Architecture students designed a 3D model of Philadelphia in the year 2050 as part of Professor Edgar Stach's Highrise Buildings class on Smart Cities.

APPLIED//

BUILDING BETTER CITIES

CONTEMPORARY CITIES ARE, SIMULTANEOUSLY, ECONOMIC powerhouses and wells of extreme poverty; catalysts of efficiency and prodigious consumers of energy; places with excellent health care and unhealthy air. To a significant degree, the future of human society depends on our ability to resolve these contradictions by making cities "smarter"—i.e., healthier and more efficient, sustainable, economically productive and equitable."

Jefferson is applying its deep expertise in architecture, design, planning, material science and public health to a growing, multifaceted program of research on how to create (and recreate) cities as society needs them to be. Here are snapshots of how three faculty members are working toward that goal.

A Place for Addressing IDEAs

Kihong Ku, DDes, associate professor of architecture and Volpe Family Term Chair for Architectural Innovation, researches new technologies for addressing architectural design challenges, such as enhancing construction safety and developing new, sustainably created and energy-efficient building materials. He also works to improve the processes that underpin the conception and development of new products and solutions.

"There are tremendous opportunities for research and innovation in the building design process, and in how new construction materials are developed, and for meaningful cross-disciplinary collaboration in applying new technology to realize those opportunities," says Dr. Ku.

At Jefferson, architectural knowledge, expertise, creativity and advanced technical resources are fruitfully combined in the **Interdisciplinary Design and Experimental Architecture (IDEA) Studio**, which Dr. Ku founded and directs. The IDEA Studio is an innovative applied research framework for engaging and educating upper-level architecture students in cross-disciplinary design research that bears on open-ended questions.

In the IDEA Studio, faculty, outside practitioners and students from the fields of architecture, textile design, engineering, industrial design, medicine and others address various subjects. These include creation of novel 3D structures with textiles or textile-creation methods like knitting, and the use of such materials and methods to design and prototype adaptive building envelopes as a sustainable energy strategy. Underlying this approach is computational design thinking and technologies that enable teams of collaborators to analyze large amounts of data from multiple perspectives and to evaluate how building systems work, individually and in combination.

Studio participants learn from various sources, including computational and systems biologists who explore complex human biological processes through parametric and system modeling. The design of adaptive building envelopes can take advantage of similar approaches which adapt a material's intrinsic physical properties to create components and systems that react to environmental forces in a different manner.

"We can use evolutionary algorithms to simulate real performance and quickly run multiple iterations that model an array of scenarios to produce brilliant and unexpected solutions to architectural problems once thought intractable," notes Dr. Ku.

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Focusing on South Africa

For more than a decade, **Christopher Harnish, MArch**, associate professor of architecture, has focused his research and practice on resilient humanitarian architecture in South Africa which is the world's most quickly urbanizing area. Through the exploration and use of participatory design methodologies and high-performance/low-tech environmental strategies, Harnish has designed community, education and arts facilities in South Africa and Malawi. In addition, while serving as a Fulbright Teaching Scholar Fellow at the University of Malawi Polytechnic—where he guided Malawian architecture students in using design to advance equity, sustainability and resilience—he created a research-based design for the Malamulo Mission Hospital and its 80-acre hospital campus.

"Much of architectural research consists of high-performance, high-cost building assemblies—exceptional examples that serve narrow interests," says Harnish. "More important to me is exploring design processes and products that meet real needs of a broad swath of the population. This is especially important in the global South, where what is 'exceptional' is often impractical and unsustainable."

For that reason, Harnish is pursuing research projects that go well beyond traditional architecture and design topics—for example, collaborations on quantitative medical and public health research that will inform new healthcare facilities in South Africa. He is currently developing a collaborative research project in Malawi to improve the design of public health centers using evidence-based, quality-of-medical-care research. Those projects include analysis of facilities, needed to enable pregnant women to move closer to a distant hospital two weeks before their due dates, so that delivery care is immediately available; and spatial studies necessary to design hospitals that

enable small medical staffs and limited technical facilities to most efficiently and effectively serve a large number of patients.

The approaches that Harnish is bringing to architecture projects in the cities of South Africa have the potential to enhance the value and impact of community-focused architecture in regions throughout the world.

Concern for the Built Environment

Edgar Stach, Dipl.-Ing., professor of architecture, is a practicing architect and an internationally respected leader in research and design of smart cities, high-performance buildings and renewable energy technologies. His work focuses on energy efficiency, ecological sensitivity and responsibility, and reflects his concern for the built environment. He has received national and international design awards and recognition for his accomplishments in these areas.

Stach's current research centers on innovative techniques and advanced technologies for energy-efficient architecture. He serves as a joint faculty member at Oak Ridge National Laboratory's Building Technologies Research and Integration Center. Previously, he was a member of the faculty at University of Tennessee, where he founded multidisciplinary research platforms for high-performance buildings, sustainable architecture and solar energy harvesting. His ongoing focus on materials, technology and sustainability is supported through a mode of working that combines practice, teaching and research, as well as active engagement in the discourse of contemporary architecture through international design competitions and collaborations.

Stach has published more than 50 scientific papers and technical publications, and a scholarly book on architect Mies van der Rohe. He is currently writing a volume on Renzo Piano. The combination of knowledge, ideas, experience and skills that he brings to his research and his teaching are catalyzing today the conception and development of buildings that will comprise the cities of tomorrow. ■

Chris Harnish and biomedical engineering students from the Malawi University of Science and Technology captured drone footage that Jefferson students use to help redesign Malawi's Kamuzu Central Hospital.