The environmental sophistication of Phipps Conservatory and Botanical Gardens' lush Tropical Forest Conservatory was a precursor to the "living building" design of the new Center for Sustainable Landscapes.

living building

PITTSBURGH'S PHIPPS CONSERVATORY AND BOTANICAL GARDENS IS GOING TO THE OUTER LIMITS OF GREEN IN CONSTRUCTING ITS NEW EDUCATION-AND-RESEARCH CENTER. PLANS ARE TO CREATE A "LIVING BUILDING" WITH A SELF-CONTAINED ENERGY AND WATER SUPPLY. THE AMBITIOUS PROJECT IS ATTRACTING FOUNDATION SUPPORT AND A RANGE OF DESIGN CHALLENGES.

BY JEFFERY FRASER PHOTOGRAPHY BY JOSHUA FRANZOS

They gather just beyond the edge of the Thailand forest where mango, lotus, strangler figs, teak and Bodhi trees thrive, protected from a temperate, decidedly untropical Pittsburgh climate by the most energy-efficient conservatory in the world.

It is not the two-year-old Tropical Forest Conservatory's "greenness" that staff, trustees and influential friends of Phipps Conservatory and Botanical Gardens have come to celebrate. Nor is it the LEED-certified Welcome Center, nor plans to replace natural gas with methane generated from organic matter on site, nor the fact that the conservatory has abandoned its lawn irrigation system in favor of drought-resistant grass and 100 percent organic lawn care. The attraction isn't even the awards and industry accolades Phipps' existing environmental accomplishments have earned.

They've gathered to mark a more ambitious undertaking on this September morning. Phipps, led by an executive director and a board of trustees given to questioning convention, is breaking ground on a "living building": the 20,000-square-foot Center for Sustainable Landscapes. The new home for the conservatory's administrative offices and education and research programs is being designed to meet all energy and water needs without drawing a single watt from the grid or tapping city water.

It's a dramatic step in an evolution of thinking at Phipps that has led it to fully embrace the notion that the built environment must be one with its natural surroundings. "One of the problems I think we have in the world today is that we've become so disconnected from nature," says Richard Piacentini, Phipps' executive director. "We don't know where our electricity is coming from, how it is made, where our food comes from or how it is produced." And Phipps officials believe the new building could help in finding answers to those important questions.

Jeff Fraser is a Pittsburgh-based freelance writer and a frequent contributor to h.
His last article, published in this year's Annual Report issue, was about a foundation-supported program to help minority and women contractors acquire the bonding needed to bid on construction projects.

Above from left, Chris Minnerly, lead architect, The Design Alliance; Sutter Wehmeier and Jose Alminana of the Philadelphia-based landscape architecture firm Andropogon; and Phipps Executive Director Richard Piacentini engage in a hands-on discussion about the still-evolving model of the Center for Sustainable Landscapes. Below left, Kelly Ogrodnik, Phipps' sustainable design and programs manager, listens to another conversation about the new center during the meeting. Below right, a close-up of a model of the center reveals how detailed the miniature replica has to be.

"When we first there was huge headache and a challenge this

Renderings of the Center for Sustainable Landscapes, shown above, indicate how architects continue to work on the specifics of the building and its surroundings.

Also inspired by the building's potential are guests at the groundbreaking, who include Pittsburgh Mayor Luke Ravenstahl; Heinz Endowments Chairman Teresa Heinz; and Gil Sperling, program manager of energy efficiency and renewable energy for the U.S. Department of Energy. Teresa Heinz notes that one goal of the Endowments' environmental philanthropy is to support pilot projects and innovative models that will attract attention and change architecture and construction around the world. The foundation has awarded a total of $2.6 million in grants to help make the Center for Sustainable Landscapes a living building.

"What would it be like if every building in the world were built like a tree—using energy from the sun to power all its internal systems; capturing, using and treating its own water; and making it available for others to use?" she asks. "For one thing, not only could we avoid the cost of building new power plants, we could begin to shut down the least efficient and harshest polluters, reducing the coal-generated soot that puts Pittsburgh on so many cities-with-the-dirtiest-air lists and leaves a legacy of asthma, heart disease and other serious health problems… You are earning international attention—and keeping this city at the forefront of the green design movement—with a building that will set new standards in green design and construction."

