Boston Society of Architects / Massachusetts Institute of Technology
MASS IMPACT | CITIES AND CLIMATE CHANGE
Tang Center, MIT March 28 and June 9, 2008

OVERVIEW / PROSPECTUS

While cities cover only 2% of the world's surface, they accommodate 50% of the world's population and consume 75% of its resources. Paradoxically, however, in their compactness and density, cities present a substantial opportunity for alleviating the global warming crisis. Recognizing that in the United States, buildings account for 48% of the nation's energy consumption and greenhouse gas emissions, the American Institute of Architects has pledged to reduce new buildings to zero fossil fuel energy use by the year 2030, a position endorsed by the U.S. Conference of Mayors.

New England has a challenging environment in which to build, with a wide range of geographic and climatic conditions and a high proportion of existing and underperforming building stock. As a coastal region substantially dependent on 'out of state' fossil fuel energy sources, Massachusetts has the incentive to accept the Mayors' and AIA challenge to become more energy independent and in particular to mitigate the anticipated rise in seawater levels on some of the most valuable and historic real estate in the country.

With vision and the right set of strategies, **Boston has the material and intellectual resources to become an exemplary 21st century sustainable global city.** The region's universities, medical facilities and research and policy institutes, combined with leading practitioners in energy systems, transportation engineering, public health and policy-making, as well as leading architects and urban designers, are collectively capable of making a significant change in the way we use our natural resources.

While the nature of what constitutes a sustainable city is complex and demands an interdisciplinary approach, architects, planners, engineers and the construction industry bear special responsibility for synthesizing and implementing appropriate strategies. The BSA, as the leading organization of design professionals in the region, and the School of Architecture and Planning at MIT, a major international center of research and education, are convening speakers from nearby and around the world who can bring knowledge, inspiration, innovation and research to the challenge of climate change in the city of Boston and its region.

Significant progress has recently been made on the causes and effects of climate change on a global scale; progress has also been made on energy and resource conservation on a building scale. Formidable challenges remain in applying this thinking at the intermediate scale of the spatial and ecological relationships that constitute the city. The symposium series is designed as briefing on the issues, a presentation of work in progress, and a forum for exploring new initiatives. Policy initiatives in other cities and regions are presented with the intention of translating them into the Boston and New England contexts. This is an **opportunity to rethink the nature of the city and region in the face of climate change and to make the Boston region a major contributor to the reduction of greenhouse gases and non-renewable sources of energy and resources.**

The symposia are planned as **two one-day events, the first on March 28, 2008 and the second on June 9, 2008.** While keeping the bigger multidisciplinary picture in mind, each will focus on a field of interest (explained in greater detail below):

1 | Natural Systems and Architecture for the Green City
2 | Energy and Mobility in the Green City

Each symposium is structured in three sections. An introductory address by a keynote speaker frames the topic at hand within the broader context of designing for a sustainable metropolitan region. For the main part of the day, researchers and practitioners present current work and innovative projects, allowing ample time for questions and answers. Halfway through the longer presentations there is an after-lunch series of "short takes" in which a number of initiatives are presented in 10-minute slots. In the evening, a panel of public officials and policy experts discusses ways in which the work presented can be implemented in the New England context. These evening sessions are structured to invite audience participation. Regular intermissions are built into the schedule to allow time for informal meeting, networking and discussion.

The aim of these two symposia is to stimulate designers and policy makers to take advantage of the extraordinary resources in the greater Boston region to address the very real issues of climate change. Learning from initiatives throughout the world to take action in this particularly challenging bio-climatic region, Boston and Massachusetts have the opportunity to assume leadership in research, policy and design and to play role in retarding and mitigating the effects of climate change.

Speakers at the symposium are researchers and practitioners bringing national and international outlooks and experience to the topics. The audience consists of architects, engineers, planners, advocates, public officials and policy makers. In this way connections will be made between design and technology and the political context and leadership that makes implementation both publicly desirable and politically feasible. The translation of leading initiatives worldwide to the specific context of metropolitan Boston and its region will be in itself a case study of the limits and possibilities of technological and political adaptation.

