Inspired Innovation

WaterShed
AT THE UNIVERSITY OF MARYLAND
Two years before the University of Maryland took first place at the U.S. Department of Energy Solar Decathlon 2011, a group of students, faculty and professional mentors came together under a common purpose—to create a beautiful, sustainable and affordable home that responds to the needs of its occupants and the environment. The result is WaterShed, named for Maryland’s beloved Chesapeake Bay, and reflecting the team’s desire to change the way people use and conserve water. Their inspiration and commitment to WaterShed’s design, as well as the University of Maryland’s role in leading the team, demonstrates the value of multidisciplinary collaboration in creating innovative design. This project serves as a model for the building industry, providing a cost-effective, sustainable alternative to traditional living as the world faces a challenging and changing environment.

The WaterShed team comprises of over 200 students from various departments and schools, including the School of Architecture, Planning and Preservation, the A. James Clark School of Engineering, the College of Computer, Mathematical and Natural Sciences, and the College of Agriculture and Natural Resources.
Dear friends:

Congratulations to the University of Maryland’s WaterShed team for earning first prize in the U.S. Department of Energy Solar Decathlon 2011.

Historically, the Chesapeake Bay has been one of the most productive estuaries on Earth, providing a tremendous habitat for fish and wildlife, as well as unparalleled economic and recreational opportunities. During our generation, however, we’ve seen a dramatic decline in the health of the Bay and the rivers and streams that flow into it. Together, we share a moral imperative to chart a new course for Bay restoration and to leave a healthier Bay for our children than the one we inherited.

The WaterShed team’s entry serves as a model for future development. By analyzing the challenge and harnessing each member’s creativity and knowledge toward a shared vision, the team created a home that manages stormwater, minimizes water use and harnesses green energy to reduce the need for fossil fuels.

For Maryland to create jobs in this changing economy and restore our most precious natural resource, we must continue to educate and innovate. Our country is in a fight for our future. In this struggle between “education and catastrophe,” human innovation holds the key to victory: innovation in renewable energy, innovation in resource use and conservation, innovation in green building design, innovation in transportation and urban planning and innovation in environmental restoration and environmental redesign. It is by working together with partners like the WaterShed team, that we may nurture these great ideas out of the labs and into the marketplace to create jobs and opportunity in our State.

On behalf of all Marylanders, thank you for your dedication and best wishes for many more environmental and economic successes.

Sincerely,

Martin O’Malley
Governor, State of Maryland
When I received word on Saturday, October 2nd that the University of Maryland’s entry, WaterShed, had taken the first place prize at the U.S. Department of Energy Solar Decathlon 2011, I was delighted and proud. I was not, however, surprised. I had the opportunity to closely follow the hard-working students, faculty and mentors involved in WaterShed as their entry took shape. The team’s design concept pushed beyond the competition guidelines by putting the global issue of water consumption into the forefront, a topic that is of particular concern here in Maryland. In talking with students on the construction site, it only took a minute to understand the level of dedication to both their project and their message. Their energy and passion was contagious, and made it all the more exciting to follow their progress.

The WaterShed team exemplifies the can-do spirit that defines the University of Maryland. It is in our students’ nature to be persistent in their thinking and in their actions. They do not imagine the possibilities, they realize them. That is the Maryland way. The over 20,000 people who came to see WaterShed at the competition site are proof that our team inspired hearts and minds with their sustainable message and design innovations; innovations that will undoubtedly influence the future of the building industry. That, in my opinion, was WaterShed’s big win. The trophy is icing on the cake.

I am confident that through the pages of this book, Team Maryland’s journey will continue to inspire and educate. Their hard work, creativity, passion and perseverance are tremendous, and I could not be prouder of their achievement.

Sincerely,

Wallace D. Loh
President, University of Maryland
In the foggy, early morning hours of September 14, 2011, a small coalition of students and faculty from the University of Maryland stepped foot on the damp grass of West Potomac Park in Washington, DC and took stock in both the past and the future. That morning, “move-in” for the U.S. Department of Energy Solar Decathlon 2011, marked a crossroads in a two-year collective journey for nearly 200 students, who dedicated countless hours of course work, brainstorming, design and construction to create a solar-powered house inspired by the Chesapeake Bay, aptly named WaterShed. The Decathlon represented an opportunity for the students to display the fruits of their labor in a high-profile, international competition; to share their vital message of sustainable, affordable design within reach; and hopefully, to win.

And win they did. Team Maryland took first place, scoring the highest number of points ever in the history of the Solar Decathlon. They also won many hearts and minds, with over 20,000 visitors pouring through the doors of WaterShed during competition week and an outpouring of praise from government officials on a state and federal level.

