SUSTAINABLE COMMUNITIES

What makes a community sustainable?
What would a sustainable city look like?
Are there examples from the past?
How do we get from here to there?

As we have seen in previous lectures and heard from our several guest speakers, much can be done at the level of a single building to make it more durable and sustainable.

In particular, one should mind the energy, water and materials that go into the building during its construction and use.

It remains, however, that a building does not exist in isolation but needs constant inputs from the exterior and generates constant waste to be assimilated by the exterior.

How does the picture look like when we consider many buildings together and start considering a community?

Is there an economy of scale that one can take advantage of for energy, water and materials?
A thought from Bill McDonough D’73:

If a building can be compared to a tree, because it uses materials and consumes energy to provide shelter, then a city ought to be compared to a forest.

MIT’s ultimate concept of a tree house, built from 100% living nutrients including soy-based plastic windows. The building utilizes gray water biological filtration, and the sun for both ventilation and hot water. Best, it grows with time like a real tree!


A forest is more than a set of trees, each performing its own function. At the level of the set (system), additional functions are performed, such as:

- materials cycling
- water cycling
- habitat for multiple species that interact together
- energy cascading.

A major planning failure: Physically functional but humanly dysfunctional.

The Pruitt–Igoe was a large urban housing project in St. Louis, Missouri. Living conditions began to decline soon after its completion in 1956. By the late 1960s, the complex had become internationally notorious for its poverty, crime, and segregation. Its 33 buildings were demolished in 1976, and the project became an icon of urban renewal and public-policy planning failure.

(Source: Wikipedia)
A tentative definition:

The Government of the United Kingdom defines a sustainable community in its 2003 Sustainable Communities Plan as follows.

“Sustainable communities are places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all.”

Source:

Critique of this definition:
- Emphasis on people's needs without mention of non-human needs,
- Vague statements like “well planned, built and run”,
- Desirability and inclusiveness (“want to”, “inclusive”, “equality of opportunity”, and “for all”) are worthy attributes but not relevant to sustainability.

Can we venture to propose a better definition?

What should be the elements of sustainable community?
First-order thoughts that come to mind:

- Harvest and convert energy locally,
- Cascade energy as much as possible,
- Harvest, use, treat and reuse water locally,
- Use only local and renewable materials,
- Build no more than needed,
- Build in a durable way,
- Respect environmental surroundings (flora & fauna).

Second-order thoughts:

We also need to mind
- People's health and welfare,
- Economy and jobs,
- Transportation of goods and people within the community as well as in/out.

Reality:

– Net-Zero Energy is hard to achieve for a single building.
– But low-intensity and generating buildings can offset high intensity buildings
– Thus, one can achieve Net-Zero Energy more easily at the community scale.

(Source: Malcolm Lewis, lecture to ENGS44 in 2011)

Integrated Design Approach

Premise:

• Creating a low-energy / low-carbon community requires a methodology of integrated design analogous to that used for low-energy buildings.

• Interactive analytics are needed to inform the integrated design process.
The actual aspects will, of course, depend on the nature of the community and on its geographical location.

So, what kind of communities exist in the world?

**Examples:**

- Cities, urban centers
- Towns
- Villages
- Eco-villages / environmentally-oriented communities
- Tribes
- Religious communities (ex. monasteries)
- Kibbutz (Israel)

*Note:* Suburbs don’t count as they are satellites of other communities, and communist collectives don’t count either as they have been failures.

“A city is a congestion of animals whose biological history is enclosed within its boundaries, and yet every conscious and rational act on the part of these creatures helps to shape the city’s eventual character. By its form as by the manner of its birth, the city has elements at once of biological procreation, organic evolution, and esthetic creation. It is both a natural object and a thing to be cultivated; individual and group; something lived and something dreamed.”

“In China, dreaming of the cities of the future has become a national priority.”

