



Sustainability Curricula at GeorgeMason University

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Fellow for Sustainable Curricula

Introduction

- Associate Professor, Civil Environmental and Infrastructure Engineering
- First Fellow for Sustainability Curricula
- First appointment 2008/9 academic year
- Reappointed for the 2009/10 academic year
- 1/2 time appointment
- Report to the provost on matters related to sustainability within the curriculum
 - New courses
 - New degree programs
 - Certificates
 - Minors
 - Research

Other related positions

- Sustainability Coordinator (Lenna Storm, Fall 2007)
 - Reports to the Vice President for Facilities (Thomas Calhoun)
 - Office of Sustainability
 - Sustainability Master Plan
 - Climate Action Plan
 - Farmers Market
 - Organizes the Sustainability Advisory Council
 - Focuses on “greening” the campus
 - Developing a campus that “practices what it preaches”

Workshop

- Sustainability Across the Curriculum workshops held in January 2007 & 2008
 - Courses created or redesigned through faculty members' involvement
 - Over 30 courses developed related to sustainability as a result of the workshop



Grown to Over 40 Courses Related to Sustainability

Graduate

CEIE 501: Sustainable Land Development
CEIE 690: Environmental Sustainability and Entrepreneurship
CONF 714: Community and Organizational Conflict Analysis and Resolution (Sustainability Laboratory and Simulation)
EDCI 573: Teaching Science in the Secondary School
EDLE 690: Using Research to Lead School Improvement
GCH 560: Environmental Health
HIST 615: American Environmental History
TOUR 540: Sustainable Tourism Management

Undergraduate

ANTH 370 - Environment and Culture
CEIE 355 - Environmental Engineering and Science
CEIE 401 - Sustainable Development
CEIE 450 - Environmental Engineering Systems
CEIE 456 - Environmental Law
CHEM 155 - Introduction to Environmental Chemistry I
EOS 121 - Dynamic Atmosphere and Hydrosphere
EOS 304 - Population Dimensions of Global Change
EOS 305 - Global Environmental Hazards
EOS 306 - Sustainable Development
EOS 312 - Physical Climatology
EOS 322 - Issues in the Global Change
EOS 353 - Observations of the Earth and Its Climate
EOS 455 - Environmental Impact Assessment
ECON 335 - Environmental Economics
EVPP 110 - The Ecosphere: An Introduction to Environmental Science I
EVPP 201 - Environment and You: Issues for the Twenty-First Century
EVPP 335 - People, Plants, and Culture
EVPP 336 - Human Dimensions of the Environment
EVPP 337 - Environmental Policy Making in Developing Countries
EVPP 361 - Introduction to Environmental Policy
EVPP 421 - Marine Conservation
GEOG 303 - Conservation of Resources and Environment
GEOL 305 - Environmental Geology
NCLC 220 - Energy and Environment
PHYS 331 - Physics of Renewable Energy
PHYS 385 - Materials Science with Applications to Renewable Energy
PRLS 250 - Wilderness Travel and Sustainability
PRLS 300 - People with Nature
PRLS 402 - Human Behavior in Natural Environments
PRLS 501 - Introduction to Natural Resources Law
PHIL 343 - Issues in Environmental Ethics
SOC1 320 - Social Structure and Globalization
TOUR 312 - Ecotourism
TOUR 340 - Sustainable Tourism



Existing Programs Related to Sustainability

Minors

- [Minor in Sustainability Studies](#) - A society grounded in the principles of sustainability achieves balance among the "Three Es": Ecological integrity, Economic vitality, and Equity among people. The Sustainability Studies Minor (SSM) introduces students to the concepts, principles and ethical and moral issues that inform the sustainability paradigm.
- [Minor in Renewable Energy](#) - The mission of the George Mason University Renewable Energy minor is to provide a sound scientific education in renewable energy that will prepare students for graduate studies and research, employment opportunities and a socially and environmentally responsible lifestyle.

