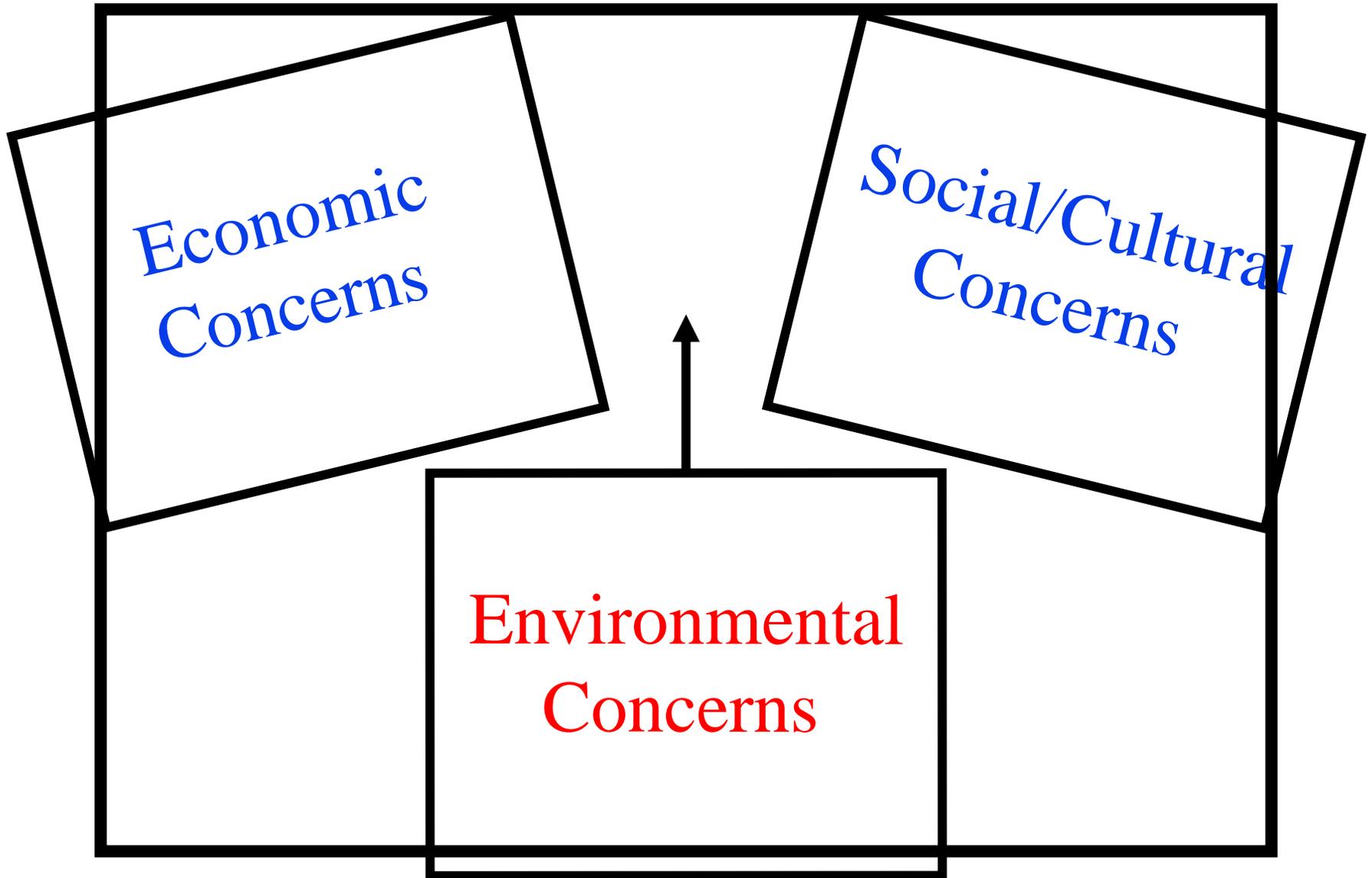
- ☞ Historic paradigm: Corporation as enabler of mass society
 - Meeting needs/wants of mass society
 - Trans-national capacity to mobilize resources
 - “The business of business is business”
- ☞ Emerging paradigm: Corporation as enabler of long term, sustainable well-being
 - De-emphasize “mass”
 - New emphasis on social and environmental responsibility