In order to develop a common approach to the wide range of subject matter involving multiple disciplines, a letter of invitation asks each speaker to address related questions:

> *What is the **most important unsolved technical problem in your field**? What resources would it take to 'solve' the problem? i.e. what part can academic research play?*
> *What are the **major organizational or institutional barriers** that must be overcome to implement your ideas? i.e. what will it take to implement new technologies, needed changes?*
> *Where would you look for **leadership to implement the changes** proposed – for example, political leadership, business leadership, design leadership as well as research and advocacy?*
> *How would you propose to **most effectively capture the public imagination** to build support for the proposal you have in mind?*

The MassImpact symposia are planned to continue at later dates, the proceedings published and a website maintained to serve as a continuing resource for designers, advocates and policy makers and all the disciplines that have a common interest in making a difference.

The keynote speaker for each symposium gives an overview of the issues that constitute the brief for an environmentally efficient and livable city, making the necessary connections between design, policy and implementation.

The starting point for looking at cities as a form of sustainable living is the **measurement of the eco-footprint of urban development.** For example, Vancouver has 472,000 residents living in a city whose physical footprint[1] is 11,400 hectares. Based on the average Canadian 'eco-footprint' of 7.7 hectares per capita, that measurement for Vancouver would be about 3.6 million hectares or 320 times its nominal area[2].

But cities, for their density, agglomeration of capital investment and infrastructure, also present the possibility of an environmentally sustainable future. The **sustainable leverage of the city[3]** is based on:

> High population density that by definition **reduces the per capita consumption of land;**
> **Reduction of energy use** through shorter traveling distances and agglomerated buildings;
> **Higher densities that promote walking** (things are closer to one another) and public transit (the population is sufficiently intense to cover the initial high investment).
> A **resource-efficient infrastructure** for water, sewage, waste collection, etc;
> A wider range of **options for recycling, re-use and re-manufacturing**;
> **Economies of scale** in manufacturing and services;

British architect Richard Rogers adds the **social, political, cultural and aesthetic advantages** of living in a sustainable city, expanding the definition of sustainability beyond the physical.[4]

The greater Boston region in its network of urban centers overlaid on a rural 'field', constituting a population of approximately 3 million, has the potential of achieving both the **efficiencies of production and the economies of consumption** implied in the objective of sustainable urbanism. The question is how to balance the productive efficiencies of cities with their scales of consumption.

This symposium presents novel approaches to building technologies and development within an urban and regional context to clarify the potential for creating a sustainable urban ecology. The emphasis is on making connections between micro- and macro-scales to illustrate the imperative for achieving carbon neutrality by thinking systemically and multidimensionally. Presentations include case studies in research and practice in zero carbon development, tall buildings, high density, intense-use institutional sustainability, and urban and regional resource conservation and regeneration. Transportation and energy systems are addressed in the subsequent symposium.

Through comparative case studies drawn from Asia, Europe and the Americas, this session illustrates a range of approaches currently being employed for designing and managing cities towards a sustainable future – with particular application to metropolitan Boston and New England.

How can the design community respond to the challenge of building the 21st century carbon-free city?[5] The correlation between the urban fabric on one scale and the design of individual buildings on another in the pursuit of carbon reduction is an essential part of a visionary strategy for cities, including Boston.

Building technology and materials | Energy-consuming mid-20th century building technologies will eventually be supplanted by digitally-based nanotechnology manufacturing, new material applications, and devices to monitor performance in real time. How can this process be hastened?

Zero-carbon and super low-energy buildings | Existing and new building stock will have to dramatically reduce energy consumption and develop ways to integrate renewable energy generation.

Many examples exist in European architecture where regulation and technology have been in place for several years. How can such 'next generation' examples translate to the climate and locale of New England? Is the trend towards carbon negative development possible without off-loading environmental responsibility elsewhere in the system? Is such a strategy possible on a scale beyond single buildings and without reverting to mitigation schemes such as carbon trading that too often avoid the resource efficiencies that are ostensibly the objective?

Tall buildings and density | The height and density of buildings are parameters in the larger ecological system of the city. Can this level of intense urbanism be sustained in terms of resource consumption, waste management and the efficiency of land use?