Majors

- [B.S. Degree in Global and Environmental Change](#) - The B.S. Degree in Global and Environmental Change, one of the first of its kind in the nation, distinguishes itself from other degrees in the natural sciences in that it examines, from local, regional and global scales the dynamics of Earth's systems and their interactions: the geosphere, the atmosphere, the ecosphere and the sociosphere.
- [Undergraduate Concentration in Conservation Studies](#) – (Bachelor of Arts in Integrative Studies) Promotes the scientific and social study of the phenomena that affect the maintenance, loss, and restoration of biological diversity. Integrative curriculum deals with biology, ecology, public policy, international relations, economics, history, ethics, literature and other arts as these pertain to conservation issues.

Graduate Studies

- [PhD in Climate Dynamics](#) - The mission of the Ph.D. Degree Program in Climate Dynamics is to train the next generation of scientists in climate dynamics and related fields.
- [Graduate Certificate Sustainability and the Environment](#) - The principal focus of this advanced Certificate is to provide a detailed understanding of evolving Real Estate concepts, particularly as relating to land development, sustainability and the impact of evolving development on the environment.
- [Graduate Certificate in Environmental Conflict Resolution and Collaboration](#) - The Graduate Certificate in Conflict Resolution and Collaboration focuses on a systems approach to environmental conflict to understand how it is embedded within formal legal, regulatory, and ecological systems as well as informal networks of governance.

Concerns

- How do we ensure that there is sufficient academic content to be listed as a sustainability related course?
- How do we ensure that there is not “too much” overlap between academic programs?
- How do we better coordinate faculty interested in sustainability research?

Sustainability Studies Advisory Council

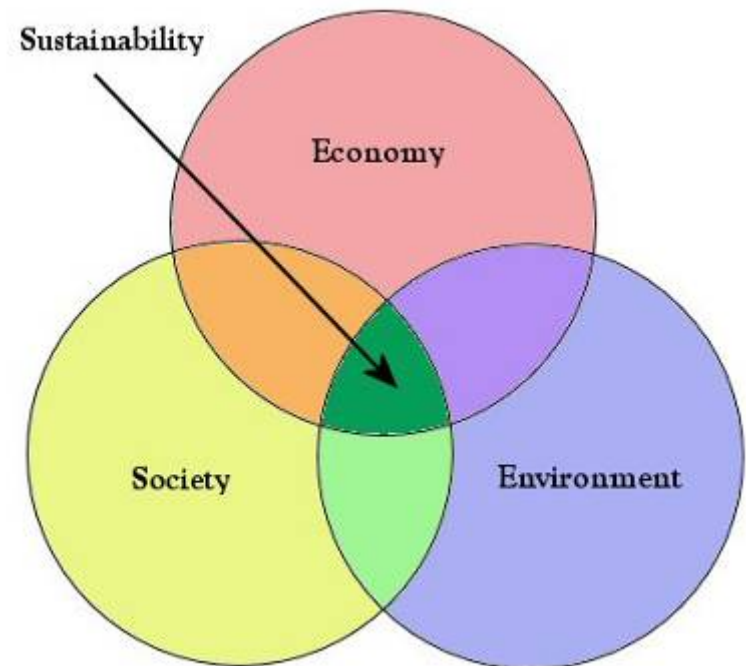
- Chaired by the Fellow for Sustainable Curricula (2 year term)
- An advisory body on inter-unit sustainability activities.
- Responsibilities
 - Review course syllabi for sufficient sustainability content
 - Maintain the sustainability studies web site
 - <http://sustainablestudies.gmu.edu>
 - Promote research and teaching at the highest level
 - Oversee the development of academic programs related to sustainability
 - Encourage interdisciplinary collaboration and exploration
 - Advise on new sustainability hires