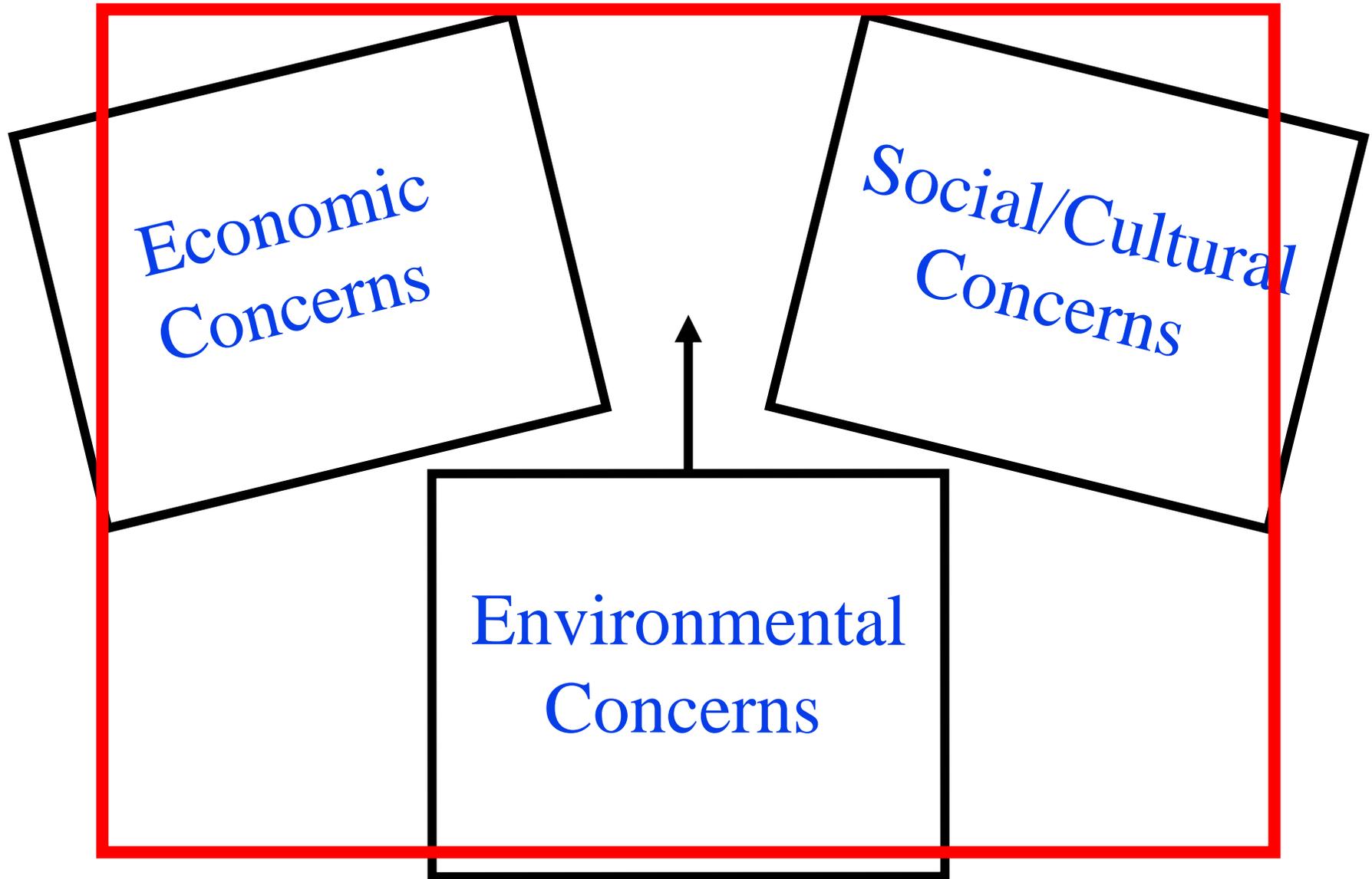
Western Civilization - Historic Model