From our standpoint as program administrators, the Decathlon exercise represents something far more rewarding. Bearing witness to a combination of talents from architecture, engineering, life sciences and seven other disciplines, collaborating, sharing, challenging and learning from each other to create an industry game changer. Innovation cannot arrive in a vacuum. WaterShed is the result of many minds putting forth their best efforts to create, beautiful, net-zero design, new technologies and sustainable solutions to reduce our environmental impact.

Our society faces environmental challenges unparalleled to any other time in history. It is the sense of teamwork and collaboration demonstrated by the students, faculty and mentors of WaterShed that is needed to tackle such problems as global warming, energy sourcing, water consumption and urban sprawl. It is the joining of diverse backgrounds and expertise that will create, innovate, and inspire a better, more sustainable future.

The Solar Decathlon experience is not something you can replicate in any classroom, and is the closest thing you will find to preparing these individuals for working — and succeeding — in the professional world. We have an obligation to the state of Maryland and the built environment at-large to prepare our students to meet the environmental changes we face, to push our boundaries of thinking and to make a solid contribution to sustainable innovation. The people who visited WaterShed in West Potomac Park were energized and excited. They could imagine it being replicated. It is a power message that drives our mission into the future.

Deans Cronrath, Pines and Wei

David Cronrath Dean and Professor, School of Architecture, Planning and Preservation

Darryll Pines Dean, A. James Clark School of Engineering

Cheng-i Wei Dean, College of Agriculture and Natural Resources
The team’s mission was to design and build a solar-powered house that was inspired and guided by the Chesapeake Bay ecosystem, interconnecting the house, landscape and people who live in it.
The team’s revised objective created a new set of challenges, but also many opportunities. These included turning what is commonly viewed as a liability in modern society — water management — into an asset. Instead of addressing how to dispose of water, the team examined how it could be conserved, reused and integrated into the house in a way that benefited both the inhabitants and the site. The addition of water conservation as a predominant theme in the team’s mission inspired new and exciting design elements and technologies, both cutting edge and inspired by nature. Water was integrated into the very core of the design, and almost every decision, every challenge and every proposed innovation filtered through this lens.

WaterShed operates on the premise that, like an ecosystem, every aspect of the house should integrate in a way that protects, enhances and informs part of a larger cycle. The house was designed to participate with its environment, harmoniously interconnecting with its site and its inhabitants. Similarly, each design innovation works in concert with others in an intricately choreographed way.

The same spirit was also reflected in the team’s make-up. WaterShed’s team comprises over 200 students, faculty and mentors, from the disciplines of architecture, engineering, environmental science and technology, plant sciences, construction and more. Like WaterShed itself, the team’s diverse members worked together under a common goal: to create a beautiful, energy-efficient and affordable home, whose technologies, architecture and environment work together to guide its inhabitants toward a more sustainable way of life.

Driving The Design

When designing WaterShed, the central theme of water was considered in different ways: in terms of how the house should respond to collecting, filtering and cleansing water; in integrating water with internal systems such as humidity control; and through material choices in building the house, geared to protecting it from rain and water vapor. These ideals materialize in the form of sloped roofs, liquid desiccant waterfalls, constructed wetlands and a multi-layered building envelope.

Water interacts with the built environment in three forms: bulk water (such as rain or greywater), water vapor and water that moves with air diffusion (humidity). Using water as an asset — through recycling and reuse — was a key element to WaterShed’s winning design.

At its core, the project has two principles:

1. WaterShed mimics the cyclic nature of the Chesapeake Bay ecosystem. Strong connections between the house and its site allow WaterShed to demonstrate the hydrologic cycle on a micro-scale using elements such as a green roof and constructed wetlands. WaterShed’s design showcases the carbon cycle in the edible garden and composting system. Like a food web, the technical systems are interconnected, leading to energy conservation and cost savings.

WaterShed provided students with real-world project experience, where architects, engineers and other professionals collaborate on every stage of the design-build process. Because students wore many hats, each was able to fully understand the variety of tasks needed to achieve a successful finished product.
There is a significant amount of research and time that goes into these homes, showing the creativity and how the community, industry and many different trades can work together to improve the way homes are built for the future.

Scott Tjaden, Student Team Leader (Environmental Science and Technology, ’12)

WaterShed’s Design Concept

Inspired by the Chesapeake Bay, WaterShed integrates with its landscape by using passive and active energy strategies, using its surrounding resources (sun, water, landscape) to minimize the impact of its inhabitants. Through innovative, efficient technologies, intuitive architecture and natural practices, WaterShed is a mechanism to help people make smart, ecological choices through design and connects them fully with their environment.

WaterShed’s two volumes reflect the concept of a flexible live and work environment. Designed for a single occupant, working couple or recent empty nesters, WaterShed provides an ideal situation for telecommuting or a small business.

Integrated Design

Two shed forms seamlessly accommodate architecture and engineering needs.

Passive Design

Strategic openings fill living spaces with ambient light and naturally ventilate the house.