Membership and Organization

- Faculty of the Sustainability Studies Advisory Council (SSAC)
 - All persons in George Mason University holding faculty rank as defined in the George Mason University Faculty Handbook:
 - Who are actively engaged in sustainability research, as evidenced by publications or funding, and/or
 - Who are actively engaged in sustainability teaching in the previous five years, and/or
 - Others as approved by the officers of the SSAC.
- Officers of the Sustainability Studies Advisory Council
 - Chair: The Fellow for Sustainability Curricula (2 year appointment)
 - Representatives of the following units as appointed by their Deans
 - College of Science
 - College of Humanities and Social Sciences
 - Volgeneau School of Information Technology and Engineering
- The Sustainability Studies Advisory Council will send a written report of their activities at the end of the Spring semester each year, to the Provost and the Deans of the following units:

GMU Goal

- Develop world class academic programs that honestly reflect the interdisciplinary nature of sustainability



Under Development Undergraduate Programs

BS in Environmental Science (BSES)

- The BSES focuses on scientific understanding of the biosphere and the ecosphere, and techniques for investigating the mechanisms by which systems from the cellular to the ecosystem level function in response to anthropogenic perturbations. It includes study of the techniques of science and engineering that might be used to understand, protect and improve environmental quality. The degree provides an introduction to environmental policy processes wherein risk assessment based on natural science is integrated into risk management through a variety of public and private decision-making processes.

BA in Sustainability Studies

- This degree program is truly interdisciplinary in nature and immerses students in the study of environmental protection, social justice, and economics as these relate to sustainability. Students will select from one of three concentrations.

Under Development

MS in Sustainability Science

- Status - Beginning dialog with sustainability community at GMU
- Some thoughts on what might be included
 - The program must reflect the complexity and the multidimensional character of the sciences that support sustainable development
 - Environmental and earth sciences, health sciences, civil engineering, electrical engineering, physics, chemistry, and others
 - Balance scientific learning with an understanding of economics, finance, ethics, social responsibility, risk and environmental communication
 - Entrepreneurship and business development
 - Fundamental understanding of decision sciences and risk
 - Possibly psychology
 - Before attempting to change human attitudes and choices, we need to better understand human behavior



Under Development Graduate Programs

Graduate Certificate - Engineering for Sustainability

- This certificate is focused on sustainable design, construction, O&M and ultimate retirement of the built environment. Students are introduced to sustainable lifecycle practices related to structures, transportation systems, water and wastewater treatment facilities, energy systems, natural and recovered resources, and civil infrastructure.

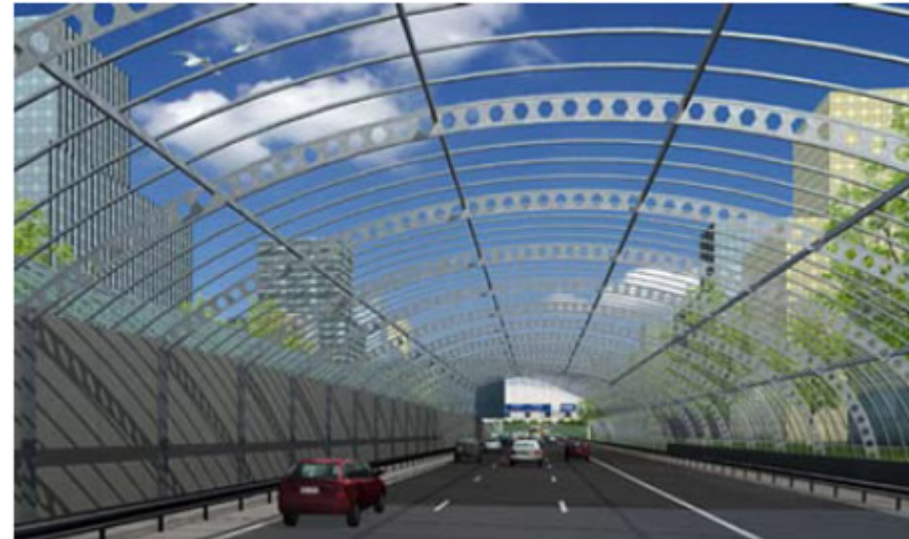


Engineering for Sustainability Certificate - The Vision

- Sustainable infrastructure must be planned, designed, constructed, operated and ultimately retired in a manner does not diminish the social welfare, economic viability and ecological integrity
- American Society of Civil Engineers estimates that raising America's current overall infrastructure grade from a D to a B will cost \$1.6 trillion.
- Moving forward in a sustainable manner may require a revolutionary change in the way that we approach public works and support services
- Working with what we have, constrains our thoughts and inhibits our creativity
- If you think in an iterative way, you will move forward in an iterative way
- The new certificate is designed to help students think beyond the constraints of our current infrastructure.

