Living for Tomorrow

"Houses of the future" sold tickets at world's fairs, but they didn't affect home building. Can MIT's prefab smart house change the way we build and live?

By Peter Hall
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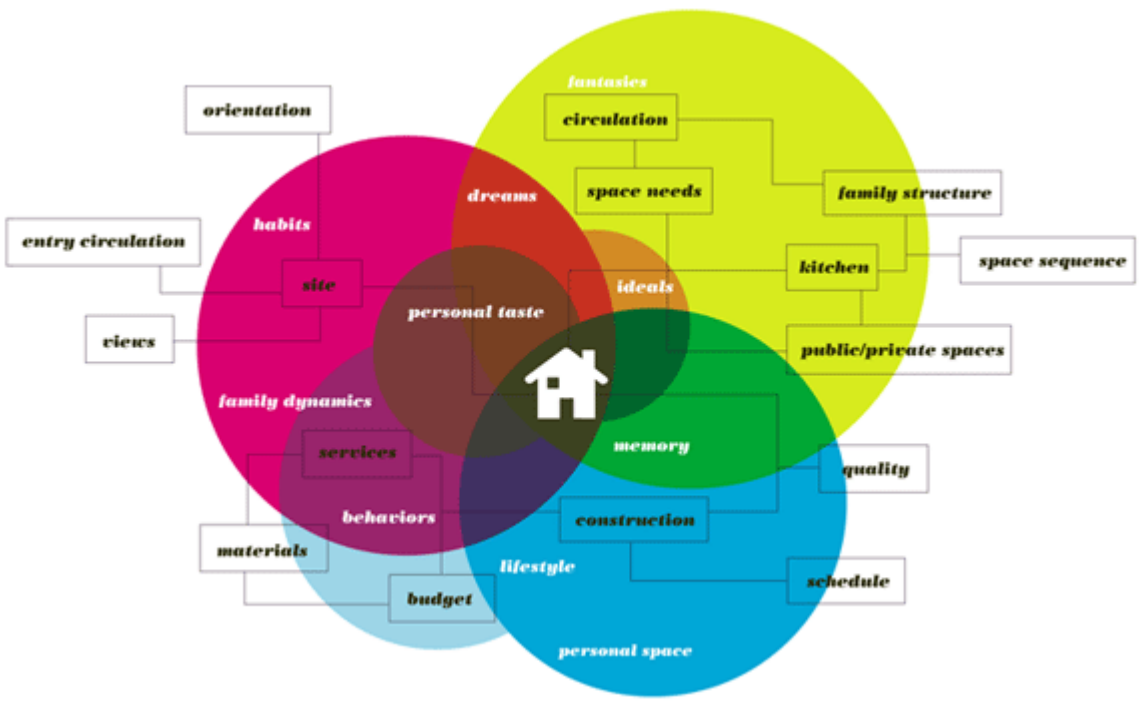


Designing Your Own House

The home-building industry could be transformed, MIT researchers argue, if it adopted the mass-customization methods being introduced in other industries. Dell Computer, for example, allows PC customers to pick their preferred hard-drive size, monitor type, and memory configuration from a Web-site menu. The elements are then pieced together from existing parts and delivered a few days later. Applied to home building, the customer-design process would be considerably more advanced. A Web-based "preference engine" would take home buyers through a series of questions, design games, and diagrams in a dialogue that would ideally approximate a conversation between a client and an architect. Having established the basic facts (budget, number of inhabitants and their ages, working habits, cooking habits, etc.), the preference engine would then attempt to determine more subjective preferences. For example, it might show different interior spaces, then ask the customer to pick a favorite and answer questions on what makes it preferable (lighting, color, detailing, sense of comfort or security).

For much of the last century architects and designers have wondered why the home-building industry couldn't be more like the automotive or aircraft manufacturing industries. Cars and airplanes were the apogee of the machine age, precision-engineered in factories with the latest materials and technologies, their aerodynamic forms molded by functional requirements. Houses were the opposite: dumb boxes laboriously hammered together on-site. Designers, architects, and even governments spent untold hours and dollars trying to force construction to go prefab. "We have only to apply to building the same techniques of design, manufacture, and selling that have given us a motor car for every four people in the land," wrote Walter Dorwin Teague in 1942. "In this way the American genius of mass production that is winning the war can win the peace as well."