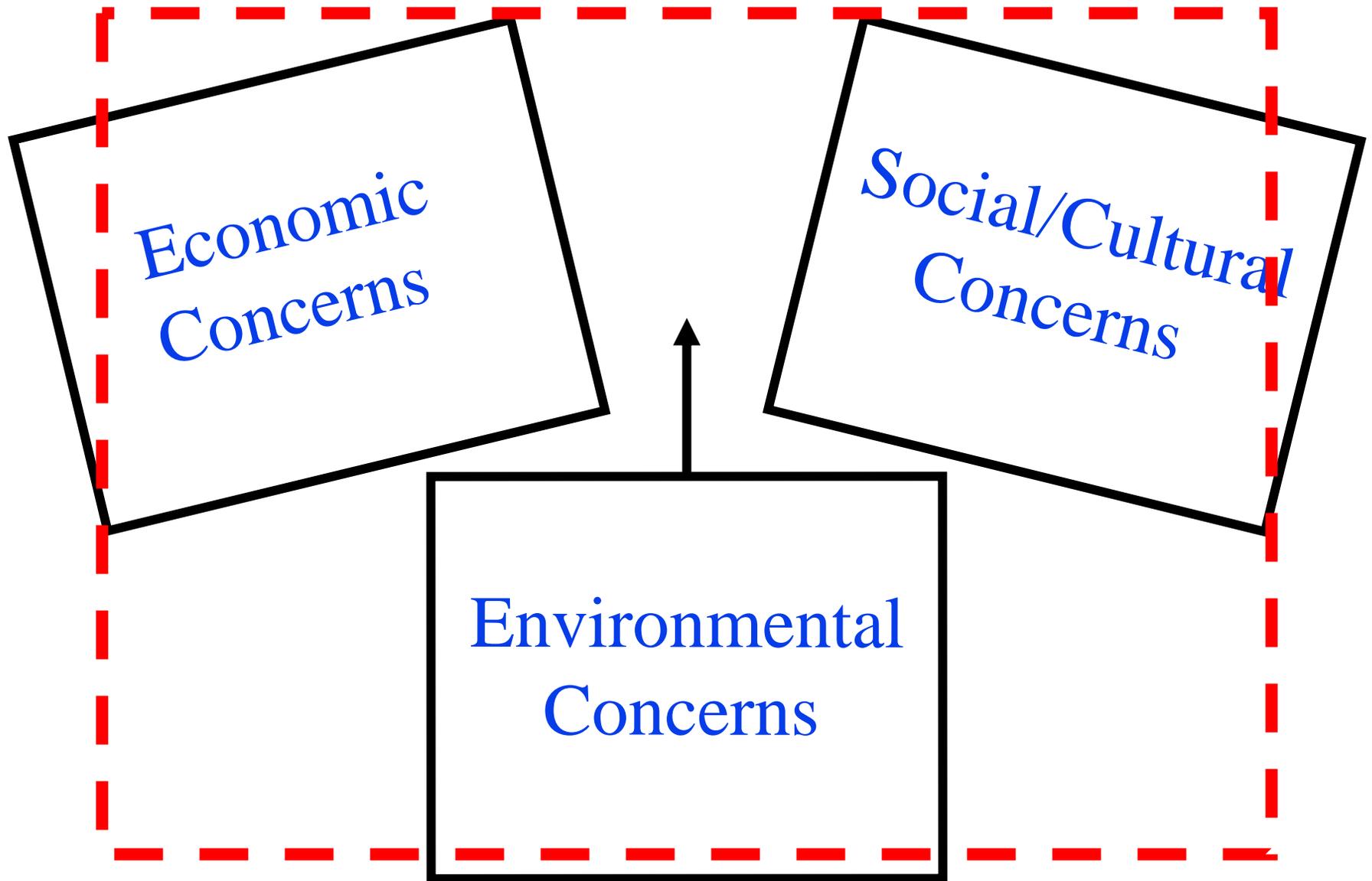
Western Civilization - Emerging Model?



