A fragile and contaminated ecosystem, intense industrial activity, and human inhabitation struggle to coexist along the Elizabeth River. In three intertwined projects, we have developed translatable urban and architectural strategies interdependent with ecological regeneration, while demonstrating the didactic value of design in public environmental education. This design research model operates at multiple scales, reaches out to diverse communities, plans for varying, overlapping periods of time, and makes positive change in the world.

I have been working on the Elizabeth River in two projects with Crisman + Petrus Architects and one with students at the University of Virginia. Together, they demonstrate an integrated analytic and design methodology that reveals spatial, environmental, and temporal connections and operates across scales—from the Elizabeth River watershed, to the Money Point district, to a floating environmental field station. Each project is in collaboration with the Elizabeth River Project (ERP), a nonprofit, environmental organization that has been working with government, business, and community partners since 1992 to regenerate the river’s ecology after more than a century of industrial impact. The Elizabeth River is a highly polluted tributary of the Chesapeake Bay joining the cities of Norfolk, Portsmouth, Virginia Beach, and Chesapeake, Virginia (Figure 1). Home to the U.S. Navy’s Atlantic Fleet, the river is a major world port with a devastated ecosystem that threatens human health and well-being. These grant-funded initiatives were not responses to international competitions or paying clients but emerged from the idea of a grassroots architectural practice that identifies opportunities and acts. Ultimately, each project develops a proactive model of design research in both university-based service learning and professional practice.

Money Point Sustainability Study
Money Point is a 330-acre contaminated and neglected peninsula on the Elizabeth River in Chesapeake, Virginia. A tight-knit African American residential community coexists with scrapyards and petroleum businesses (Figure 2). In 1967, a catastrophic fire released vast quantities of creosote that resulted in high levels of toxins in soil, groundwater, and river sediment. The City of Chesapeake had given up on Money Point as a polluted industrial zone not worthy of consideration as a place, while disenfranchised residents lived with poor city services and tragic environmental conditions. When funds finally became available to clean up the toxic river sediment in 2004, a task force of community residents and businesses, nonprofit organizations, academics, design professionals, and federal, state, and local agencies was formed to envision a 10-year plan. Together, we engaged in a two-year public process to imagine and implement an environmentally, socially, and economically sustaining future for this non-place. As part of my larger investigation into overlooked and environmentally degraded urban conditions, this design research articulated four strategies for operating on these sites: creating a role for design, establishing vital public/private alliances, collaborating with diverse disciplines, and employing methods of analysis and design that reveal unseen connections over time.

1. Southern Branch of the Elizabeth River with Learning Barge route. (Image by the Learning Barge studio.)
The process fostered a sense of shared mission and stewardship, the plan received a 2007 Environmental Design Research Association (EDRA)/Places Planning Award, and nearly $15 million has been secured for implementation. Crisman+Petrus’ design proposed an integrated sidewalk and bioswale storm water system using native plants to filter runoff, create wildlife habitat, and make walking safe and pleasant (Figure 3). Businesses donated land for community spaces, riparian buffers, and wetlands to sustain native wildlife, and an urban forest of 1,200 trees has been planted to clean up toxic soils through phytoremediation. Currently, the Elizabeth River and her shores are largely unseen visually and cognitively by area residents, since industry often forms an impenetrable physical barrier between the neighborhoods and the riverfront (Figure 4). In response to this condition, we conceived of a nomadic site—the Learning Barge—that would provide education and public access to the inaccessible river.

The Learning Barge
Since January 2006, I have led an interdisciplinary team of University of Virginia students to research, design, and build a self-sustaining classroom that demonstrates the didactic value of design for environmental education (Figures 5 and 6). Unlike field stations located in pristine “nature,” the nomadic Learning Barge will seek out marginalized sites. As ERP cleans the river, “One Creek at a Time,” the Learning Barge will be a work platform to stage operations and provide interactive K-16 and adult education about the tidal estuary ecosystem and ongoing sediment remediation, wetland and oyster restoration efforts. The Barge’s mobility is an architectural strategy that supports ERP’s approach of initiating several smaller projects that proceed over time, rather than singular, big-budget remediation projects. The Barge will enter the public realm as a highly visible symbolic element revealing the common purpose that unites restoration sites along the river.

The Learning Barge has been designed to teach through example by harnessing energy from sun and wind, collecting rainwater, filtering gray water in a contained bed wetland using native plants, and using recycled materials and green technologies (Figure 7). ERP will own and operate the Barge, which will support environmental research, public outreach, and education to the large population of economically disadvantaged 2. View from the cement silos at Money Point. (Photo by Phoebe Crisman.) 3. Analysis of existing transportation infrastructure and impervious surfaces at Money Point (left). Proposed biological overlay with integrated water and habitat networks (right). (Crisman+Petrus Architects.)
and educationally underperforming children who live in the Elizabeth River watershed. The project scope includes the barge and its revealed systems and site-specific curriculum, the expanded context of the river including the sites that the barge engages, and the national significance of a new model for addressing environmental contamination at the scale of the region.