Translation and Implementation | To conclude the day, a panel of policy experts, public officials and private industry implementers is asked to discuss policy initiatives for applying ideas and strategies presented throughout the day to metro-Boston and the New England region, inviting participation from the audience. Issues addressed include the role of government, institutional and private leadership in effecting change; the ability of the market and private investors to respond to the issues that have been posed; the relative effectiveness of incentives versus mandates to achieve desired ends; and lastly, the role of designers – architects, engineers, planners and others - in promoting and applying this agenda through their work.

The second symposium focuses on two specific aspects of the urban matrix - **Energy** and **Mobility** - that are central to any strategy to manage climate change. The development of the twentieth century city has been characterized by centrality of place (Boston as the so-called "Hub" is indicative of this model) and centrality of service, as in the utility infrastructure characterized by central power stations, waterworks and sewage. In a reciprocal relationship, the urban fabric has formed around the framework of the circulation and utility infrastructure which serves it.

Congestion at the center has become the near-universal characteristic of cities given over to the private automobile and inflexibility and operational inefficiency are the hallmarks of centralized utility systems. This requires alternative structures to address the inefficiencies built into energy generation and distribution and the related problems of air emissions and congested traffic.

London, New York and other so-called 'C40' cities[6] are leading the way in employing new technologies and implementing new policies to address these issues. Specialists and public officials engaged in these initiatives will be presenting material on their work with a discussion to follow on the potential for transfer to the Boston region.

Energy Generation and Distribution Systems | Historically, despite its climate, Boston has been an American success story, but the current economic prosperity of the city and its region faces challenges based on comfort and cost. Cold dry winters and hot humid summers drive a demand for indoor conditioned space – for comfort and efficiency – which contributes to high energy demands coming from a narrow range of sources that make the price of energy the highest in the country.

Compared to other US cities, the cooling and heating loads on buildings in the Boston region are relatively severe. Annual average temperatures range from 24°F to 82°F while 30-year extremes go from -7°F to 102°F, a range of 109 degrees. The population of the state has increased approximately 5% from 1990-2000 and since then has remained relatively stable. Meanwhile, over a comparable period, energy

consumption has increased 15%. In 2003, 95% of the state's energy sources consisted of non-renewable fuels imported from outside the region. Prices in the region for all non-renewable energy sources have increased between 40-50% in the three years from 2003 to 2006 alone.

The effects of this energy consumption on health and the quality of the environment are alarming. According to a 2003 survey,[10] asthma rates for Massachusetts and for New England are the worst in the nation. While the pathology of asthma is complex, the quality of the air both outside and inside buildings is a contributing factor. The Massachusetts Office of Environmental Affairs' Greenhouse Gas Policy and New England's Regional Greenhouse Gas Initiative (popularly known as "Reggie") are positive steps, but there is still a long way to go.

There are major opportunities for improvement in energy generation, distribution and demand. First, the region has natural resources that can be translated into energy, such as wind power, wave and water power and, to a lesser extent, solar power. Second, the region combines not only the highest concentration of population in the United States but also a rare balance of urban development interlaced with open space and agriculturally productive land that can serve as a model for the economic synthesis of natural resources with market demand. Third, precisely because of high energy prices, New England has the economic incentive to apply new technologies to each of these segments of the energy cycle with a higher comparative advantage. Just as Germany and Japan have become world leaders in addressing energy conservation because of their chronic dependence on high-priced energy from outside, so Massachusetts and New England can turn this comparative disadvantage around to become leaders in the United States, if not the world.

These issues of alternative energy sources and distribution have far-ranging implications for city planning and building design. The structure of the city and the spatial relationships embedded by present infrastructures are open to reinterpretation. The introduction of wireless high speed communications will mitigate the strictures of physical form, perhaps even obviating traditional approaches to centrality and place. Site- and district-based decentralized energy systems, already instituted in other cities and regions, are reviewed for their potential application to Boston and other 'old cities' typical of New England. Case studies may include the San Francisco "Energy Independence" plan; the London Climate Change Agency; the Toronto Energy Action Council ("Eneract") as well as planned initiatives of the World Cities Leadership Climate Change Summit and the Clinton Foundation, and the global programs of the International Council for Local Environmental Initiatives (ICLEI).