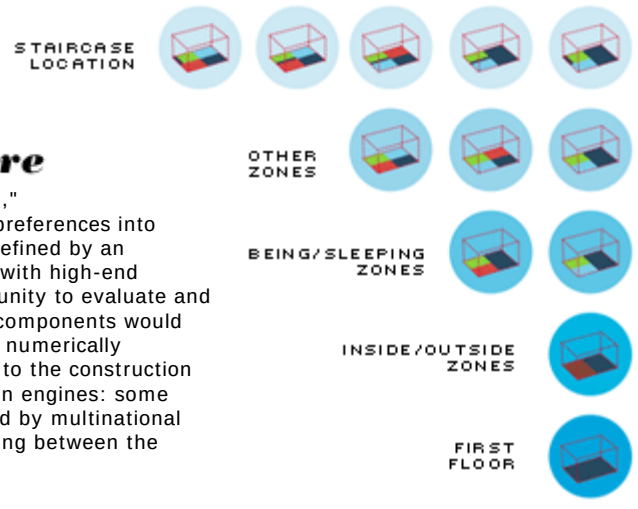
Offsite:
The MIT Home of the Future Consortium, architecture.mit.edu/house_n.

Peace is an elusive target, and so is automated home building. Even the most ingenious of schemes for mass-produced prefabricated homes--Buckminster Fuller's Dymaxion Dwelling Machine, and Walter Gropius and Konrad Wachsmann's Packaged House--became treasured failures of architectural history. Fuller pulled out of the Dymaxion project in the late 1940s, ditching a few thousand orders, and Gropius and Wachsmann saw only 200 houses built before their company closed down. The "house of the future" has consequently remained a curious artifact of the exposition showground.

But in the last three years Kent Larson, an architect at Massachusetts Institute of Technology, has been laboring to revive the Modernist dream and produce a housing system of the future that will have a real and lasting impact on home building. The twentieth-century smart home was doomed by its prescriptiveness, according to Larson. "It became a timeline of buildings that essentially had no effect on the industry because they were single-purpose structures with a single form driven by one ideology," he says. The MIT project, on the other hand, is infinitely adaptable. "It's about creating a methodology that can be scaled to different climates and people," Larson says. "What we're proposing is that houses should move toward a mass-customization process."

One argument fueling the project is that a smart home equipped with sensing networks could help avert the crisis looming over America's overworked health-care system. During the next 30 years or so, our elderly population will double, increasing the burden on the creaking health-care infrastructure. The answer, according to the MIT team, is to upgrade the home so that it can support the needs of an aging population. Their prototype housing will test a monitoring system that can keep track of its occupants' activity levels, issue early warnings of congestive heart failure, and offer reminders to take medication. MIT's future living environment will even monitor its own air quality for hazards like smoke, carbon monoxide, mold spores, and--since we're living in the specter of terrorism--anthrax.

At first MIT chose to call the project House-n, the "n" being scientific shorthand for "variable." In much the same way that Lands' End, Nike, Ford, and BMW are investigating computer-based manufacturing to offer customers swappable or "mass-customized" components for their jeans, sneakers, and cars, so could thousands of unique house parts be customized to buyers' demands. The auto-industry analogy even extends to fabrication: the heart of House-n is a chassis with an "infill" of cheap sensing devices like LEDs, speakers, displays, automatic lighting, heat sensors, and miniature cameras that can be plugged in at any point and upgraded on the fly. The network will be self-configuring; to add new devices, the occupant won't have to go through complicated rituals comparable to programming the VCR. Like the Internet, it is decentralized, so that if one part breaks down, the house network won't crash. "You can cut the wires and it won't stop working," says Larson, who asserts that all of the above is possible with existing technology.