(Bill McDonough ’73, 2009)
Project in China by Bill McDonough

Before
After
Waste = Food

Current Solar Income
Large, compact cities

Typical characteristics:

- Dense housing → common walls → energy savings
  → smaller living quarters → energy savings
- Pedestrian friendly → fewer cars/person
- Short distances for road traffic
- Public transportation
- Market oriented → jobs

In 2005, carbon dioxide equivalent emissions in New York City were approximately $58 \times 10^6$ metric tons ($\sim 1\%$ of US total), with $79\%$ coming from buildings.

On a per-capita basis, the carbon footprint is less than a third of the average in the U.S.

However…

Cities are far from being closed systems. They are heavily dependent on their surroundings for

inputs: procurement of water, processing of building materials

outputs: treatment of used water, disposal of solid waste.

The concept of vertical farming in New York City

The concept of urban farming has taken the shape of the wings of a dragonfly on Roosevelt Island in New York City. The initiative aims at relieving shortage of food as well as “reconnecting” consumers with producers.

The 132-story Dragonfly could accommodate 28 different agricultural fields for producing fruits, vegetables, grains, meat and dairy, while its power needs could be entirely met by a combination of solar and wind power generators.

http://www.greenpacks.org/2009/05/21/dragonfly-%E2%80%93-the-high-tech-vertical-farm-for-space-starved-metros/
Curitiba, Brazil

Curitiba is the capital city of the Brazilian state of Paraná and the largest city with the biggest economy of both Paraná and southern Brazil. It has over 1.8 million inhabitants (4,232 people per km²).

Features:
- Preservation of historic sector
- Public transportation by bus in restricted lanes with single fare, used by 85% of the population
- Reduction of vehicular traffic in the downtown area
- 51.5 m² (554 ft²) of green space per inhabitant
- Strict controls on urban sprawl
- "Faróis de Saber" (Lighthouses of Knowledge), free educational centers that include libraries, internet access, and other cultural resources
- Job training, social welfare and educational programs coordinated to supply labor to improve the city’s amenities and services, as well as education and income.

In 2010, Curitiba was awarded the Globe Sustainable City Award which recognizes cities and municipalities which excel in sustainable urban development around the world.

According to the Reader's Digest, Curitiba is the best place to live in Brazil.

New York City and older, European-type cities were not planned to be run sustainably. Actually, they are not sustainable; they only have a rate of emission per person lower than elsewhere.

Some cities, or neighborhoods, have been planned to be sustainable.

Example 1: Bennington Zero Energy Development (BedZED) near London

- Reuse of "brownfield"
- Compact layout
- Serious attempt at carbon neutrality
- PV solar panels; electric cars
- Rainwater harvesting; water treatment on site
- People oriented

Example 2: Masdar in the Arabian desert (Abu Dhabi)

- Local energy generation
- Smart use of natural ventilation, evaporation/condensation
- Taking advantage of day-night contrast
- Closed water loop
Chattanooga, Tennessee

In the 1970s and early 1980s, after much suburban growth, the downtown of Chattanooga was in decline and plagued by a few environmental problems.

In 1984, the city began to develop a community-wide vision that incorporated sustainable community concepts into city planning.

The major driving force behind the revitalization was the Vision 2000 project, which was established as a collaborative effort between residents, business, and local government. Open public forums were held throughout the mid-1980s, and goals were set.

Chattanooga, Tennessee (cont’d)

Forty specific goals were identified, one of which was reduced dependence on the personal automobile through reliance on clean public transportation (electric buses). Others fostered the development of multi-purpose facilities and affordable housing. Cleaning up the Tennessee River and developing the waterfront for recreational purposes was also on the list.

Perhaps the most visible component of the revitalization effort has been the freshwater aquarium. Standing as the cornerstone of the Riverwalk district, it has been a major tourist attraction. Its presence has been the catalyst for the construction of new residential apartments, businesses and recreational facilities.