Then, with a ceremonial turning of soil in a wheelbarrow, Pittsburgh's competition to produce a building with a level of sustainability never before achieved is officially begun.

It won't be easy. The sustainability criteria for the Living Building Challenge were written by the Seattle-based nonprofit Cascadia Region Green Building Council to exceed those required for Leadership in Energy and Environmental Design (LEED) platinum certification, the most demanding standards on the books today.

Although no prize is involved, monetary or otherwise, some 60 nonprofits, developers and others across the United States and Canada have accepted the challenge to take projects ranging from single-family homes to apartment buildings; education centers; and large-scale, mixed-use structures to the loftiest heights of sustainability. Work is under way in places such as Portland, Ore.; Rhinebeck, N.Y.; and Vancouver, B.C., though no project has been completed. Reaching the goal of constructing a living building will be an impressive individual achievement for Phipps or any of the others in the competition. But

looked over the requirements, both concern that it was a excitement over an opportunity to tackle big on a national stage." **Chris Minnerly**, principal, The Design Alliance

success also will have broad implications in areas such as energy and water usage, building materials and design. By demonstrating the potential of sustainable construction, the projects could revolutionize how buildings across the globe are developed in the future.

As part of the Cascadia challenge, these living structures must be net zero energy with on-site renewable sources providing all energy needs. All water needs must be met with water captured, treated and managed on site, and without discharge of a single drop of waste water into sewers. The buildings must occupy previously developed sites. Demolition and construction waste must be reused or recycled. Interiors must be people-friendly and maximize fresh air and daylight. They must in some way serve to educate the public on sustainable solutions. The materials with which they are built cannot contain polyvinyl chloride or any of the other 12 hazardous chemicals on a materials "red list." Even shipping distances for materials are limited to a prescribed radius from the building site.

"When we first looked over the requirements, there was both concern that it was a huge headache and excitement over an opportunity to tackle a challenge this big on a national stage," says architect Chris Minnerly, one of the principals of The Design Alliance, the Pittsburgh-based firm selected to lead the design of the Phipps living building. Given the degree of difficulty involved and the uncharted territory that must be covered, it would be disingenuous of him, he says, to guarantee they'll be able to meet the objectives within the budget. "But having said that," he adds, "we're confident we have the team around us to do it."

The size of that team underscores the complexity of the task. A conventional 20,000-square-foot building might require a single architect and a consultant or two. With the Center for Sustainable Landscapes, it is not unusual for a design charrette to pack The Design Alliance's conference room with upwards of 40 experts: architects; LEED consultants; engineers; storm water managers; construction management specialists; cost consultants; advisors from Carnegie Mellon University, the University of Pittsburgh and the Green Building Alliance; and others—all of whom have been enlisted to solve this architectural and engineering Rubik's Cube on an $11.8 million construction and landscaping budget.

That budget found strong support among a Phipps donor base impressed with the nonprofit's sustainability strategies that have been winning applause. Yet, asking donors to finance the living building did give trustees pause because Phipps had raised $36.6 million only a few years earlier to pay for the new Tropical Forest Conservatory, Welcome Center, Production Greenhouse and a special events center—projects that ended up being greener and more expensive than originally planned.

"There were concerns that we had just been through a major capital campaign and to take this on was a major challenge," says Richard Soeder, a Phipps trustee. "But it also made a lot of sense because we had the momentum."

The Endowments was among the funders that supported both, giving $1 million to the Phipps capital campaign, $150,000 for the installation of underground "earth tubes" to help control temperatures in the Tropical Forest Conservatory and, more recently, $2.6 million for the Center for Sustainable Landscapes. Several other foundations have contributed an additional $7 million to date for the living building, including the John G. Rangos Sr. Charitable Foundation, the Fisher Fund and the Richard King Mellon, Colcom, Eden Hall, Kresge and Pittsburgh foundations.

"When they came to us with the idea, we thought it was a perfect venue," says Caren Glotfelty, Environment Program director for the Endowments. "Their board and staff understand

green building. They had practical experience around LEED, having built certified components within their facility. It's not as if they were just starry-eyed about the idea. And Phipps is a place with very high visitation and a message of sustainability."