Multi-use Space

Reconfigurable design features allow the bedroom to be used as an office.

Outdoor Connection

Integrated decks extend interior spaces into the landscape.
From the beginning, the team blurred the lines between disciplines so that architecture, engineering, living systems, IT and other programs worked side by side as one cohesive unit. Course work, studios, lectures and discussions all took place under the roof of the School of Architecture, Planning and Preservation every Tuesday and Thursday evening for three semesters. New to the decathlon experience were students from the College of Agriculture and Natural Resources. The many plant-based energy systems seen in WaterShed, such as the manufactured wetlands and green roof, are a direct reflection of their vital contribution and expertise.

A Flat Team Hierarchy

Operating on a flat hierarchy allowed the project’s core principles to lead the design. This provided students, faculty and mentors more opportunities for development and collaboration throughout the design process.
At the heart of WaterShed’s design are innovative technologies, natural elements and smart architecture that each contribute to the home’s goal of conserving and producing energy. A liquid desiccant waterfall adds both form and function as an architectural element and a dehumidifier. The vertically mounted solar thermal array produces all of the home’s hot water using the power of the sun. A self-healing exterior membrane shields the house from the elements, such as air and moisture, and vertical gardens provide shade from the summer sun and produce food for the dinner table.

What makes WaterShed perform so exceptionally, however, are not just these individual components themselves, but the whole they create. Though each one is integrated, these technological, biomimetic and design innovations create systems that work in concert. They are intentional components intertwining, complimenting and cooperating, sometimes very dynamically, sometimes quite subtly. WaterShed was designed around five of these interdependent systems: mechanical, nutrient, water, architecture and the exterior envelope. The parts within each system collaborate to produce, re-use and transform energy and resources, producing significant rewards for the house and its inhabitants: maximum space and efficiency, reduced material waste, massive energy savings and harmony with the natural environment.

Working in Concert

The systems within WaterShed work together, optimizing their overall performance, creating efficiency and comfort for the homeowner. For example, the Liquid Desiccant Waterfall, Solar Thermal Array and Regenerator work together to control humidity within the house. This in turn eases the cooling load, saves energy and provides an ideal environment for the home’s structure.

Some of WaterShed’s components — such as those found in the nutrient and water systems — not only support one another but actually cycle in harmony, where the waste of one equals food for another. Greywater collected from gutters and sinks is filtered and treated in subsurface manufactured wetlands, providing water for irrigation. Food scraps are recycled into compost, nourishing the plants that will produce food to feed the inhabitant.
Liquid Desiccant Waterfall

One of the more innovative technologies incorporated into WaterShed’s design is the Liquid Desiccant Waterfall, or LDW; a high-functioning dehumidifier disguised as a stylish architectural element. Originally developed for LEAFHouse by the 2007 team, there are two LDWs installed in WaterShed, recessed into the cabinetry in the living space and the bedroom/office space. Visually, the LDWs bring the team’s core theme of water into the house through a calming aesthetic; each LDW consists of a clear desiccant solution trickling through a vertical bed of airy, plastic orbs. Functionally, the LDW plays a key role in the house’s sustainable energy systems. The desiccant solution acts as a magnet, pulling excess moisture from the air, significantly reducing humidity levels in the house. The LDW saves electricity, can significantly reduce demand on the air conditioning system and — during certain times of the year — eliminates the need for cooling through air conditioning all together.

The Path of Liquid Desiccant

1. **Depleted Desiccant**
   Desiccant that is saturated with water will be pumped to the regenerator and stored in a tank to await regeneration.

2. **Hot Glycol from Solar Thermal Array**
   Heat needed for regeneration comes from the solar thermal array.

3. **Heating the Desiccant**
   Heat from the solar thermal array is transferred to the liquid desiccant.

4. **Moisture is Transferred to the Air**
   Hot liquid desiccant is sprayed from the top of the chimneys and mixes with rising air. Moisture is transferred from desiccant to air, which is expelled from the regenerator.

5. **Desiccant being Regenerated**
   Liquid desiccant is continuously cycled through the system until all the excess moisture is driven out.

6. **Fully Regenerated Desiccant**
   When fully regenerated, the liquid desiccant can be pumped back to the waterfalls in the house.

Twin stacks release moisture captured by the LDW back into the atmosphere.
The LDW, originally developed in 2007 by the LEAFHouse team (not pictured), was designed as a waterfall to safely and seamlessly integrate into the house’s architecture as a focal element.

Unlike traditional dehumidifiers that condense moisture in the air, a desiccant system actually absorbs the air’s moisture, pulling it into the liquid desiccant. The desiccant is then heated by the solar thermal array, driving the moisture out of the system into the outside air. This process, called “batch regeneration,” re-concentrates the desiccant to cycle back again into the house.