There is no doubt that Chattanooga is a vibrant and far more pleasant city than it was 20 years ago.

Critics, however, argue that in the push for economic revitalization and environmental restoration, some social aspects have been disregarded. The effort has profited the middle class far more than the working class and minorities.
River Street Market
Carborro, North Carolina

Starting with a block grant from the municipality, an enterprising group of people set out to put Carborro on a sustainable track. The nucleus is a member-owned (cooperative) foodstore. Around it are a restaurant and cultural attractions.

Through its store, the Weaver Street Market promotes local produce, natural foods and reduction of consumption. The emphasis on local, organic produce has a trickle effect: enhanced sense of place, self sufficiency, sustainable farming practices, protection of local water resources, etc.

Ashville, NC shares similarities.

University campuses

In such a situation, one can leverage one type of building against another.

For example:

- Co-generation of electricity from steam generated for heating.

- The heat rejected from refrigerators in a lab building can be captured and used to heat water in the dorm building next door;

- Solar energy harvesting on south facing roofs may be use to power other buildings that do not have a favorable orientation;

- Composting from dining services can be used to fertilize the grounds.
On the yet smaller scale:

**Sustainable villages – “eco-villages”**

In Europe during the Middle Ages and in many parts of the world not touched by the modern idea of “progress”, society was / is organized to ensure stability, and hence durability.

The development of eco-villages is inspired from older modes of living, with emphasis on adaptation to surroundings, local food production, off-grid power, water cycling, cottage industries, affordable housing, and, generally, people working together toward a common purpose.

Examples abound. See: [http://www.ic.org/directory/ecovillages/](http://www.ic.org/directory/ecovillages/) which list over 100 examples

Cobb Hill Co-housing in Hartland, Vermont

Cobb Hill is co-housing community of 16 buildings, including a common house, 7 single-family houses, duplexes and apartments, all built at moderate cost. The goal is to create an environmentally sound community with an emphasis on preserving the surrounding agricultural landscape and developing organic farming ventures. The project includes the restoration of two older farms with careful site planning in order to preserve and enhance the agricultural land and forests.

Many consultants, including architects and planners, engineers, systems experts, biologists, and contractors were all part of an integrated design process. During development, particular attention was made to climate and micro-climate, solar access, hydrology, geology and habitat. The site for Cobb Hill was selected for its rich soil, southern exposure and proximity to the Hanover/Lebanon, NH area and Dartmouth.

The Cobb Hill plan includes clustered housing and a common house on four acres of a sloping pasture. The site planning separated parking and pedestrian friendly zones while preserving over 265 acres of agricultural fields, pastures, and forest. A majority of the land was put into conservation, and the funds generated are committed to the affordable homes.
Cobb Hill Co-housing – Key features

| Layout       | Tightly clustered housing with respect for place  
|             | Emphasis on community and pedestrian access     |
| Buildings    | Project rehabilitated two farms and several farm buildings  
|             | R-15 walls, insulated with dense pack cellulose    |
| Energy       | Heating via centralized wood-burning GARN stoves   
|             | Locally harvested wood                              |
|             | Solar thermal hot water                             |
|             | Energy Star appliances                              |
| Water        | Composting toilets                                  |
|             | Front-loading washers                               |
|             | Greywater reclamation system                        |
| Food         | Locally produced maple syrup, hay, wool, lamb, eggs, chicken,  
|             | flowers, and an abundance of organic fruits and vegetables |
|             | Award-winning cheese                                |
| People       | Some tending the fields                             |
|             | Others commuting to jobs in the Lebanon/Hanover area |

Cobb Hill co-housing – Lessons learned

- Enlisting the builders early in the process was key. Commitment to green materials, systems, and quality was developed through this process.

- Making some allowances for future needs has worked. Though all homes could not afford solar hot water systems at first, all were piped from attic to basement to allow for future installation. Almost all homes have completed the systems.