Over the last 10 years, the Endowments has invested more than $15 million to support green building in southwestern Pennsylvania, including grants toward making Pittsburgh's David L. Lawrence Convention Center the first green convention center in the world. The Endowments also requires nonprofits that receive bricks-and-mortar grants to build those projects to LEED certification—a policy that helped bring sustainable design to the Sen. John Heinz History Center and the hybrid *Explorer* education-and-research boat that now sails the city's three rivers.

Green building in the United States has accelerated since LEED was introduced in 2000, establishing sustainable building standards and a graduated rating system for energy and environmental efficiency. Recent studies suggest an even healthier future, says departing Green Building Alliance executive director Rebecca Flora, who is leaving to join the U.S. Green Building Council. "Despite this really weak market we've fallen into in the past few months, the commercial space and residential homes that are still selling and competing are the green ones because they are seen as having greater value and lower operating costs."

In southwestern Pennsylvania, the 2003 opening of the David L. Lawrence Convention Center, the largest LEED Gold–certified building in the nation, proved to be a watershed event in elevating Pittsburgh as a leader in green building. Flora and others point to surveys showing that the green design of the convention center, which is three times the size of its predecessor, influenced some meeting planners to select it as the site for their events.

"Basically, if it were not for green, our new convention center would not have received the level of publicity and support it has," says Flora. "We were ahead of the curve, and it is a good thing or [the previous convention center] would be antiquated now…But this goes beyond image. The real value that came out of that project was how it served as a learning opportunity for our local designers, contractors and the products that went into it."

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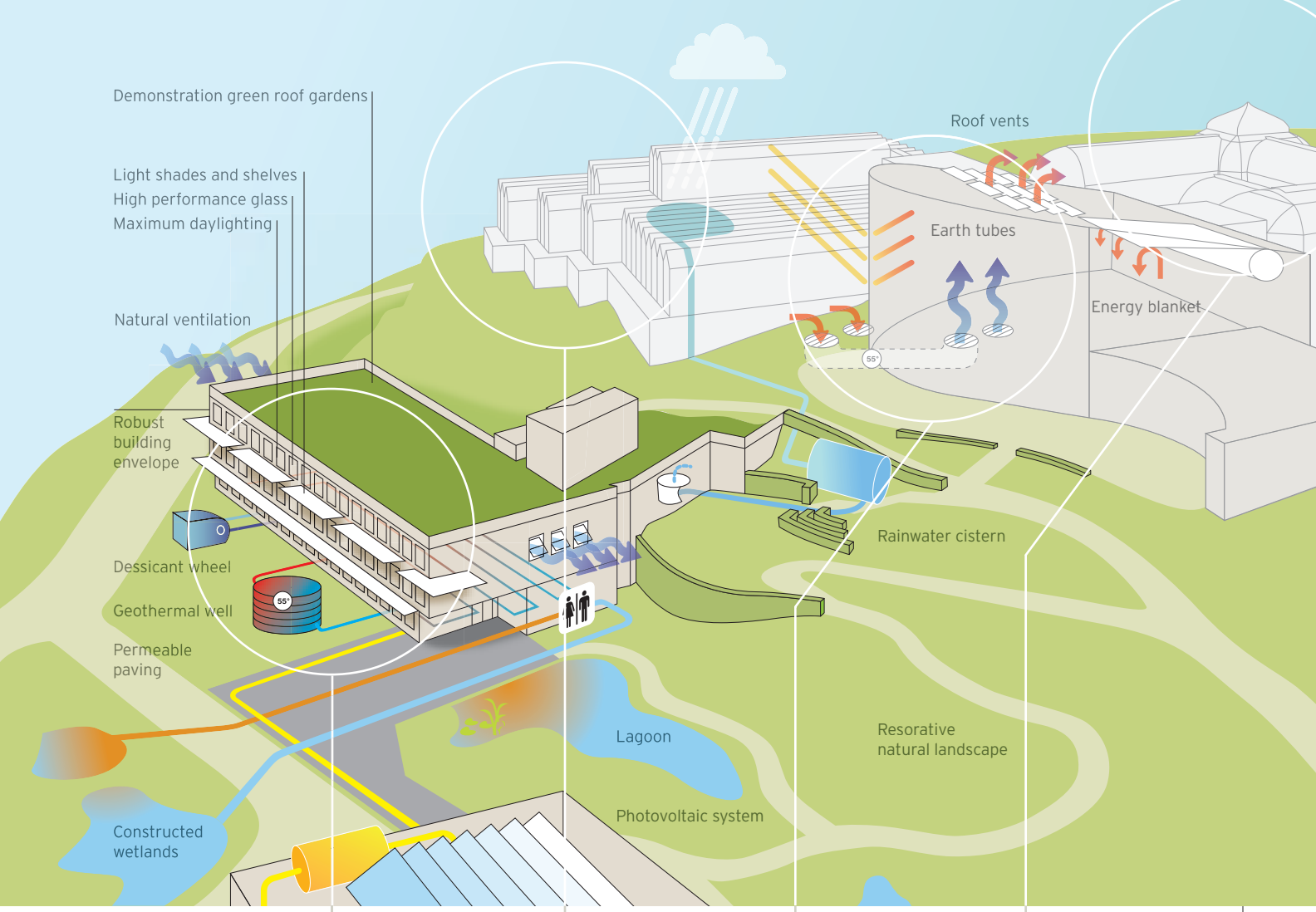
>
> **Richard Piacentini**, executive director, Phipps Conservatory and Botanical Gardens