Mobility – Technology and the Redefinition of Urban Space | Transportation of people and freight accounts for approximately 25% of global greenhouse gas emissions. In the United States that proportion increases to 32%. In Massachusetts, the ratio increases further to 36%.[7] To meet 'pre-1970 levels' of carbon emissions – considered an achievable target – total emissions (including from the transportation sector) would have to be reduced by 44%. In the US as a whole, transportation in general accounts for about 28% of the effort, split between the strategies of improving vehicle efficiency (13%) and system efficiency (15%)[8]. Yet in Massachusetts, automobile registrations have increased 40% in the fifteen years since 1992 while MBTA transit ridership has increased by only 10%[9]. The rate of increase in private and public transportation usage can only be offset by improvements in technology (e.g., the clean vehicle), system efficiencies such as the optimum utilization of infrastructure (e.g., smart highways) and the reconfiguration of towns and cities to drastically reduce transportation demand. While these may be necessary steps on the path to carbon reduction, they do not by themselves answer the issue of greenhouse gas emissions.

Accordingly, the “cyber-city”, a virtual metropolis in electronic space, is presented as an alternative to the sclerosis entailed by physical form. Case studies are presented of experimental alternatives in cities in the United States and abroad (including London) pursuing efficiencies in technologies and systems as well as urban reconfigurations. These address issues of personal mobility, urban systems re-design based on communications technology as well as new urban forms being developed in London, the Middle East and Asia.

Translation and Implementation | To conclude the proceedings, a panel of policy experts, public officials and private industry implementers is asked to address how to apply what has been presented to the metro-Boston and the New England region, also inviting participation from the audience. Panelists are asked to identify the most promising tools that national, state and local government have at their disposal to reduce greenhouse gas emissions from buildings, energy generation, and transportation systems. These include leading by example in the siting and design of government facilities; creating financial incentives to shape private actions; implementing market-based solutions such as cap-and-trade regimes; and imposing regulatory mandates for specific technologies or practices. We ask whether the most effective measures are to be taken at local, regional, national or international level. How much attention should be paid to designing and adapting cities to the impacts of climate change – from altered ecosystems to sea-level rise – that will inevitably occur? Do cap-and-trade regimes and concepts of carbon neutrality create only the illusion of environmental progress? Do we have too much faith in market-based solutions? And lastly, what is the role of the professional design community in effecting change?

[1] Defined as the land area required to supply a city or nation with food and timber products and to absorb its output of waste gases such as CO2. Wackernagel and Rees, Our Ecological Footprint, New Society, 1996.

[2] Example from Rees, Understanding Urban Ecosystems, p.10

[3] Modified from Rees, Understanding Urban Ecosystems, p.12

[4] Rogers: Cities for a Small Planet, London, 1997, p.159

[5] Boston Mayor Menino has issued an Executive Order mandating the reduction of the city’s carbon dioxide emissions by 7% below 1990 levels by 2012 and 80% below by 2050. Massachusetts Governor Patrick has set a statewide target of reductions from a 2002 baseline of 25% in 5 years, 40% by 2020 and 80% by 2050. The State has also set a target to reduce total energy consumption by 20% by 2012 and 35% by 2020 (Boston Indicators Report). Massachusetts depends almost entirely on imported, polluting fossil fuels and 76% of all power-plant-generated electricity in the state is used just to operate buildings. ISO New England estimates that electricity demand will increase in the Northeast by 23% by 2030, with carbon emissions rising by 37 metric tons per year. Massachusetts greenhouse gas emissions total about 21.7 metric tons.

[6] C40, a partnership of the Clinton Climate Initiative and the large cities’ Climate Leadership Group, is a group of the world’s largest cities committed to tackling climate change.

[7] Energy Information Administration, 2007: Energy State Emissions by Sector (2003)

[8] NRDC figures from Pacala and Socolow, reproduced in Al Gore: An Inconvenient Truth pp.280-281

[9] A Time Like No Other: a Summary of the Boston Indicators Report 2004-2006, Boston Foundation, June 2007

[10] Centers for Disease Control and Prevention, 2003