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Western Civilization - Emerging Model?



The Challenge Going Forward...

☞ For Governments

- Shared sovereignty

☞ For private sector

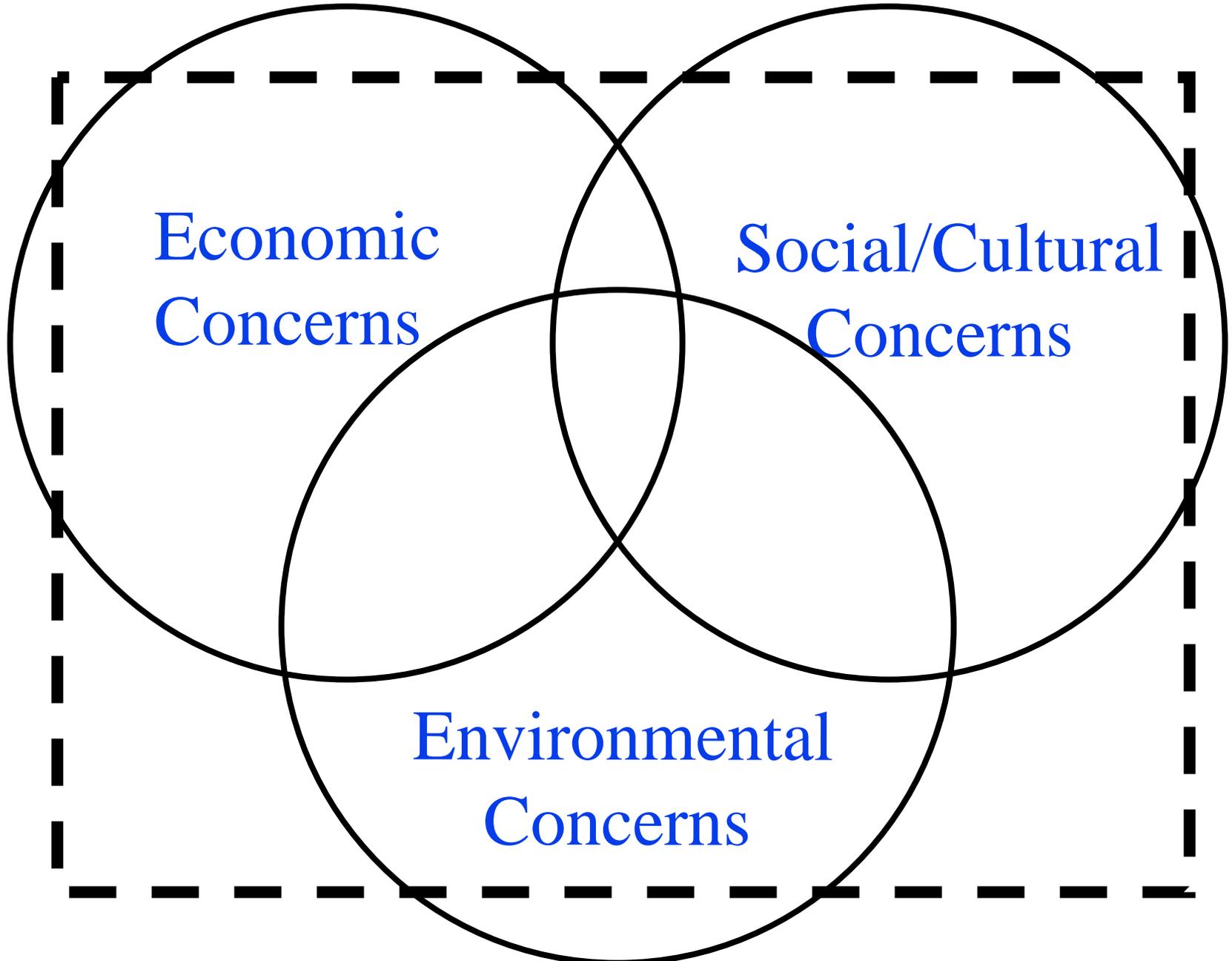
- Added responsibility for environmental and social/cultural dimensions
- “The business of business is **no longer** just business”

