Oct. 31, 2006 — - Architect Kent Larson has a radical vision that just might transform America's construction industry: Build houses the way we build computers. Welcome to the world of open-source homes.

Imagine if cars were built the way most houses are. A procession of trucks would deliver materials and parts to your driveway--sheet metal, spools of wire, screws, pistons, a roll of carpet, bumpers and a steering wheel. Then day laborers would arrive to put it all together. In the rain. It sounds absurdly inefficient, yet that's the accepted way of constructing a modern American house.

While cars, computers and other products have improved dramatically in recent decades, houses have changed almost as little as the methods used to build them. "Every product except homes has become more sophisticated, with higher quality at lower cost," says architect Kent Larson of the Massachusetts Institute of Technology. "Homes are just the opposite."

Larson is perhaps the country's lead proponent of a radical new approach to designing and constructing homes. The house of the future, he says, should be more like a personal computer or a car. It should be affordable, built mostly in a factory, and with parts that are easy to repair or replace. You should be able to design your own home online, just as you can today with a Dell laptop or a Honda minivan. The key to making it happen? Follow the lead of other industries: standardize and accessorize.

Take personal computers. Products made by competing manufacturers are standardized for compatibility. You can buy virtually any printer or mouse on the market, and it will work with the computer you already own. "Nobody has to agree on what a mouse is; you just have to agree on the USB port," Larson says.

Now imagine a building industry that worked the same way. Every new house would have a structural frame, or "chassis," that would be expected to last 200 years or more. That chassis could be fitted with your choice of an endless selection of roofs, sidings, interior wall panels and electronics made by a variety of manufacturers. The home's parts would be replaceable--just as computer keyboards and car mufflers are--so an extreme makeover wouldn't require a bulldozer. Need an extra bedroom? Add a few more interior walls. Remodeling your kitchen? Pop off the cabinets and plug in a new set.

Before houses can be built this way, though, the industry needs standards analogous to the USB standard for computers. "You don't have to agree on the toilet, but you have to agree on how the toilet connects to the wall or the floor," Larson explains. That may sound easy enough, but getting dozens of manufacturers to sync their johns will require fundamental changes in the home-building industry.

To lay the groundwork for just those types of changes, Larson has teamed up with New Hampshire-based homebuilder Tedd Benson to construct four prototype houses, the first of which was completed this summer. Contributing to the project is a diverse group of manufacturers who have joined MIT's Open Source Building Alliance (OSBA) as a way

to experiment with this new approach to designing and constructing houses. "It's an attempt to get industry to develop the standards that are necessary to change how things are built," Larson says. "We're not by ourselves going to change the world."

Design for the Masses

Larson coined the term "open-source building" three years ago, inspired by the computer scientists who work with him in the MIT research group known as House_n. Before joining MIT's faculty, Larson spent 15 years as an architect in New York City. In an office on the top floor of a loft building overlooking Union Square, he designed custom homes for wealthy clients, with great attention to detail and quality. Everything looked perfect on paper, but when workers actually built the homes Larson had designed, "the processes were just so primitive," he recalls. Workers were shaping raw material in the field, often with mixed results. If one piece of insulation in a wall cavity came up short, for example, the thermal performance of the entire house was compromised. It became clear to Larson that, in terms of automation and control, the building industry was literally decades behind other industries.

Larson was also troubled that so few people could afford to own a house tailored specifically to their needs. Less than 5 percent of Americans live in homes custom-designed by architects. "Everyone else," Larson says, "lives in boxes thrown up by land speculators." Worst of all, the owners of even the lowest-quality homes are paying for custom building. "Every board cut and every hammer strike is custom--even if the house itself isn't an expensive custom home," Larson says. "There is a way to democratize architecture," he argues, "to capture the knowledge of good architects and good engineers in a computational design engine. There are no technical barriers to doing it. It's just a matter of inertia in the industry."

In 1996 Larson decided to leave private practice and go to MIT, which was courting him for a new program that would bridge the gap between architecture and computer science. "He's unusual among architects because he's thinking as much about the process for changing architecture as he is about creating interesting one-off spaces," says Stephen Intille, technology director for the 18-person House_n research group. (The "n" in the group's name symbolizes an indefinite number of houses.)

While Larson's group was getting started developing the computational strategies that would support their open-source building concept, Benson was looking for better ways to do what he had already been doing for 30 years: precutting walls, floors and other components in his shop rather than at building sites, a practice that is highly unusual in the wood-home industry. (Benson's homes are different from the "modular" homes that have become more popular in recent years. Built just like conventional houses, modular homes are shipped fully assembled, and thus have little size or design flexibility.)

The 50-some employees of Benson's company, Bensonwood Homes, build custom timber-frame houses for middle-and upper-income clients all over the country.

Centralizing most of the actual building in his factory allowed Benson to manage costs--and quality--far better than he would be able to do if his homes were built entirely on their far-flung plots. But there was still much Benson had to do outside of the controlled environment of his Walpole, New Hampshire, shop. Wiring and drywall, for example, still had to be installed at the site, where the skills of locally available craftsmen were uneven at best. (Business leaders consistently cite a critical shortage of skilled craft-speople in the construction industry.)

For decades, Benson had been bothered by the inefficiency of American construction methods. Then, about 15 years ago, he discovered the writings of Dutch architect N. John Habraken, whom he invited to come speak to his employees in New Hampshire. Habraken, who taught at MIT until his retirement in 1989, laid the theoretical framework for a movement that came to be known as "open building" (and has since evolved at MIT into Larson's "open-source building"). He proposed separating a building's support structure from its "infill"--interior elements such as partition walls, wiring, plumbing and cabinets.