The Sustainable Highway

- **Developed by Mr.László Vákár**
- The 'Sustainable Highway' concept offers an integrated solution to motorway emission and noise problems.
- Motorway canopy made of cold-bendable laminated glass
- Transparent material is bendable on site at ambient temperature
- The material is as flexible as plastic and lightweight.
- The optical quality is much better than laminated glass and the price is considerably lower
- It does not scratch, it does not age and it requires little maintenance.



Winner of the "Nationale Geluid en Trillingen Innovatieprijs 2007" (National Noise and Vibrations Innovation Award 2007) and the "Nationale Innovatieprijs Luchtkwaliteit 2007" (National Innovation Award Air Quality 2007)

Stormwater Management Green Roofs



❑ The green roof at the School of Art, Design and Media at Nanyang Technological University in Singapore.

❑ Glass facade provides a high performance building envelope that reduces solar gain and heat load while allowing the benefits of natural views and daylight into creative spaces.

❑ Diffused natural daylight is abundant throughout studios and classrooms, filtered through the surrounding foliage.

❑ The roofs create open space, insulate the building, cool the surrounding air and harvest rainwater for landscaping irrigation.

❑ Planted grasses mix with native greenery to colonize the building and bond it to the setting.

<http://www.inhabitat.com/2008/01/23/amazing-green-roof-art-school-in-singapore/>

The Greenroof City

- Benefits
 - Increase city biodiversity
 - Sequestration of CO₂
 - Decrease stormwater runoff
 - Capture excess rainwater in underground cisterns for landscape watering
- The greenroof city is estimated to retain up to 75 percent of water from storms
- Potential for completely eliminating the need for stormwater infrastructure



<http://www.sciencedaily.com/releases/2009/08/090803083628.htm>

<http://www.greenroofs.org/>

Is this the Greenest Hotel in the US?