The most notable change in WaterShed’s version of the LDW is the use of lithium chloride in the liquid desiccant. While this makes for a more costly unit, it increases the amount of time the desiccant can be used before being recycled, allowing for batch regeneration every few days.

### The Liquid Desiccant Cycle

The liquid desiccant waterfalls, one located in each shed module, pull moisture from their air, trapping it in the desiccant solution. The solution cycles into the regenerator, where moisture is extracted, concentrating the desiccant.

The solar thermal array generates heat for the desiccant regenerator. Moisture is forced out of the house through twin stacks and into the outside air.
Exterior Envelope

The carefully conceived design of WaterShed’s building envelope creates unparalleled protection from the elements, maximizing energy efficiency and comfort within the home. Each component of the envelope serves a special purpose, collaborating to satisfy multiple functions.

The multi-layer system begins with a structural wood system, dubbed “heavy-stick” framing by the team. Triple packs of wood studs are spaced on 4’ centers, as compared to single studs every 16”. Engineered wood decking serves as sheathing and facilitates the installation of exterior insulation. A water-resistive barrier in the form of a liquid-applied membrane coats the deck, forming a drainage plane assembly, which is then topped off with battens and finally thermo-treated cladding. The special liquid-applied membrane provides an innovative barrier to air and moisture, expanding and contracting with temperature changes and self-healing when punctured. Tucked snugly inside the walls is 5 ½” of interior spray foam insulation which, when combined with the additional two inches of rigid exterior insulation, brings the total wall insulation value to R-45, more than twice the value found in typical American homes. The roof and floor receive the same type of attention in the insulation process, using closed cell spray foam. Exterior walls are clad with thermo-treated siding, which offers the same advantages of pressure-treated lumber — rot and insect resistance, as well as dimensional stability — without the use of toxic chemicals.

Aside from delivering superior protection and comfort, WaterShed’s exterior envelope provided the team greater flexibility in designing the interior space and systems. The home’s superior insulation directly affects system performance; heating and cooling units do not have to work as hard to maintain a comfortable temperature and smaller mechanical components could be used to do the job efficiently. The team was also able to splurge on light providing windows, doors and translucent wall panels.

A liquid applied membrane ensures an airtight barrier that expands and contracts with temperature changes. A self-adhered flashing lines doors and windows, and floor/wall/roof connections, to prevent shifting and moisture infiltration, ensuring an airtight seal.
Even the smallest details of WaterShed’s design, like the sectional perspective of a window jamb (above, below), were carefully thought out, rendered and vetted by the team prior to construction.

Building Envelope
Designed with redundant layers of thermal and moisture protection, WaterShed’s wall and roof systems comprise common, everyday building components assembled in a new, innovative manner.

Insulation
Wall and roof assemblies use different combinations of interior and exterior insulation.

Doors + Windows
High-performance fenestration allows daylighting without compromising thermal performance.

Moisture + Air Barrier
Liquid-applied membrane shrinks and expands with temperature.

Sheathing
Tongue-and-groove decking used as sheathing creates long spans.

Structural Frame
“Heavy-stick” framing reduces thermal bridging.
Water Cycle

Water is indeed the tie that binds WaterShed to its environment, and interconnects the many systems at work within the house. At a time when water is a precious commodity in many areas of the world, demonstrating ways to manage, reuse and conserve water was a key principle in WaterShed’s mission.

Water is implicitly integrated into WaterShed’s design. Rainwater, wastewater from showers and sinks as well as black water from the toilet are all handled in a mindful way that minimizes impact on municipal sewer systems and maximizes opportunities for reuse. The roofs of the two shed modules slope inward to capture and funnel rainwater into catchment basins below, where water is stored for future irrigation. A green roof helps slow runoff from rainfall and acts as an initial filter. Locating the bathroom between the two shed modules allows for greywater from showers and sinks to flow into constructed wetlands below, which effectively filter out pollutants like soap and other pathogens, preparing the water to be reintroduced into the environment, or reused for irrigation. The water cycle provides sustainable options for WaterShed’s inhabitants, allowing them, with their every movement through the home, to be aware of and control their impact on the environment.

Not All Wastewater is the Same

Most homes today treat grey water — wastewater that does not contain biosolids like food or human waste — the same way they treat black water, or wastewater that does contain biosolids. Both are dumped into the local sewer system. However, in many areas of the world where rain is a scarce resource, the treatment and reuse of grey water is commonplace. Recognizing this enormous difference and missed opportunity, the team developed a functional and aesthetically pleasing filtering element in the form of constructed wetlands. The wetlands, which define the east-west axis of the house, capture grey water as it flows from the two shed modules and pathogen before returning it gently to the water table or storing it to be used for irrigation on site.