☞ For public interest

- Increasing demands for discipline and accountability



Sustainable Development



Economic
Concerns

Social/Cultural
Concerns

Environmental
Concerns

Grand Challenges & Research Needs for the Chemical Industry

- ☞ Toxicology
- ☞ Green and Sustainable Chemistry and Engineering



Grand Challenges & Research Needs for the Chemical Industry

- Toxicology
- Green and Sustainable Chemistry and Engineering
- Life Cycle Analysis
- Renewable Chemical Feedstocks
- Renewable Fuels
- Energy Intensity of Chemical Processing
- Separation, Sequestration and Utilization of Carbon Dioxide
- Sustainable Education



Principles of Green Chemistry

- ☞ Challenge to chemicals value-chain
 - Integrate sustainability into **design** of products
- ☞ R&D dominantly corporate/academic
 - Education/awareness primary challenge
 - ◆ Accelerate process already under way
- ☞ Evolutionary step toward sustainability
 - Basic themes in chemical design
 - ◆ Minimize environmental footprint
 - ◆ Reduce risk



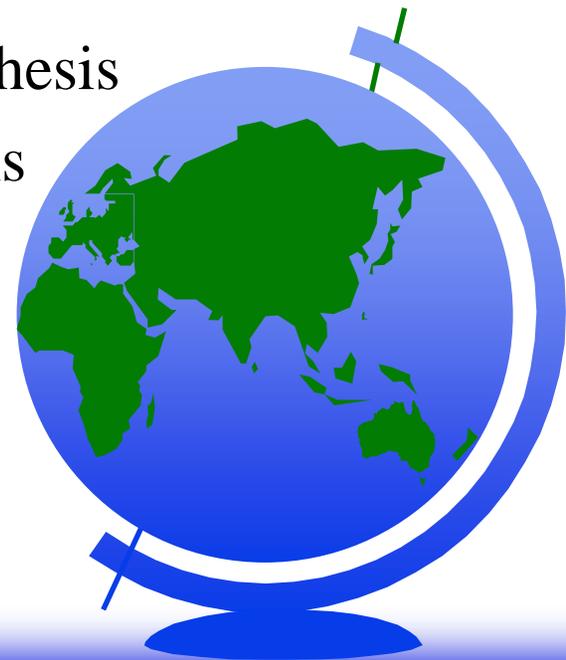
Minimize Environmental Footprint

- ☞ Lifecycle consideration of pollution prevention/reducing resource consumption
 - Translate broad drivers to chemical design & engineering
 - ◆ Prevent waste
 - ◆ Use catalysts
 - ◆ Avoid chemical derivatives
 - ◆ Maximize atom economy
 - ◆ Design to degrade after use
 - ◆ Analyze in real time
 - ◆ Use renewable feedstocks
 - ◆ Increase energy efficiency



Reduce Risk

- ☞ Reduce risk from chemicals
 - Evolving as function of science/technology
 - Translate broad drivers to chemical design & engineering
 - ◆ Design safer chemicals/products
 - ◆ Design less hazardous chemical synthesis
 - ◆ Use safer solvents/reaction conditions
 - ◆ Minimize potential for accidents



Green Chemistry & California

- ☞ California as “incubator”
 - Major goal for State
 - California and sustainability
 - ◆ Climate change
 - ◆ Sustainable production
 - ◆ Energy efficiency
- ☞ Innovation not narrowly a function of government intervention
 - Consistent, strategically appropriate regulation, yes
 - Over-regulation comes with cost
 - ◆ Economic cost
 - ◆ Stifles innovation
- ☞ Evolutionary change **under way**



Bye, Now...



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