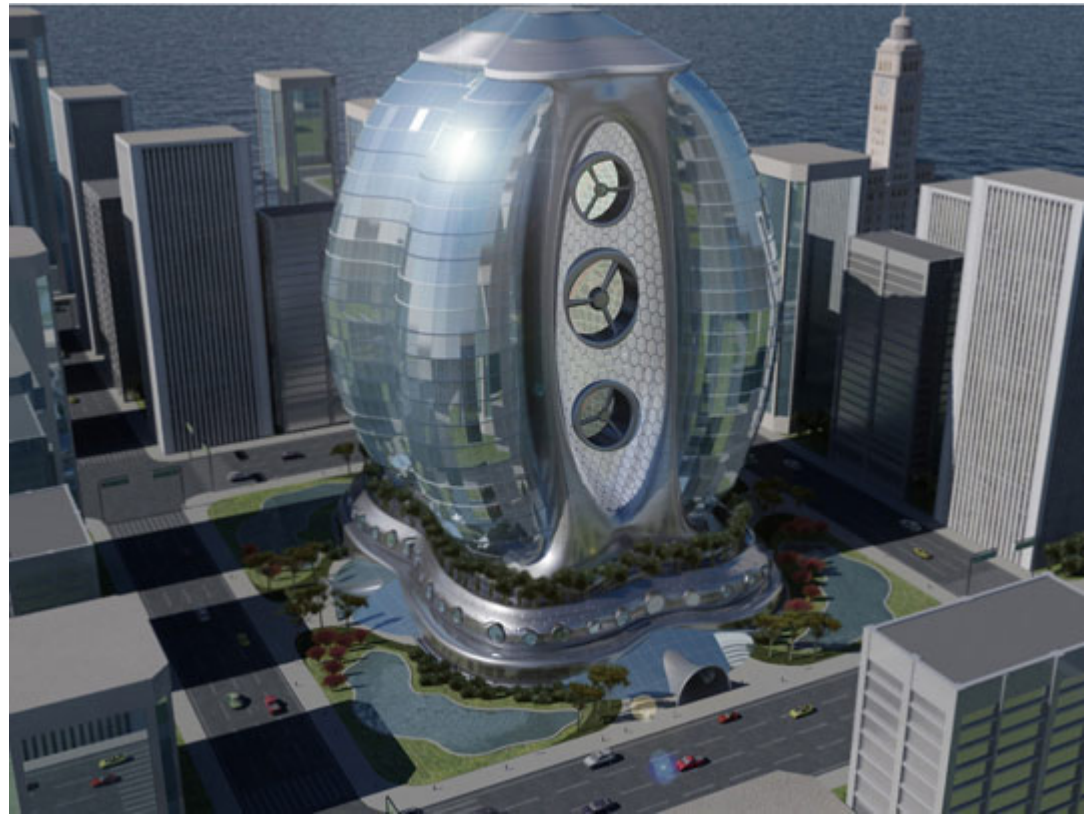
- The **Proximity Hotel** in Greensboro, NC and its restaurant were the very first businesses of their kind to be awarded LEED Platinum certification from the USGBC.
- Among the hotel's many sustainable practices are solar panels on the roof, a geothermal cooling system for the restaurant's refrigeration needs, recycled building materials and high-efficiency plumbing fixtures.



Envision Green Hotel

Living Organism Building

- ❑ Designed by Richard Moreta Architecture (founded by a partner of GMZ-Design)
- ❑ Part wind tower, part urban eco-resort
- ❑ Operating like a living organism, the Envision literally breathes through its wind and atmospheric conversion systems, which allow natural air into the interior of the building without mechanical intervention.
- ❑ Photovoltaic exterior sheathing provides the building's energy, while indoor gardens at various levels of the structure act as upward extensions of the earth, creating mini-microclimates that filter the air and act as added insulation.
- ❑ Recycled pools of water around the structure serve as catch basins, water reservoirs, fire barriers, and decorative aquatic features.
- ❑ Power from the wind turbine heats the boiler and creates steam for the chilled water plant beneath the structure to cool and heat the hotel



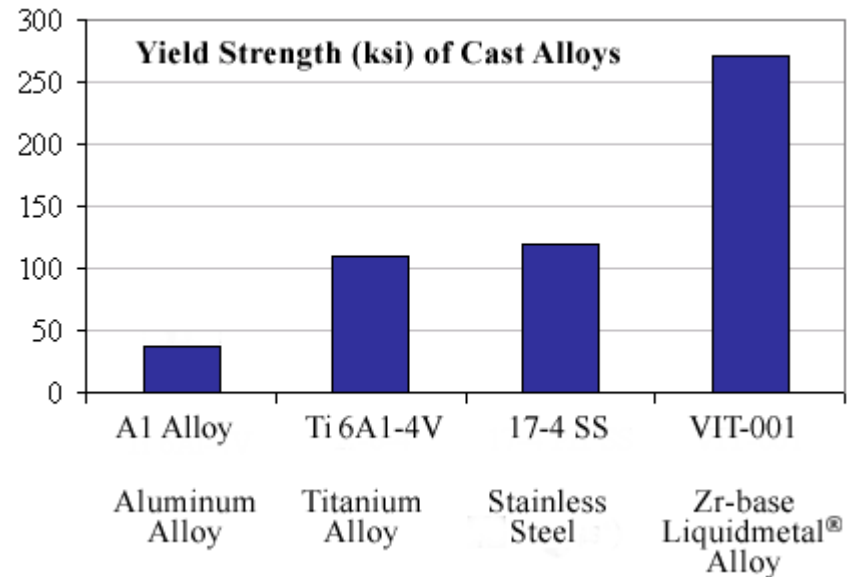
Liquidmetal: Redefining Metals for the 21st Century