Wet Core
Contains water functions within the house and distributes the water back along the path of the constructed wetlands

Treatment Wetlands
Processes grey water through plant filtration

Rainwater Harvesting
Catches and stores storm water runoff from the PV roof

Shed Roofs
Directs rainwater into water catchment basin
Available freshwater accounts for less than one percent of the world’s water supply. The constructed wetlands developed by the WaterShed team play a vital role in reducing water use and impact on the environment through re-use and reintroduction to the site’s water table. In a way that mimics the natural filtration process seen in wetlands throughout the Chesapeake Bay, WaterShed’s constructed wetlands pair microorganisms with native plant life, stripping greywater and storm water of harmful pollutants and excess nutrients. Using water processed by constructed wetlands for irrigation can reduce water usage by 30 to 50 percent a year. The wetlands also play an important part in conservation education, in that they provide a visual connection between water use inside the house and the natural environment. Understanding the impact of water usage is a key element in WaterShed’s message of sustainability.
Right: The wetlands constructed for WaterShed are known as surface flow wetlands, or free water wetlands. They consist of a basin, soil and gravel to support vegetation and a water level that is above the substrate. Resembling the natural marshes found in and around the Chesapeake Bay, surface flow constructed wetlands are effective water filters in all kinds of weather. Decompositional and microbial activity keep subsurface temperatures from freezing in the winter and, while reactions are slower, water treatment even occurs under ice (U.S. Environmental Protection Agency, 1998).

Below: The bathroom, located between the two shed modules, is where the private and public spaces converge. It is also the place where WaterShed’s design and mission intersect. Providing a visual connection between water use within the house and where that water flows into the natural environment was critical to the educational aspect of the project.
Greywater is collected from the home's shower and bathroom sink. Greywater is pre-filtered in a settling tank to remove solid particles and prevent sediment build up.

Rainwater from the green roof, pre-filtered by the green roof succulents, joins pre-treated greywater from the house where it's filtered and stored for future use.

Water is re-used for irrigation or is slowly returned to the water table.

The greywater is pre-filtered in a settling tank to remove solid particles and prevent sediment build up.

The water moves into the constructed wetland, where pollutants and excess nutrients are broken down by microorganisms. These by-products are absorbed by plants or released into the air as gas.

Rainwater is funneled into the constructed wetlands through WaterShed's sloped shed roofs.
Green Roof

Composed of 312 square feet of hardy drought-tolerant sedum species, the green roof is WaterShed’s first line of defense against some of nature’s more harmful side effects. During storms, the roof slows the impact of rainwater through absorption and filtration. On sunny days, it effectively pulls pollen and pollutants from the air. With its insulating properties, the green roof manages heat and offers resistance to heat conduction, thereby moderating air temperatures within the home. As WaterShed demonstrates, green roofs are a lightweight, effective and affordable option for surface insulation and roof protection.

Like most systems within WaterShed, the green roof performance directly affects and enhances the performance of several other systems within the home.
While independent components, these technologies work together in synchronicity, both supporting and depending on one another for optimum performance. For example, the solar thermal array provides domestic hot water for the house throughout the year. In the warm summer months, surplus energy in the form of heat from the solar thermal array is used to regenerate the humidity-saturated desiccant in the LDW, removing the water and driving excess moisture from the house. When the weather turns cold, this heat is redirected to the HXEST system to provide additional space heating throughout the home. Both of these processes significantly reduce the heating/cooling load on the home's mini-split units, which, in turn, creates a more comfortable environment and significant energy savings.
Unlike many installations of evacuated tube solar thermal arrays, WaterShed’s arrays are mounted vertically. This enhances its performance in the winter, provides needed shade and comfort in the summer and serves as an eye-catching architectural element, defining the space of the entry deck.
Nutrient Cycle

Borrowed from one of nature’s oldest processes, WaterShed’s nutrient cycle fulfills its mission of conserving and producing resources, where the waste of one equals food for another. The 87 square feet of traditional garden beds as well as the vertical garden walls generate 15 varieties of produce for WaterShed’s inhabitants. Once harvested and eaten, food scraps are combined with other organic material such as yard waste in the house’s compost bins. Under a thermophilic or heat-driven process, these raw materials mix and mingle with water, oxygen and microorganisms in compost collaboration. The result is garden gold: rich, organic fertilizer that is cycled back into garden beds, enriching the soil and feeding the plants.

Designing With Nature

Plants are an essential part of WaterShed’s design and the lifestyle it promotes. They are active stewards in connecting the built with the natural environment. In the many ways plants are integrated into WaterShed — through the green roof, gardens and wetlands — they provide protection and nourishment for both the inhabitants and native animal life.

Native Landscaping

Provides privacy screen and connects the site to its regional context.

Garden Beds and Trellis Wall — Food

From squash and tomatoes to grapes on the vine, the garden beds offer a variety of annual and perennial plants to nourish the homeowner.

Compost — Waste

Yard and kitchen waste is recycled through composting, providing organic, low-cost fertilizer for garden beds.