Automated Architecture

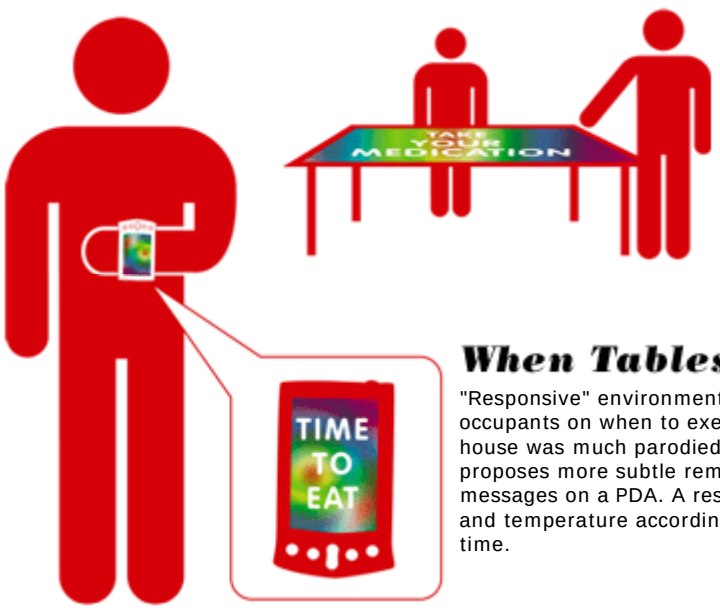
The back end of the process, the "design engine," is a computational system that turns customer preferences into buildable form using strategies and shapes predefined by an architect. The design is developed in iterations, with high-end visualizations giving the home buyer the opportunity to evaluate and respond to the engine's proposal. The required components would then be manufactured to order (using computer numerically controlled fabrication techniques) and delivered to the construction site. The MIT team envisions thousands of design engines: some might be licensed by star architects or developed by multinational brands. Customers could find themselves choosing between the Frank Gehry or BMW design engines.

The tech-heavy networked home also reveals that Larson has identified where to find his best allies. Rather than try to persuade the recalcitrant home-building industry to pony up for a vision of change it may not welcome, MIT has been working with information technology and communications companies. "High-tech companies are looking to the home as the next big market," Larson says. "They're realizing that they'll never successfully sell all the gadgets they envision unless there's a more sophisticated infrastructure in the home to plug them into--which means new ways of building." This fall the House-n team and technology consultancy TIAX (formerly Arthur D. Little Inc.) announced the formation of the Open Source Building Alliance, adopting the modish programmer terminology to depict a modular, component-based, everyone's-invited approach to building. "Mass customization," argues an MIT white paper published in September, "creates a pathway for new players to enter the $852 billion a year construction market." Unsurprisingly, 44 companies, from Alcoa to Whirlpool, have expressed interest.

One clear reason why homes of the future rarely get beyond the fairgrounds is that they have tended to be driven by corporations' ambitions rather than peoples' needs. When the MIT-designed Monsanto House of the Future opened in Disneyland in 1957, visitors were treated to a glimpse of carefree futuristic living inside a plastic-walled floating cruciform structure with picture phones, height-adjustable sinks, dishes washed by ultrasonic waves, and atomic food preservation. "It was the permanence, the durability of plastic that made the Monsanto house a marvel," writes Bernard Cooper in his book *Maps to Anywhere*. "The wings, it was said, would never sag. The plastic floor would never buckle, chip, or crack." At the time, 30 percent of Monsanto's business was in plastics, synthetic resins, and surface coatings.

MIT's House-n, with its lineup of corporate sponsors, hardly breaks the mold. A prospectus from last year offers an almost nostalgic-sounding collection of utopian scenarios: you arrive home to hear your kids playing with an interactive game embedded in the walls. You place a videoconference call that follows you up the stairs (projected on the walls) and then decide to exercise: a table retracts, a wall panel moves, and a life-size image of your favorite aerobics instructor appears. Future living is now brought to us by the health-care and telecommunications industries, yet Cooper's characterization of the 1950s dream is equally applicable to the noughties: "Time was a road that led to utopia...and life, prolonged, would be nearly perfect."

Larson and his colleagues insist that their project is not a 1950s-style prescription for better living but a research lab where technologies will be tested. As a facility shared by several corporations, it will be the first "holistic" effort to examine how our homes--and the process of building them--might change to accommodate our evolving lifestyles. "The popular vision of the house of the future is where you hardly have to get up from your easy chair," says Stephen Intille, a computer-science researcher working on the project. "That's not ours at all. We want the house to enable you to lead a more active and richer life--and encourage you to do things, not to have them done for you."



When Tables Can Talk

"Responsive" environments provide information and advice to occupants on when to exercise, eat, or take medication. The talking house was much parodied in twentieth-century culture, so House-n proposes more subtle reminders: timed projections on a table or messages on a PDA. A responsive house might also adjust lighting and temperature according to what occupants are doing at the time.