- NASA, the California Institute of Technology (Caltech) and the U.S. Department of Energy have developed a new building material.
- "Liquidmetal" is a type of alloy, a mix of three or more metals, with characteristics similar to plastic that cools quickly and has more than twice the strength of titanium.
- It has long been thought that plastic and steel were the best materials to use in building large products that might be used for aerospace and space exploration applications.
- These new "shapeless alloys" combine the strength of steel with the molding capability of plastic.
- Dr. Bill Johnson of Caltech, Pasadena, Calif., has studied metals with liquid atomic structures for over 30 years. He eventually teamed up with Dr. Atakan Peker of Liquidmetal Technologies, Lake Forest, Calif. Peker further helped Johnson develop the idea of creating thick liquid metals that form glass without the need for rapid cooling.
- **These characteristic properties are:**
 - High Yield Strength
 - High Hardness
 - Superior Strength/Weight Ratio
 - Superior Elastic Limit
 - High Corrosion Resistance
 - High Wear-Resistance
 - Unique Acoustical Properties



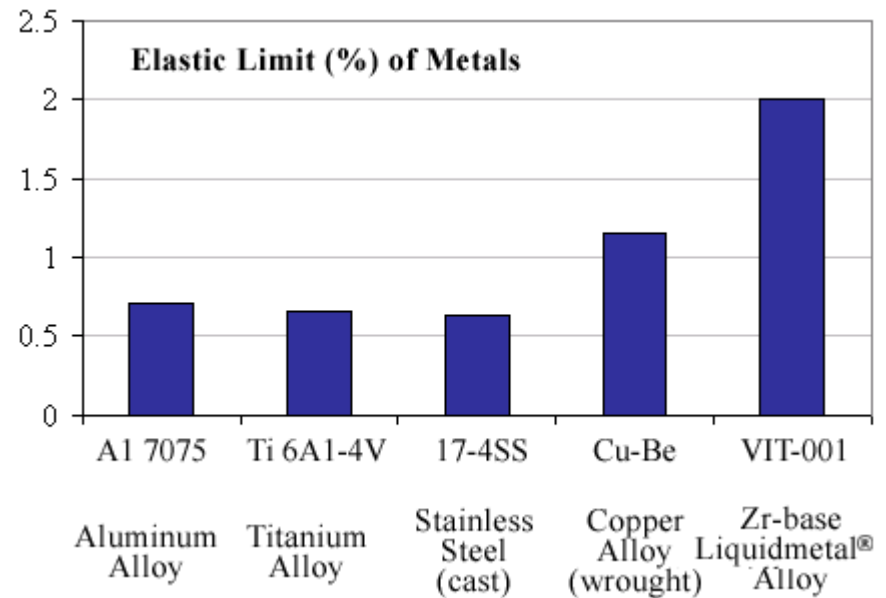
High Yield Strength

- One of the direct results of the unique atomic structure of Liquidmetal alloys is very high yield strength, which approaches the theoretical limit and far exceeds the strength currently available in crystalline metals and alloys.
- For example, yield strength of over 250 ksi has been achieved in Zr-base and Ti-base Liquidmetal alloys (VIT-001 series). This is more than twice the strength of conventional titanium alloys.



Superior Elastic Limit

- Another unique property of Liquidmetal alloys is the superior elastic limit; i.e., the ability to retain its original shape (memory) after undergoing very high loads and stress.
- The Liquidmetal alloys have much higher corrosion and wear resistance than their conventional (crystalline) counterparts due to the unique atomic structure.