Green Roof

Although made of plants, the green roof is both hardy and sturdy. It provides WaterShed additional insulation and slows stormwater runoff to the wetlands below.

Constructed Wetlands

The wetlands filter storm and grey water for irrigation and provide habitat for the many species of native wildlife.
Plants are more than just landscape. On WaterShed’s site, they perform multiple duties: produce food and shade, protect the home and manage and purify water. They also provide homes to native animal populations. The plants used in WaterShed’s landscape— all native to the Chesapeake Bay area—are hardy and low-maintenance.
Vegetable Garden, Vertical Garden and Composting Station

Consisting of traditional outdoor plots and vertical garden walls, WaterShed's gardens are an integral part of the home’s natural cycle. The gardens provide food for WaterShed's inhabitants, reinforced by compost produced on site. The vertical garden also provides shade and protection to the outdoor living space and play an important role in filtering particulates and toxins from the air.

Outdoor Living

The vegetable gardens, composed of vertical walls and traditional beds, are a beautiful living accent to the home’s outdoor pergola. Adjacent to the kitchen, the pergola area serves as additional outdoor living space, bringing the homeowner closer to the environment.

Pergola Structure

Beautiful outdoor living space that also hosts six PV Solar Panels on its roof.

Vertical Garden

Shades the pergola area as well as filters particulates from the air.

Garden Beds

Provide a beautiful and functional aesthetic for the outdoor living space.
Architecture

WaterShed consists of two shed modules connected by a striking bathroom space. This configuration clearly divides the public and private areas of the house, offering living space in one module and bedroom/office space in another. The intricate aspects of WaterShed’s architecture direct the greater narrative of the project, physically connecting the inhabitants with their environment. Each module opens up to outdoor living space, with a spacious covered pergola off the kitchen and open deck space off the bedroom and living area. The sloped roofs facilitate the collection of water and the exterior landscape provides protection, food and water filtration. Intersecting with and bridging over the constructed wetlands, the bathroom represents the culmination of innovation and nature and is where the relationship between WaterShed and water comes full circle. With floor to ceiling windows, it is also a dynamic focal point in the home.

The design details developed by the team are what make the house a home. WaterShed’s space was created to be flexible and adaptable in purpose. The addition of reconfigurable and custom designed convertible furniture gives inhabitants greater leeway for work, rest or entertaining. Well-placed windows and doors allow ample natural light and airflow.

“Witnessing the transition from 2D construction drawings to a 3D house alone taught me more than any class could have.”

Jay Chmielowski, Student Team Leader (Civil Engineering, ’12)
Team members develop a custom furniture piece for WaterShed as part of a design charrette with Gensler, an international Washington, DC-based design firm. Dubbed the “taco bed,” the design incorporates a folding mechanism, allowing the bed to double as a conference table for the home office (Right top).

Custom Furniture
At just under 1000 square feet — a rules limitation of the Solar Decathlon — the need to make space multi-functional was essential. Several casework configurations were considered by the team in an effort to provide potential homeowners with defined space, ample storage and optimum flexibility. The development of custom furniture, such as a bed that can be reconfigured into a table for meetings and home office work, fit the bill perfectly. One of the more innovative design elements conceived by the team, the furniture development was a collaboration with professional mentors from Gensler, Herman Miller and DatesWeiser.

WaterShed’s kitchen table was designed to be both flexible and functional. Comprising two dining tables that rest on moveable, counter-height storage units, they can be arranged and moved at the owner’s whim. The tables provide dining space for intimate gatherings or family entertaining, while the storage units can provide additional workspace in the kitchen. When not in use, they stack neatly together on the north wall of the kitchen.
WaterShed’s south module situates by day as a home office.
Appliances and fixtures were chosen to reflect the beauty, efficiency, and sustainability of the design.
Behind the innovative design of WaterShed lies a diverse group of students, faculty and professional mentors that make up the WaterShed Team. Both interdisciplinary and multi-generational, the team contains a varied collection of bright minds from architecture, engineering, environmental science and technology, landscape architecture and other professions. Bringing to the table their differing knowledge, experiences and backgrounds — but sharing a common vision — proved to be a winning combination.

As the design-build process got underway, the team adopted a flat hierarchy form of organization, creating a community of designers and scholars that inspired, encouraged and challenged one another, all the while keeping core design principles and intent in the forefront. From the start, the team’s philosophy — modeled after the creative development process used by the global design firm IDEO — was that each voice carried equal weight. Students, faculty and mentors all subscribed to the credo of “sometimes leading, sometimes following.” coined early on by architecture graduate student Allison Wilson. This culture fostered rich interdisciplinary interactions among team members.

“Enlightened trial and error succeeds over the planning of the lone genius.” IDEO
“One other very important lesson I have learned from the construction process is that what you draw may not be exactly what you build.”