**Process**
Supported by grants from the U.S. Environmental Protection Agency (EPA), the Virginia Environmental Endowment, and private foundations, the Learning Barge project was developed in several University of Virginia courses that employed an intertwined research and design methodology. The first course, a Spring 2006 interdisciplinary graduate studio, included four cycles of paired research and design documented in a 170-page studio book. Research areas included estuarine ecology, contamination analysis, regeneration strategies, wind and solar power, gray water filtration processes, and onboard planting. Specific mooring sites were identified by talking with people who know the river, creating a many-layered GIS-based map, making reconnaissance trips by boat, and scanning the terrain with commercial software. We also contended with the poetic challenge of building upon water, as well as the structural, ecological, aesthetic, and phenomenological implications. Our conclusions that semester were that the river offers both a site and a purpose and, although the river is in desperate need of repair, the Learning Barge teaches that the smallest efforts to respond to this enormous condition could affect exponential reverberations in the future river landscape. Graduate and undergraduate architecture students in the Fall 2006 technology seminar developed the schematic design. The Spring 2007 studio, again composed of graduate and undergraduate architecture students, finished detailing and executing the first of two construction phases (Figure 10). Students in the
7. Self-sustaining systems diagram. (Image by the Learning Barge studio.)
Spring 2008 studio will complete the final construction phase and assemble the prefabricated components at a Norfolk shipyard that summer.

Education
Along with the ERP, we partnered with the Chesapeake Bay Foundation, National Oceanic and Atmospheric Association (NOAA), and three school districts to articulate the program and onboard curriculum. The Use Plan estimates that this semi-nomadic field station will touch the lives of more than 19,000 people each year via school field trips, university research, teacher training, and volunteer wetland plantings, public workshops, and major events. Architecture and Landscape Architecture students collaborated with Engineering and Education students to visualize the occupation of the barge and create a curriculum embodied within the Barge itself. The equation Curriculum = Site + Module + Sequence yielded a specific, yet flexible curriculum that responds to the qualities of specific sites, Standards of Learning modules, and temporal cycles. A layered navigation drawing maps the Barge’s movement based on the curricular opportunities of our chosen sites (Figure 11). Six local teachers are now writing lesson plans based on this place/study area/time strategy. Through education and direct experience, the Learning Barge seeks to inspire stewards of the Elizabeth’s cultural and environmental ecologies. Visitors will learn about wind and solar energy, rainwater collection and filtration systems, and other green building practices that can be translated to their own homes. At the same time, the barge facilitates the tangible habitat restoration of the river through wetland plantings, the cultivation of new oyster reefs, soil and water testing, and other regenerative efforts.

Sustainable Guidelines for Degraded Urban Watersheds
In a third collaboration with ERP and several public and private partners, Crisman+Petrus Architects are creating guidelines and three demonstration
projects for the sustainable (re)development of the Elizabeth River’s uplands. Ranging from riparian buffer and bioswale networks to green building construction techniques, our objectives, data, and methods will be incorporated into a Regional Action Plan for reducing toxins in the Elizabeth River and the Chesapeake Bay (Figures 15 and 16). Funded by the EPA, our study will be an educational device and model to encourage voluntary industrial stewardship in other urban watersheds throughout the nation.

**Design as Scholarship**

These interconnected design research projects along the Elizabeth River demonstrate a method of generating architectural knowledge through design and subsequent dissemination. In each case, the design process offered an important method of formulating ideas about the discipline of architecture, while written speculation on ideas that can generate physical form was equally critical. For instance, this essay and an earlier one entitled “Money Point: A Model of Urban Practice”2 provided the opportunity to reflect on design research in process. Writing and drawing are mutually beneficial. Adjudication through blind, peer-reviewed awards and publications is a crucial aspect of this approach (Figure 17). The Learning Barge project has received numerous national awards, including the 2006 Student Collaborative Design Award from the American Society of Landscape Architects, a 2007 NCARB Prize for the Creative Integration of Practice and Education in the Academy by the National Council of Architectural Registration Boards, a 2007 P3 Sustainability Award from the U.S. EPA, and the 2007 Youth Council for Sustainable Science and Technology Design Award from the American Institute of Chemical Engineers. What is most gratifying in this list is the broad range of disciplines and professional
organizations that have acknowledged both the breadth and the depth of this design research.

Conclusion
The Learning Barge initiative, Money Point Sustainability Study, and Elizabeth River Watershed projects represent the future of urbanism and architecture toward greater synthesis with environment and ecology—achieved through integration, both in phases of research and design, and a way of working across scales. Gerald McCarthy, Director of the Virginia Environmental Endowment, described the Learning Barge initiative as “exactly the kind of scholarship and research that makes beneficial change happen in the real world. Students learn, faculty develop, and communities benefit.” While demonstrating the didactic value of architecture to public environmental education and manifesting an ethical commitment to the public realm and environmental stewardship, these intertwined projects establish a proactive model of design scholarship.
The Learning Barge: UVA Student Team

Community Partners
ERP, Chesapeake Bay Foundation, Public School Districts of Portsmouth, Chesapeake and Virginia Beach, and NOAA Chesapeake Bay Office.

Consultants
Eric Matherne, Michael Petrus, Dennis Moler, and Biohabitats, Inc.

Sponsors

Money Point Sustainability Study
Crisman + Petrus Architects.

Sustainable Guidelines for Degraded Urban Watersheds
Crisman + Petrus Architects.

Notes