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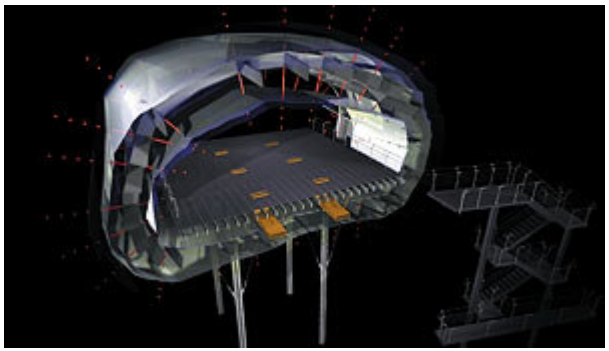
Buildings with minds of their own

Nov 30th 2006
From *The Economist* print edition

Architecture: "Responsive" buildings, capable of changing shape and responding to their users' needs, are on the drawing board



WHAT if architects could build living systems rather than static buildings—dynamic structures that modify their internal and external forms in response to changes in

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their environment? This provocative idea is making waves in the field of architecture. Houses, for example, might shrink in the winter to reduce surface area and volume, thus cutting heating costs. They could cover themselves to escape the heat of the summer sun or shake snow off the roof in winter. Skyscrapers could alter their aerodynamic profiles, swaying slightly to distribute increased loads during hurricanes. Office buildings could reconfigure themselves to improve ventilation.

Such "responsive architecture" would depend on two sorts of technology: control systems capable of deciding what to do, and structural components able to change the building's shape as required. Architects have been working to improve the control systems in buildings for many years, but shape-shifting technology is at a much earlier stage of development.

One approach being pursued by researchers is to imitate nature. Many natural constructions, including spiders' webs and cell membranes, are "tensegrity systems"—robust structures made up of many interconnected elements which can be manipulated to change shape without losing their structural integrity. "These structures can bend and twist, but no element in the structure bends and twists," says Robert Skelton of the Structural Systems and Control Laboratory at the University of California in San Diego. "It's the architecture of life."

While Dr Skelton is working on solving the engineering equations associated with tensegrity systems, Tristan d'Estrée Sterk at the Office for Robotic Architectural Media & the Bureau for Responsive Architecture, an architectural practice based in Vancouver, Canada, has begun to construct prototypes of shape-changing "building envelopes" based on tensegrity structures. Lightweight skeletal frameworks, composed of rods and wires and controlled by pneumatic "muscles", serve as the walls of a building; adjusting their configuration changes the building's shape. Mr Sterk is also developing the

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The Structural Systems and Control Laboratory has information on Robert Skelton and colleagues' research into transegrity systems. Tristan d'Estrée Sterk's Office For Robotic Architectural Media and The Bureau For Responsive Architecture (see also a related blog) and Gian Carlo Magnoli are also studying responsive architecture.

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"brain" needed to control such a building based on information from internal and external sensors.

Anders Nereim, chairman of the department of architecture and designed objects at the School of the Art Institute of Chicago, is not convinced that a central brain is the best way to control a responsive building, however. He suggests that the building should instead resemble a decentralised ecological system and should be made up of many independent sensors and actuators. Some of his prototypes include shadow-seeking lights that move around, and curtains made of flexible solar panels that use the energy they collect to open and close themselves. "Distributed systems can recover from damage," says Mr Nereim.

Cars are already capable of monitoring their own performance and acting with a certain degree of autonomy, from cruise-control systems to airbag sensors. Such responsive behaviour is considered normal for a car; architects argue that the same sort of ideas should be incorporated into buildings, too. And just as the performance of a car can be simulated in advance to choose the best design for a range of driving conditions, the same should be done for buildings, argues Gian Carlo Magnoli, an architect and the co-director of the Kinetic Design Group at the Massachusetts Institute of Technology. He is devising blueprints for responsive houses. "We need to evolve designs for the best performing responsive-building models," he says.

So will we end up with cities of skyscrapers that wave in the breeze? It sounds crazy. But, says Mr Sterk, many ideas that were once considered crazy are now commonplace. "Electricity was a batty idea, but now it's universal," he says. The same was true of suspension bridges and elevators. Dynamic, intelligent, adaptable buildings are "the logical next step", he claims.

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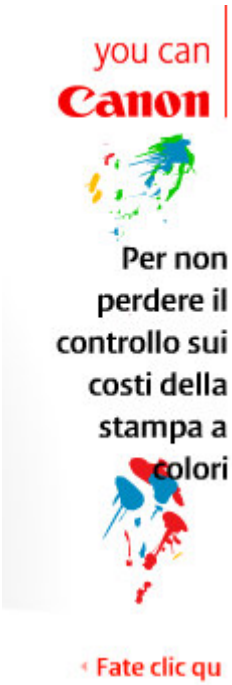

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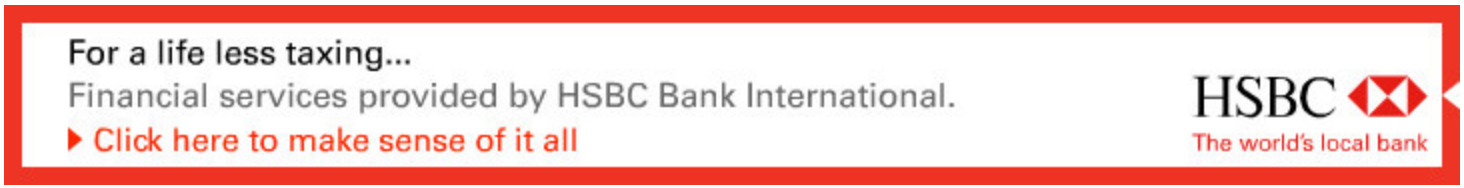

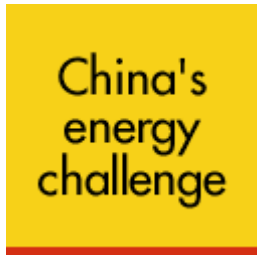

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