Benson was similarly influenced by Stewart Brand's 1994 book How Buildings Learn, which divided a house into six major systems, or layers, each with a different life span: site, structure, skin, space plan, services and stuff. The structure (what Larson calls the chassis) is expected to last for centuries. The skin--which includes the roof, siding and windows--is shorter-lived, 40 to 80 years, but still quite durable. The space plan consists of interior walls that can be rearranged as the family's needs change. The services include mechanical systems, plumbing and other elements that are fairly long-lived, as well as shorter-term systems such as computer wiring and phone cables. The stuff consists of furniture, appliances and other movable items.

Inspired by Brand and Habraken, Benson developed a building system that he now markets under the trademark "Open-Built." In an Open-Built system, "assemblies" made at the Benson-wood factory are added to a timber-frame skeleton. For example, an entry assembly might include a front door, sidelights, frame, trim and hardware. But even with his Open-Built system, Benson hadn't solved the problem of "entanglement." He could make a complete door assembly at his factory, but he couldn't install the wiring and plumbing in wall sections before shipping them to the building site. That all changed when Benson and Larson joined forces to build Open_1.

Forty Easy Pieces

Open_1, completed in July at the Crotched Mountain Rehabilitation Center in Greenfield, New Hampshire, is the first in a series of four prototypes to test the concept of open-source building. The three-story timber-frame house serves as a transitional residence for clients leaving Crotched Mountain's Brain Injury Center. These people, Larson says, have the kinds of challenges that many baby boomers will be facing in the coming years as they struggle to retain their independence and mobility. Open_1 is intended to demonstrate how a house can adapt to its occupants' changing needs over time.

Instead of cutting and fitting every piece of the house on site, Ben-sonwood's builders prefabricated Open_1 from 40 sections--including a three-story elevator shaft--and lowered each into place with a crane. All of the walls were installed as finished sections; the plumbing, wiring and insulation were built in at the factory, and exterior cladding and interior drywall were already attached. "You take it off the truck and you stick it to the frame, and voilà--instant wall," explains Barry Reid, product-development marketing manager at Georgia-Pacific, which donated the mold-resistant paperless wallboard used for the project.

Building a custom house the size of Open_1, which measures 3,500 square feet, typically takes 12 to 18 months. Open_1 was completed in less than a month, and all of the waste produced during construction fit into just two trash cans. (Normally, construction of a home this size would generate enough waste to fill a couple Dumpsters.) The house doesn't look like the futuristic stuff of a world's fair. What makes it revolutionary is the ability to upgrade easily and add new technologies as they are developed. For example, German-made wire connectors act as synapses between the electrical wiring built into the wall sections, making it easy to reconfigure walls. (In most homes, plumbing and wiring is buried deep inside insulated walls where it can't easily be repaired or replaced.) Wiring that is likely to require frequent upgrading--such as phone and TV cables--is easily accessible in raceways and behind removable wainscoting. When you build a house, Benson says, "you shouldn't have to predict where you'll want a TV in 20 years."

Open_1 also has removable ceiling panels between its timber-frame supports. Forget calling a carpenter, an electrician and a drywall guy; to change the wiring for a light fixture, you simply lift the panel out. "It should be as easy as taking out an old toaster and putting in a new one," Benson says.

Like commercial buildings, open-source houses will have interior walls that are not load bearing, so they can be moved around to create new floor plans. They'll also be easier to wire with new electronic devices--for instance, sensors to help monitor the health of the house's occupants and other technologies that make it easier for people to continue living in their homes as they age. Sprawling, hastily constructed homes may have been just what baby boomers once wanted for their growing families, but Larson predicts that boomers will soon be looking for smaller, higher-quality, more adaptable homes: "I wouldn't put my money in a McMansion in the suburbs right now."

Three more open-source prototype homes are planned, one every 18 months. The next prototype will be focused on a flexible interior fit-out--including movable walls--and will probably be a single-family home. "You can move all the pieces around like Legos," Benson says. "We're trying to promote a system that is infinitely variable, as opposed to a particular architecture that is repeatable."

Reinventing an Industry

Larson likes to call his designs "mass-customized." But realizing the "mass" in that idea will require major changes in the housing industry. Most new single-family development

today consists of cookie-cutter tract housing that is driven more by real-estate speculation than by architecture, and housing construction is an industry that is slow to evolve.

"No one entity is going to change the residential building industry. It's going to take a consortium," Benson says. So how to bring an entire industry into the 21st century? The Open-Source Building Alliance is a start. Companies such as Georgia-Pacific, Kohler, Light-olier and Huber Engineered Woods partnered with MIT and Bensonwood Homes to build Open_1. "We hope the project will help determine how best to scale this to the industry," says Sherry Walker, vice president of marketing and product development at Huber. "If scaling this up is feasible, we think it could change how homes are constructed and how homes are lived in."

"We've got a tremendous opportunity to create entire new systems and maybe even radically transform a whole industry if we can get some agreement on standards," Larson says. Currently the building industry's standards are low-level--specifying where a screw hole must be located on an electrical-outlet plate, for example. But if standardization could be extended to house-wide systems, it could open up new markets for savvy manufacturers.

Just as IKEA created a huge offering of furniture components from a standardized system--which enabled it to sell a high volume of products at low cost--other manufacturers could offer house modules such as finished windows and wall panels in all shapes and sizes. "In the end, this is the only way for the cost [of houses] to come down," Benson says. "When manufacturers are making value-added components instead of parts and pieces, it gets very competitive." And with standardization, the thinking goes, comes higher standards for quality. "Today your Maytag washer is built to last for decades, but it's OK to have a huge crack in the concrete of your house," Benson says. "This is an opportunity to really improve the quality of buildings in North America." Dawn Stover lives in a one-of-a-kind log cabin in White Salmon, Washington.

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