In Brief
Currently, the complexity of the design process makes it difficult to determine, precisely, a building’s future energy use—but this won’t always be the case. Microsoft Research and the Royal Danish Academy are collaborating with Green Prefab, a small startup in northern Italy, to develop civil engineering tools that take advantage of the power of cloud computing on Windows Azure. These virtual tools have the potential to reduce the time and cost of green building by allowing in-depth simulations of a building’s performance and appearance during the design phase.

A Window into the Future:
Eco-Testing a Building Before It Is Even Built

Architects and engineers all over the world are inventing new ways to reduce the time, cost, and risk of constructing energy-efficient, high-performance buildings. One of the key technical challenges these eco-pioneers face is the high cost of the data-intensive analysis they require to design these “green” buildings. Now, Microsoft Research and Green Prefab have a new way to analyze data cost-efficiently—and quickly.

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Furio Barzon
Founder and Chief Executive Officer
Green Prefab

Using Pre-Fabricated Parts and Fast Computation Time
Despite the fact that sustainable design is strongly promoted globally, the complexity of the architectural design process makes it difficult to predict, exactly, a building’s structural integrity, energy consumption, water use—even its appearance. As a result, the process of designing eco-friendly buildings is expensive and lengthy.

Small and medium-sized design businesses, in particular, face many practical implementation challenges, such as the time-intensive process of performing computer simulations, the high cost of the powerful technology that is needed to reduce execution time, and the high cost of in-house sustainable design specialists and proprietary computer aided design (CAD) software. The good news: cloud computing has tremendous potential to change all of that.

Green Prefab, a small startup company in northern Italy, is working with Microsoft Research Connections and the Royal Danish Academy to develop next-generation tools that will one day make it possible to conduct in-depth simulations of a building’s performance—before the physical construction begins. This innovative approach is possible by using cloud computing—on Windows Azure, Microsoft’s open and powerful public cloud platform—to provide inexpensive data-intensive analysis.

Green Prefab is developing digital services that will allow...
architects to evaluate design alternatives in relation to performance factors at the early design stage. According to Furio Barzon, Green Prefab founder and chief executive officer, the company is developing a library of prefabricated green building components that can be used to design eco-friendly buildings. Barzon envisions a radically different building process once the library is operational. “A typical architect will first view the prefabricated components in 3-D, then select components appropriate for the project, and finally design the building using one of several different well-known CAD formats,” Barzon explains.

During the design phase, the architect will be able to access civil engineering services, via the cloud, to produce energy efficiency reports, conduct in-depth structural analysis, and view photo-realistic images of the building—long before the site is excavated or the foundation poured. Green Prefab is collaborating with Microsoft Research Connections to develop some of the first tools for Windows Azure. “The key to improving building performance is the ability to virtually simulate projects while they are in design—as they are taking shape,” Barzon says.

Green Prefab is also collaborating with a community of 20,000 Italian architects and engineers to lay the groundwork for the company’s cloud-based offerings. One essential ingredient of Green Prefab’s industrialized approach is its use of a data model that was developed for the construction industry in the 1990s by an international consortium known as buildingSMART. The buildingSMART model is an open format that makes it easy to exchange and share building information modeling (BIM) data between applications that were developed by different software vendors. Vladimir Bazjanac, scientist in the Building Technologies and Urban Systems Department at the Lawrence Berkeley National Laboratory, has been involved with buildingSMART since its inception in 1994. Recognized as an expert in the area of software interoperability, Bazjanac explains that the open format of buildingSMART’s Industry Foundation Classes (IFC) data model of buildings has made it easier for Green Prefab to model prefabricated green building components.

“Professionals in the construction industry have always wished they could run multiple energy simulations rapidly. That would make their building designs more energy efficient,” observes Emanuele Naboni, associate professor of Sustainable Architecture at the academy. The effective use of parametric building performance simulations has the potential to optimize building designs; it facilitates in-depth, pre-construction analysis of energy use. Despite this potential, parametric energy studies are rarely used. Complex parametric analysis models require simulation on a scale that is nowadays available only to large private, academic, and government research laboratories. “A new generation of architects and engineers will totally rethink the building design process when a series of cloud-based simulation tools become more widely available,” Naboni remarks. “One scenario is that a firm’s customers will be able to actively participate in design decisions, knowing the impact the proposed building’s designs will have on energy use.”