With 24 LEED-certified buildings, Pittsburgh ranks fifth among U.S. cities in green construction. And any concern that Pittsburgh would grow complacent in that regard has been erased by the plans Phipps has for its Center for Sustainable Landscapes. After nearly a solid year's work, Minnerly, Piacentini and the project team remain consumed by a challenging process during which the solution to a problem in one area of design may well create a problem in another, or push expenses beyond the limits of the budget. In fact, costs have been reevaluated at least five times as design strategies evolved—a process that will be repeated several times over in the two to three



A Living Complex

Center for Sustainable Landscapes

The education, research and administration building is the signature project of Phase III of Phipps' multi-year expansion. The center is part of the Living Building Challenge and, as a result, is being designed to exceed LEED—Leadership in Energy and Environmental Design—Platinum certification, the highest standard for green buildings. It must have net zero energy consumption, with renewable sources providing all energy needs, and all water needs must be met with water captured, treated and managed on site.

Production Greenhouses

Within a total of 36,000 square feet, the two-year-old production greenhouses include computer-controlled temperature, light and humidity levels that create 16 different growing environments. This enables Phipps to grow a wider variety of plants than the conservatory was able to do in its previous facilities. The greenhouses also include a quarantine area where new plants are kept until it has been determined that they are pest- and disease-free and therefore ready to be placed in existing gardens.

Tropical Forest Conservatory

This section helped solidify Phipps' commitment to green technology with its revolutionary heating-and-cooling system. Passive cooling and heating techniques such as underground earth tubes, strategic use of single-pane and double-pane glass, and computer-driven ventilation and shading eliminated the need for less energy-efficient mechanical systems. A new fuel cell also was installed to convert natural gas to electricity.

Original Conservatory

Opened in 1893, Phipps Conservatory was a gift to Pittsburgh from entrepreneur and philanthropist Henry Phipps. The steel and glass Victorian greenhouse cost $100,000 and was originally stocked with tropical plants from the Columbian Exposition in Chicago, which closed in November 1893. At the time, Phipps said he wanted to "erect something that will prove a source of instruction as well as pleasure to the people."

Courtesy of Phipps Conservatory and Botanical Gardens

The design of Phipps' LEED-certified Welcome Center lends itself to creative displays such as artist Dale Chihuly's glass sculpture that hangs from the center's domed atrium. The combination catches the eye of conservatory visitors, such as Joel Lichtenstul, who snaps a photograph.

more years that are expected to pass before the building opens.

The team also is making every effort to ensure that the center's campus is in harmony with the existing natural and built environment as much as possible, taking into account stakeholders' recommendations such as using trees as a canopy and border for walkways rather than concrete or metal structures. Also suggested has been to have the detailing, bricks and other materials for the center be contextually consistent with the "Pittsburgh aesthetic" of surrounding historic buildings, including the original conservatory.