One of the MIT team's biggest challenges will be to avoid turning their smart home into what looks like a virtual panopticon. One group is looking into information delivery. Their charge is the growing problem that patients at home frequently forget to take their medications. Using devices like a PDA or the IBM-developed "anywhere projector" (which can display information on any surface in the home), the team will test ways the house can remind occupants to down the pills. "Every day we're compromising our privacy so that people can tell where we are," Larson says. "We want to give people control and choice. If you want to turn off the system, you can. But for an 80-year-old woman living in the city, there may be a clear benefit to monitoring systems that tell family members where she is."

PAGE 1 **2** | **NEXT**

MASTHEAD | SUBMISSIONS | AWARDS | PRIVACY POLICY | TERMS OF USE **BACK TO TOP**

Living for Tomorrow

Page 2

This line of argument is essentially MIT's trump card. The program counters fear of surveillance, high-tech living, or futuristic forms with the twenty-first-century idea of consumer choice: if you don't like it, choose something else. Larson believes that the real lesson of smart homes of the past is to avoid allegiance to inflexible ideologies. "Open source" building MIT-style, on the other hand, is a variable system based on standardized guts--the architecture's formal manifestations may be innovative-looking, or not, depending on the environment for which it is intended.

If it begins to sound as though the House-n team counters arguments by morphing into something else, that is a reflection of the project's evolution and, to an extent, its dependence on sponsorship for survival. It began as an architecture-department scheme to explore the aesthetics of combining new materials and new sensing technologies in a "transgenerational" family house. But despite attracting a fair amount of press attention and sponsors--including Owens Corning, International Paper, and State Farm Insurance--the project struggled to hit funding targets and tripped on the stringent zoning regulations of Cambridge, Massachusetts, where MIT planned to build. Larson responded by raising the stakes. Late last year MIT announced that the House-n team would join a larger consortium with the Media Lab, a department with an impressive track record in securing generous corporate sponsors. Now recast as the Open Source Building Alliance, the project is divided into nine special interest groups looking at everything from active shades on building exteriors to the Web-based tools customers might use to design their own houses.

If MIT's ambitious new strategy pays off, within the next two years its Cambridge campus will sprout a house of the future called the Place Laboratory where researchers can study the effects of all this technology on volunteer dwellers. Complementing the Place Lab will be a portable version that can be installed in existing homes, workplaces, and urban environments. Further down the line, MIT plans to retrofit a loft building and build a new market-rate condominum using the same House-n system, featuring a single integrated heating, ventilation, and air conditioning system. This alone is anathema for home building, which currently depends on separate subcontractors to install three distinct systems. "I propose that that's insane," Larson says. "Somebody needs to make a single appliance that allows this all to happen."

Whether the project will succeed in persuading developers and builders to take on its means and methods is a big question. MIT's would not be the first project to be thwarted by industry recalcitrance. Even the government-backed, multibillion-dollar initiative of the 1970s, Operation Breakthrough--which set out to increase housing production and reduce costs with an engineered approach to building--failed to infiltrate what is essentially a craft-based industry. Bob Kuehn, a Massachusetts builder, welcomes MIT's initiative but remains skeptical about its applicability. "Frankly I don't see it," he says. "There are too many barriers from the way the craft unions are organized. It's hard to come in and say, 'This used to be carpentry, but now it's somebody else's work.' I can remember when we stopped using lumber and went to metal studs, and what a big fight that was."

Larson pulls no punches when it comes to depicting the industry: "It's fragmented, conservative, worried about lawsuits, resistant to change, and involves labor-intensive processes that no industry in the world would use."

Industry representatives counter that their innovation comes not in sweeping revolutions but in subtle increments tempered by cost constraints. "Factory-built and site-built sectors have coexisted for a long time in the industry," says David Dacquisto, former vice president of technology at the National Association of Home Builders Research Center in Upper Marlboro, Maryland. He cites prehung doors, roof trusses, and even prefabricated foundations as innovations that have

Past Houses of the Future

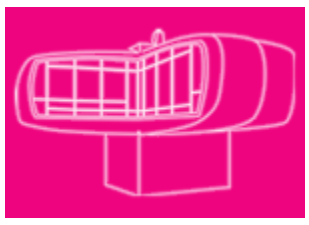
1927

Dymaxion Dwelling Machine Developed by Richard Buckminster Fuller as a kit home for mass production, this energy-efficient dome-shaped house measured 36 feet across but managed to include two bedrooms, two bathrooms, a kitchen, and a sitting room. The prototype--built with the Beech Aircraft Corporation in 1946--attracted 3,500 orders, but Fuller pulled out when he suspected profiteering among his partners. The prototype was restored for the Henry Ford Museum in 2001.