Philadelphia's 20/2 Collaborative Designs Algal-Hydrogen Production Stations

- The 20/2 Collaborative, has designed a system for the on-site biological production and distribution of hydrogen
- The hydrogen, created by algae situated in large ponds, is captured by floating balloons



Coming soon to a neighborhood near you

- ❑ Scientists at UC Berkeley, are researching the production of hydrogen from algae.
- ❑ Hydrogen has large containment requirements and, in the US, refilling stations exist only in LA, New York, and DC.
- ❑ The 20/2 Collaborative developed a prototype algae pond (10 meter diameter) and balloon that could produce and store hydrogen for use by up to 12 vehicles.





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Farming - Energy Spent in Transportation and Distribution of Crops

- Transporting food consumes a vast amount of fossil fuels.
 - Domestic agricultural products total 566 billion ton-miles, or 20 percent of the commodity transport within the United States.
 - A rough estimate predicts that 120 million tons of CO₂ emissions are directly attributable to domestic food transport each year
 - U.S. imports and exports likely account for an additional 120 million tons.



Vertical Farms - Towers of food, farms in the sky: self-sustaining skyscrapers in the city



- What if “eating local” in Shanghai or New York meant getting your fresh produce from five blocks away?



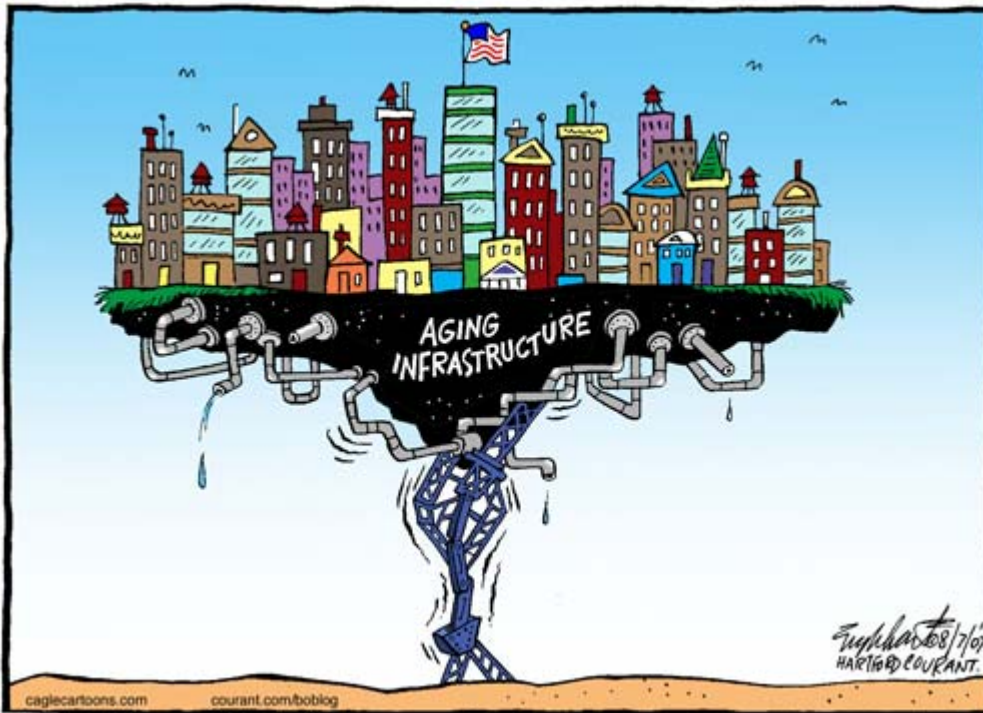
Vertical Farms

- Dickson Despommier, a professor of public health at Columbia University, hopes to make the zucchini-in-the-sky visions a reality.
- Dr. Despommier estimates that it would cost \$20 million to \$30 million to make a prototype of a vertical farm, but hundreds of millions to build one of the 30-story towers that he suggests could feed 50,000 people.



Engineering for Sustainability Certificate Vision

- Progressive
- Challenge the established practices



http://z.about.com/d/politicalhumor/1/0/a/1/aging_infrastructure.jpg

Questions?