Leah Davies, Student Team Leader (Master in Architecture, ’11)
“Our team would have been at a loss without the knowledge, skill and patience of our mentors. The learning opportunity has been a once in lifetime experience that I will carry with me into the professional design field.”

Zachary Klipstein, Student Team Leader (Master in Architecture, ’12)

While the team began to piece together elements of WaterShed’s overall blueprint, subgroups were formed to flesh out design concepts for various systems. As these concepts took shape, teammates took turns teaching and being taught, taking classroom principles and syncing them with contributions from their peers in other disciplines. Ideas and prototypes were presented to the entire team where they were critiqued, tweaked and combined. Over a period of months and a mountain of sketches, the vision of WaterShed came into focus.
WaterShed’s exterior siding is a thermo-treated poplar. A prolonged and intense heating process provides the same strength and resilience as pressure treated wood without the use of chemicals. Thermo-treated wood is dimensionally stable, rot and insect resistant and, with the application of a waterborne sealant, holds up to moisture.
This sense of integrative collaboration continued as the team moved from classroom to construction site in January of 2011. By May, with the ink still wet on final exams, the team was in the throes of full-time construction, installing waterproofing, plumbing and wiring, and nurturing seedlings in the greenhouse. This process of “learning by doing” increased their understanding of the complexity of the project, sometimes revealing how the best laid plans have a habit of bringing unanticipated consequences to the fore. Ideas drawn up in the classroom that needed reworking in the field to accommodate a design or aesthetic, required on-the-spot creative solutions. With the careful guidance of mentors and faculty, the students used the analytical and problem-solving skills practiced in the classroom to tackle the real-world challenges that emerge when ideas are empirically tested in a full-size, fully functioning, construction project.

Students built confidence not only in their abilities within their professions, but personally as well. The project led to each team member’s continued discovery of their personal strengths, and allowed them to carve a special niche within the team. Some students proved to be natural leaders; others demonstrated their capacity for technical excellence; a number of students found they were effective communicators; still others revealed hidden talents that proved instrumental later during the competition contests. All of them discovered their grace under pressure. Finding their special roles added to the synchronicity and camaraderie on the construction site and strengthened the team as a whole.
Johnson Crane Service lifts one of WaterShed’s shed modules into position on the competition site after a carefully orchestrated journey from College Park, Maryland. The three modules needed just the right placement for a proper fit.
While the two-year effort behind WaterShed was ultimately geared to win the Solar Decathlon, the larger narrative of the project was public education; demonstrating that energy-efficient, sustainable housing can be affordable, comfortable and beautiful, and that water conservation is an issue as important as the need for alternative energy sources. The ideals behind WaterShed were ingrained in the team members and guided their every action. The message provided them a platform for innovation that reached far beyond the building standard. Now with the construction effort behind them, the team looked forward to the challenge of putting their design to the test, and sharing the larger narrative that inspired it.

The U.S. Department of Energy Solar Decathlon challenges 20 collegiate teams to design, build and operate a solar-powered house that is both affordable and attractive. Similar to an Olympic decathlon, the nine-day competition consists of 10 juried contests constructed to assess the houses’ affordability, performance and livability, measuring everything from hot water performance to architectural design. For competing teams, it is a non-stop parade of tests, judged demonstrations, public tours and media interviews. The competition is preceded by an equally intense assembly phase; a middle-of-the-night procession of flatbed trucks, each carrying team entries in pieces onto West Potomac Park, is all at once stressful, exhausting and exhilarating. Once on site, teams work quickly to re-assemble the homes they spent months building, in just under a week.

Despite grueling conditions, the team worked round-the-clock for six days to move and reassemble WaterShed onto the competition site at West Potomac Park in Washington, DC. The team’s deep understanding of the house, combined with their unwavering discipline and a good dose of adrenaline, made the reassembly process run without a hitch. The WaterShed team led the pack in competition-readiness, quickly getting their systems operating and passing inspections. Among the 19 teams competing, theirs was the first house to be “grid-tied.”

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Competition
On the final day of the competition, hundreds of people waited in line to catch a glimpse of WaterShed.
For the WaterShed team, telling their story proved easy. Because of the team’s inclusive organization, each student, regardless of their discipline, knew the story by its parts and as a whole. They could clearly explain the technical innovations throughout the house, communicating an excitement and enthusiasm that was contagious. The institutional memory imparted from previous decathlons gave them a sound edge, helping them anticipate potential pitfalls and stay focused.

From the beginning, the team wanted to make its design purposefully transparent, the house serving as both a teaching model as well as a place to live. The 20,000 visitors who came through WaterShed were able to see, touch and understand the concepts because they were self-evident by design. Team members adeptly explained the processes in a way that was both understandable and inspirational. For the students, this was a meaningful victory, and a successful end to their journey. Although they started out as passive recipients of information, they studied and shared to better understand the purpose and impact of their design, by reinforcing it in practice and finally, fully realizing it through the shared public experience of the competition.
“I hope people walk away with an understanding of how hard the project as a whole is to put together and how many people it takes, but at the same time how easy it is to make small but significant changes in their own homes.”