- Provisions have been made long-term to replace the heating plant with some form of renewable based co-generation, for combined heat and power.

- It takes a village to restore a farm.

- Harder lesson: The communal living arrangements in the Common House and a "shared" house have been problematic, both with banks and residents. (Banks do not like group financing. Residents bicker.)

- The central energy system works well most of winter, but houses at the end of the warm-water lines occasionally need to supplement with propane stoves during cold winter spells.

- The greywater system has been clogging on occasions.

- It takes enormous commitment for residents to be their own developers, about 5 years from inception to move in. And it takes significant designer and contractor efforts to coordinate a process with this many families involved and a developing client base during the course of the process.
Las Gaviotas
a sustainable village in the inhospitable Llanos of inland Colombia

Gaviotas is an eco-village located in the llanos (savannah) of the Colombian department of Vichada.

It was founded in 1971 by Paolo Lugari in an attempt to create a mode of sustainable living in one of the least hospitable political and geographical climates in South America.

Gaviotas began as an idea that attracted scientists, engineers and environmentalists, each going to the place and inventing new ways of living and building technologies on the spot. These innovations are often simple changes to existing technologies.

Las Gaviotas, Colombia
some additional characteristics

- Solar panels locally made out of cheap building materials that are well suited to the peculiar climate of the region.

- Use of local building materials like a unique form of “quickcrete” brick made with dirt from the region.

- A human-driven water pump that can tap aquifers six times as deep as conventional pumps with less effort being expended. While existing pumps in the region raised and lowered a heavy steel piston in a pipe, the Gaviotas engineers created pumps that leave the piston in place and instead lift and lower a cheap, light PVC sleeve around the piston.

- Homemade windmills

- Local pine forest used as a sustainable source of resin in the production of a wide variety of products like turpentine, sold to export in order to sustain the community economically.
Eco-villages: Lessons learned

- People can live in harmony with nature.
- Community living leverages talents and skills.
- Balance is key to sustainability.
- There is an economy of scale for energy and water.
- Social interactions need to be addressed from the start. Living in an eco-village is not for everyone.
- If financing is needed, special arrangements need to be made with local banks.
- There does not appear to be a critical or optimal size, but the larger the eco-village, the more careful the planning needs to be.

Eco-villages: Pitfalls

Need to plan for the long run, not imminent apocalypse
Need to engage with, not retreat from, modern society
Need to move forward to sustainability, not backward to neo-primitivism
Need to recognize that small is not always more beautiful than large
Need to perform careful audits of alternative eco-techniques
Need to measure results accurately
Need to use effective techniques of persuasion
Need to value experience by reducing members' task rotation
Need to foster political efficiency by limiting consensus decision-making
Give up the "pathetically false" notion that one's own group has all the answers
Avoid falling victim of dogmatic, utopian communalism.

Source: http://findarticles.com/p/articles/mi_7051/is_2_10/ai_n28759013/ (now dead link)
**Medieval monasteries**

Monasteries of the Middle Ages are prime examples of sustainable communities, from both environmental and economic perspectives.

Aside from their religious duties, monks were tending farms for their own sustenance, growing medicinal herbs to heal the sick, managing inns for weary travelers, and teaching local children, all out of their own land. Some even raised and bred flowers only for their sheer beauty.

With their surroundings villages, of which they were the cultural centers, monasteries formed complex societies providing material as well as spiritual goods.

Gardens of the medieval monasteries remain an inspiration to some in modern times who study them.

Countless monasteries lasted centuries (ex. Solesmes in France was founded in 1010 and still exists) despite wars and pestilence. Surely, they were/are sustainable!

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**A closing note**

Much thinking has been pursued about sustainable communities and cities, and actual projects (experimentation?) have yielded practical lessons.

The **engineering** of sustainable communities, however, has been practiced piecemeal but is yet to be tackled in a formal way.

This is "white space"!

System thinking is required.