1931

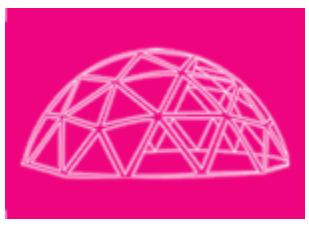
Aluminaire House The first all-steel-and-aluminum house to be built in America, the Aluminaire was an experiment in using standardized hardware to make mass-produced housing. Designed by Albert Frey, a disciple of Le Corbusier, and MIT-trained architect A. Lawrence Kocher, the house attracted streams of visitors at the Allied Arts and Building Products exhibition and prompted one perturbed reviewer to worry that its severe rectilinear forms might be too businesslike for husbands returning from work, driving them to seek out "fluffier apartments." The house is now preserved as a landmark in Central Islip, Long Island, New York.

1957



Monsanto House of the Future The weird floating cruciform shape and synthetic construction of the MIT-designed Monsanto House of the Future attracted 20 million visitors during its ten-year residence at Disneyland. "Hardly a natural material appears anywhere," the publicity boasted. As if to prove the point, a wrecking ball turned out to be ineffective when the house was closed in 1967. It bounced off the plastic walls instead of demolishing them, and the house had to be dismantled by hand.

1985



Spherhome French engineer Jean-Noël Pigout designed this computer-controlled geodesic dome home to achieve energy efficiency by opening and folding in like a flower. It closes up when the temperature is too hot or cold, turning its back away from or toward the sun. A 2,600-square-foot prototype was unveiled in January 2001 at the Paris Furniture Fair.

2001

Orange at Home The British telecommunications company Orange turned this average Hertfordshire house into a remote-controlled show home to research wireless technologies. Operating with Bluetooth and 802.11 protocols, the house is powered partly by solar panels on the roof and is equipped with energy-saving innovations like a hot-air recovery system that draws warm air from the kitchen and bathroom to heat the cooler rooms. Security is automated, and the front door can be opened with an Orange

mobile phone. Room temperature can be set by yelling at the walls.

reduced field labor costs. But he adds that the technologies paraded in smart houses like MIT's are often too expensive to be greeted with enthusiasm. "There are few products in this business that are slam dunks, but I don't believe that's responsible for the slow development of the smart-house concept. I think the reason these technologies haven't come further is that they've been expensive and have delivered very little as far as tangible benefits are concerned."

Larson argues that pioneering technology can be paid for by savings in labor costs. He mentions a survey cited in the industry newsletter *Construction Labor Report*, where 80 percent of contractors identified a lack of skilled labor as the most significant challenge facing the industry during the next five years. By automating fabrication, he says, we could reverse the ratio of field labor to material costs, which can be 80-20, and four times as much money could be devoted to materials, design, and technologies. As for tangible benefits, MIT proposes revolutionizing not just home building but the whole lumbering health-care business. "The existing health-care system is really crisis care," Larson says. "Our position is that there's plenty of money in the system; it's a matter of development."

If House-n does make the leap off the digital drawing board into the real world, architecture could be confronted with an intriguing new model of practice. When customers can "design" their own houses--customizing their preferences online from a menu of choices as they might a computer--what is left for architects to do? In their paper "A New Epoch," Larson and two MIT colleagues suggest that mass customization finally allows architects to play a significant role in the design of houses for the mass market. Larson himself knows from experience that house commissions currently come only from "adventurously wealthy" clients. But with a Web-based design system, architects can become involved in the earlier stage of creating design "engines" from which modest-income customers could develop their own permutations. It has a faintly Modernist, and solidly idealistic, ring to it: architects would no longer be designing forms as the expression of technological function but algorithms that produce expressive skins, each offering a variation from the next.

Ultimately this is a project for home buyers who are not enticed by the new homes developers offer. It is about making sophisticated design and technology environments for them. But if they can't be shaken out of their current penchant for traditional materials, handcrafted on the spot, House-n will join the ranks of history's demonstration smart homes, forever awaiting their offspring. As Bob Kuehn puts it, "Fiberglass is fiberglass, and shingles are another thing. I'm not suggesting that people have good taste in their housing, but they do cleave to traditional forms." The choice, in the end, may be ours.

PREVIOUS | PAGE **1** 2