How to supply 100 percent of the building's energy needs from on-site renewable sources is a particularly thorny problem. Here, designers considered solar to be the best renewable option. But the region's annual sunlight is not necessarily abundant. "What that means is you need more photovoltaic cells to capture that energy," says Minnerly. "We can do it. But we've been running the numbers, and the problem with photovoltaic is that the cells are expensive. The more you have to buy, the more your budget gets out of whack."

The problem then became how to lower energy demand and find alternatives that can lessen the load on photovoltaic cells. The designers decided to coax enough natural light into the building to slash the need for electric lighting by 80 percent. That meant designing a long, narrow, window-lined rectangle of a building that will allow daylight to penetrate to its deepest interior spaces. But they'll lose some of the energy savings earned from using more daylight because windows are less efficient than solid walls when it comes to heating and cooling a building. So, to further offset the demand on photovoltaic cells, designers added a geothermal well, which has ground coils that remain at a constant 50 degrees Fahrenheit. Air blown over the coils reduces air conditioning demand during summer months and, because the underground air is warmer than winter air, the process reduces the energy needed to heat a building when the weather chills.

And so it goes for every issue that designing a living building raises. To meet the building's water needs, a system has been designed that involves taking rainwater from the glass rooftops on the Phipps campus, treating it on site, storing potable water in a nearby lagoon for dry months and treating sanitary water in a constructed wetland. The uncertainty here is that Phipps officials have yet to run the specifics of this strategy past city and county officials whose regulations have not been updated to accommodate such a self-contained system. But Piacentini is fairly confident of approval because similar systems have been created successfully in places such as the Powdermill Nature Reserve in Rector, Pa., and the John Heinz National Wildlife Refuge at Tinicum in southwest Philadelphia.

Still, this was not the journey Piacentini anticipated taking some 10 years ago when he and the trustees were mapping out plans for a major expansion of the 115-year-old conservatory campus. In fact, early design of the Tropical Forest Conservatory followed the conventions of that period, which included a mechanical ventilation system with energy-hungry fans. Then, Piacentini asked a simple question: "What would happen if the design didn't follow conventional roof venting?"

He asked for a study on the dynamics of the air flow in the conservatory. The data suggested that staggered roof vents would eliminate the need for mechanical ventilation and cooling. He asked for a study that tracked winter sunlight, which is critical to plant performance during cooler months. The original design called for using single-pane glass exclusively, which maximizes sunlight at the expense of greater heat loss. The study suggested that was unnecessary. The south conservatory wall, which gets nearly all of the direct sunlight, was then designed with single-pane glass, and double-pane insulated glass was used elsewhere to reduce heat loss.

Architects also added a novel shading system using solid cloth instead of porous cloth to trap more heat. The earth tubes were installed beneath the floor to passively cool the building in the summer and help heat it in the winter, further making a conventional heating-and-cooling system unnecessary. And Siemens Power Generation agreed to use the conservatory as a demonstration site for its prototype of a new fuel cell that efficiently converts natural gas to electricity. While such fuel cells are not in commercial production yet, the conservatory's 5 kilowatt cell has performed well and is the second-longest running fuel cell of its kind, with only one in Italy surpassing it.

The Tropical Forest Conservatory opened in 2006 as the most energy-efficient building of its kind, with a $2,400 annual heating and cooling bill that is a fraction of the estimated $16,800 Phipps would be paying had a conventionally designed conservatory been built.

A year later, Piacentini learned of the Cascadia Living Building Challenge. It took little convincing to get the trustees' blessing for designing the Center for Sustainable Landscapes to meet that challenge. By then, the Phipps mission had been revised to emphasize environmental sustainability. Green thinking had spread throughout the campus. Everything from the café food to the front lawn was open to reevaluation.

"You start to question everything," says Piacentini. "And you can't go back once you realize this is the way you should do things." *h*

Below left, Maureen May and Raj Narendran take a moment to soak in the verdant beauty of the Tropical Forest Conservatory's many different plants. Below right, conservatory guests make their food and beverage selections in the café of the environmentally green Welcome Center.