Working on green building innovations has inspired Barzon to dream of a time when large communities of engineers and architects will be able to analyze complex building scenarios extremely quickly. To that end, his company collaborated with the Institute of Architectural Technology of the Royal Danish Academy to validate the potential usefulness of building-performance energy simulations in the cloud.

DEVELOPING ENERGY SIMULATIONS

The Royal Danish Academy’s experiment involved using Green Prefab’s prototype web-based tools with the supercomputer in Barcelona, Spain, to execute parametric energy simulations of buildings through the power of cloud computing. An experienced architect created an energy optimization experiment with 220,184 variable combinations. “The objective was to show how architects could use cloud computing to address an energy design problem with methods that are now only accessible to a few research centers with computation clusters,” Naboni explains.

The design of the test building reflected the floor space, occupancy, and environmental setting of a standard office in Copenhagen, Denmark. In order to understand the advantages of the proposed service, in comparison to conventional ways of using simulations, a parallel experiment was conducted. Starting from the same building design, the same architect conceived and tested 50 design options with a standard dual-core PC. In the end, the cloud-based approach achieved approximately twice the potential energy savings: 33 percent, compared to only 17 percent energy savings for the conventional approach. It also reduced computing time significantly. Running the 220,184 parametric simulations on a standard dual-core PC would have taken 122 days; running those same energy simulations in the cloud took only three days.
Searching for drugs that fight tropical diseases has always been a lower priority for drug companies because it hasn’t been a good commercial prospect.

Cloud computing makes it feasible to conduct green building studies that were unimaginable in the near past. “We were able to demonstrate that cloud computing has tremendous potential to improve business opportunities in the green building industry,” Barzon remarks. “The next step will be to implement parametric energy simulations in Windows Azure for commercial use by the construction industry.”

Naboni is already at work on new simulation experiments that involve actual construction of a zero-energy building. “Architects and engineers will one day be able to tweak a building’s design so that it operates with a limited use of fossil energy, reducing the need for traditional heating or cooling systems,” he says.

REDUCING BUILDING TIME, COST, AND RISK

Fabrizio Gagliardi, director of Microsoft Research Connections EMEA and former chair of the VENUS-C Project Management Board, expects that wide adoption of cloud-based civil engineering tools will radically reshape the green building industry. He remarks that Green Prefab’s photo-realistic, 3-D illustrations of what a building will look like are only the first step: “The advent of in-depth modeling in the cloud that simulates the performance of pre-fabricated components opens up a whole new range of fascinating building design possibilities.”

“The success of our initial experiments allows us to imagine a world in which it will be commonplace to construct buildings with the same standardized processes used today for airplanes and automobiles,” Barzon explains. “Based on industrial production methods that produce digital, fully-detailed models of a building, Green Prefab will one day be able to guarantee its physical appearance and performance, while saving construction time and reducing costs by up to 30 percent.”

Barzon continues, “Imagine a time when a thorough testing phase, led by engineers and sustainable building experts, will help to prevent design faults while the high quality of prefabricated parts will reduce waste on-site during construction.”

Even small architectural firms will be able to control costs in the pre-construction phase and reduce uncertainties during construction. “We expect to see the ‘democratization’ of sustainable building as civil engineering tools in the cloud become available to mid-sized and smaller architecture and engineering firms across the globe,” Barzon notes.

“On average, building-related activities consume more than 40 percent of a country’s energy,” states Naboni. New cloud-based tools, like those resulting from Microsoft’s collaboration with Green Prefab, have the potential to reduce the energy consumption of buildings substantially. This and future scientific innovations will facilitate a shift towards building more environmentally friendly buildings that use energy and water efficiently, reduce waste, and provide a healthy environment for working and living.