Soft design for a sustainable world

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"Around the world at unprecedented rates, people are moving from the country to the city," says Sheila Kennedy, professor of the practice at MIT's Department of Architecture. "But this rapid urbanization is not a one-way movement—there's an increasing level of mobility and an inevitable permeability between the borders of our natural and urban environments."

Her research seeks to answer the call of this global trend with innovative buildings and infrastructure that minimize demands on energy and environment. "My group at MIT is working on the design of soft infrastructure, or resilient infrastructure," she says. "We're trying to think about a synthetic approach to design that includes natural ecologies, the built environment, and the movements and cultures of people."

"With soft design, we think about materials that are resilient: earth-abundant materials, materials that are biodegradable, and new materials that can be made with very low-carbon or no-carbon manufacturing processes," Kennedy explains. "We then try to radically transform these materials with software, using computation to alter the form of materials that are affordable and prevalent. We can customize the form to different manufacturing circumstances and different needs."

Getting buy-in for low- or no-carbon energy use is a critical theme throughout her efforts. "With soft policy and soft design, we try to shift the culture of energy in such a way that it becomes compelling and people really want to use the new technology," she emphasizes.

"Technology isn't much good if people don't want to use it."

Scaling-up Soft Infrastructure

Among its recent projects, Kennedy's design firm, Kennedy & Volich Architecture, has completed a public ferry terminal on the East River in Manhattan that is "the first project in the United States that has taken a low-carbon approach to public infrastructure," she says.

Connecting commuter boat passengers with the New York subway, the bike sharing program, and taxis, the terminal "also provides a new kind of public place," she notes. "We've created the first soft tensile roof canopy system in the United States, and that allowed us to build this building without a lot of steel, and to build it offsite in pieces and bring it to the site in a very efficient manner." Additionally, the roof canopy features an interactive display for information about river currents. "It's like an eye into the river, showing people what's going on in that ecosystem," she says.

Another example of soft infrastructure is Minneapolis's RiverFirst initiative, in which Kennedy and her colleagues work with dozens of organizations to revitalize miles of degraded industrialized riverfront. "We need to find new ways to bring people to the river," she says. "We're developing a systematic trail system with bridges and public trails as well as a new park that will have sustainable development within it, bringing new value to this blue and green lifestyle that will be the future of the city of Minneapolis."

On a still larger scale, she partners with industry and non-governmental organizations on a new approach to clean energy in South America. "Rather than having solar panels that are made in China with a lot of carbon expenditure in the clean rooms, in the manufacturing, in the waste and in the global shipping, we're trying to develop a system within

Brazil where we can make solar panels," she says. "We can integrate electronics to create a very small scale but very high impact portable clean energy network, which allows people to have renewable light and also power to charge a cell phone."

Changing Material Culture

Her MIT group also investigates the use of materials that are either carbon-negative or very low-carbon use, and this includes redefining the set of materials used to make buildings and the systems, furniture, and other objects within them, Kennedy says.

One example of rethought materials is the Soft House, a set of row houses in Hamburg, Germany. The project has won many international design awards, most recently being chosen as one of the top 20 most impactful real estate developments in Germany by FIABCI, the International Real Estate Federation.

The Soft House began with a simple building structure, assembled by a traditional local soft wood construction technique. "The walls are solid wood and they become very long-lasting and enduring," she says. "The domestic infrastructure, the lighting and the energy, becomes much more mobile, replaceable and configurable, like furniture. The infrastructure is literally soft because we use textiles to harvest energy and distribute light and low-voltage DC power."

Following up on the Soft House as a model for low-carbon development, Kennedy and her co-workers will soon break ground on the Chrysanthemum Building, located in a dense urban neighborhood in Boston's North End. The building will use sustainably grown wood studs both for standard construction and for elevator walls and the party walls that abut buildings on either side. This construction approach will employ very little steel and no concrete blocks, helping to keep costs

down. The mixed-use project will have a variety of different units, including very small apartments with all-wood infrastructure that can be taken out or replaced and changed, as well as large flexible urban lofts for families.

"It's a smart building in a very simple way," she adds. "We've developed a mobile phone application that connects residents with the already existing green systems in the city."

Advancing Flat-to-form

Her research group has been extending a fabrication process called flat-to-form, "which basically enables us to take ordinary flat sheets of building industry materials and transform them into almost any form or any shape via computation," Kennedy says. "You can think about flat-to-form as self assembly, where the energy that goes into the system is human energy."

Customizing existing materials "really allows our group to transform the building industry from within," she says. "We might look at an Industrial Liaison Program partner's material and shift it from one market segment to another. We also might think about just radically transforming or reimagining the material product or piece of infrastructure."

For example, her group is interested in rethinking the form of refrigeration. "Today a solar refrigerator, which is one of the most important pieces of domestic infrastructure in the developing world, has over 300 parts, and none of them are particularly sustainable," she points out. "Could we make foldable paper refrigerators?"

Her group already has created lights that combine an organic light-emitting diode (OLED) with all-paper parts. It's also developing flat-to-form designs for solar streetlights, one of the most important and rapidly

growing kinds of clean infrastructure worldwide.

"Another project is thinking about ways to deliver sunlight deep into a building," Kennedy says. "Sunlight comes in through windows, but it doesn't come in very far and it doesn't come in all the time. So imagine a very lightweight, foldable mirror system, perhaps made out of paper, which could adjust during the day so that no matter how dense an urban block you might live in, you could always have direct sunlight coming right into your kitchen or your room or your bedroom."

She emphasizes that bringing such innovations into widespread use requires tight collaborations with companies and other partners. "As an architect, I work in the world every day. My group at MIT has been fortunate in that we've worked with many outstanding industry leaders. The most important requirement for partnership is a real commitment and desire for innovation, and a desire to make change."

"We're particularly interested in collaborating with manufacturers to create designs and to create resilient soft infrastructure that works not only here at home but also in the developing world," she adds. "We can get ideas from working in the developing world and bring them here at home, and vice versa. In the end of the day, it's really only one world."

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