Moshe Katz, Student Team Leader (Computer Science, ’12)
The week held its challenges; suspense greeted each day thanks to continuously overcast skies and the formidable competition. In the end, however, WaterShed’s formula hit all of its marks. The team placed in the top four for all but one of the juried contests, earning first place in architecture, energy balance and hot water. Finishing the competition with a 951-point score out of a possible 1000 — the highest percentage ever awarded at the Solar Decathlon — WaterShed emerged the winner of the U.S. Department of Energy Solar Decathlon 2011 on October 2, 2011.

Students kept constant vigil on team scores by syncing their mobile devices to the Department of Energy’s website. Up-to-the-minute results were posted to a listserv, Facebook and Twitter, allowing news to be shared with the entire team and its many supporters.
Team members celebrate the first place win in the Solar Decathlon architecture contest.

Architecture graduate student and team leader Lynn Aku accepts the third place award for the Solar Decathlon communications contest.
WaterShed was not a traditional project in any sense. It did not follow the customary evolution of a project undertaken within a professional setting, nor did the instruction surrounding it adhere to a traditional academic format. It married participants from within and external to the academic setting, and asked flexibility and discipline of those it bound together. Ultimately, it was the product of a unique combination of ideas and talent of an eclectic bunch. Energetic, bright and dedicated students came together from a spectrum of disciplines to formulate and execute a meaningful vision, through their extraordinary efforts. Industry professionals and journeymen generously donated hundreds of hours of their time and experience. Faculty clocked countless hours guiding the development of the project from its conceptual beginnings to “end” as it took physical form on the construction site. This unconventional nature of the project is what made WaterShed so meaningful, so valuable and so successful for all who were involved.

Our project shined its light on water management. In many parts of the world, water management isn’t a new frontier. Parched societies have adapted their habits and habitats to preserve, recycle and reuse this precious commodity for centuries and across generations. As a team, we put water management innovation and design in the forefront, not because the decathlon requirements weren’t challenging enough, but because we recognized the inextricable link between water stewardship and energy conservation on scales as small as a single building and as large as cities and regions. Throughout the course of this experience, we learned many things as a team. Here are some I would like to share:

Universities can be perfect laboratories for developing innovations in sustainability. Adapting the standard structure of traditional academic courses to the demands of the competition and our project mission, we modeled our team structure based on our hypothesis of what the “practice of the future” should look like. We chose not to work with each discipline in its respective disciplinary vacuo, but rather to tackle the project under one roof. Birthed from our previous Solar Decathlon efforts and running contrary to accepted norms of course credit and structure, room assignments and teaching loads, this messy but productive model was our way forward toward new research and practice initiatives. Our collaborative professional partners brought experience and viewpoints that helped shape this vision and, in the end, created something inspiring and meaningful.

There is a desire for houses like WaterShed. The over 20,000 people who came to visit us on the National Mall, including the many hundreds who waited in the rain to see our house on each of the final days of competition, would agree. Industry professionals, sponsors and government representatives who saw our vision, supported our journey and ultimately celebrated our win, are asking us for more: “Share your ideas with us.” “Work with us.” And, dare we say, “Do it again!”

Houses like WaterShed have the power to teach. WaterShed teaches the industry and the public that sustainable homes can be beautiful and affordable. It teaches the importance of working now to protect our most precious resources before it is too late.

Recently purchased by the primary energy provider in the Mid-Atlantic, Pepco, WaterShed’s next chapter will be as a “living classroom,” sharing its innovations and sustainable living practices with the general public. It will be a test-bed for new eco-smart technologies.

WaterShed is only the tip of the iceberg. There were things we couldn’t attempt due to the competition structure and the limitations of a temporary installation on the competition site. For instance, grey water is successfully recycled and reused for consumption in many parts of the globe, including parts of the United States. We couldn’t execute a fully-functioning grey water system in the competition, but that doesn’t mean it can’t be done. Everyday habits, common practices, regulatory structures, and ultimately laws must fundamentally change if we are going to meet the challenge of a healthy, equitable and sustainable culture of water use.

There is a future for houses like WaterShed.
The 200 dedicated students, faculty and mentors who make up the University of Maryland WaterShed team are a collection of some of the brightest minds from the architecture, engineering, life sciences and other University programs.
The many companies, groups and individuals that make up WaterShed’s donor list were the springboard for WaterShed’s success. Materials, tools, and guidance were all key components provided by our sponsors for the construction of WaterShed. Donated furniture, appliances and native plantings helped make the house a home. Most notably, WaterShed’s sponsor support allowed the team to share their message of sustainability with the world.

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