Researchers tap into cell power to create building 'skins' that adapt to heat/light of environment

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Engineers, design architects and cell biologists from Penn will use the flexibility and sensitivity of human cells as the models for next-generation building "skins." Credit: University of Pennsylvania

Engineers, design architects and cell biologists from the University of Pennsylvania will use a National Science Foundation grant to utilize the flexibility and sensitivity of human cells as the models for next-generation building "skins" that will adapt to changes in the environment and increase building energy efficiency.

Based upon the dynamic responses that human cells generate, researchers hope to redesign, then re-engineer interfaces between living and engineered systems with the ultimate goal of implementing some of the key features and functions revealed by cells for sensing and control at the building scale.

Administered by the NSF's Office of Emerging Frontiers in Research and Innovation, the four-year, $2 million grant was awarded to Penn for its proposal "Energy Minimization via Multi-Scalar Architectures: From Cell Contractility to Sensing Materials to Adaptive Building Skins."

The objective of the Penn project is to explore the possibility of translating human cells' ability to respond to and alter their surrounding environments into new building materials. Cells alter their extracellular matrices, and thus their surrounding environment, with minimal energy through a combination of physical forces and chemical transactions. The hope is that insights into how cells accomplish this will lead to bio-mimetic designs and to engineers who can turn these findings into passive materials, sensors and imagers that will be integrated into responsive building skins at the architectural scale.

The novelty of the study lies in the collaboration of researchers and laboratories:

- Peter Lloyd Jones' lab in the Department of Pathology and Laboratory Medicine at the Penn School of Medicine will analyze cellular nano- and micro-mechanics.

- Jenny Sabin and Andrew Lucia in Penn's School of Design will use architectural and computational algorithms to measure and visualize in real time how cells interact with and modify substrate geometry, thus guiding the design and fabrication of soft substrates with generic 1-D to 3-D geometrical patterns in Shu Yang's Lab in the Department of Materials Science and Engineering in Penn's School of Engineering and Applied

Science.

- Based on resulting understanding of materials-environment response at the nano- and microscales, Nader Engheta and Jan Van der Spiegel's labs in Penn's Department of Electrical and Systems Engineering will design bio-inspired sensors and high throughput diagnostic tools, as well as their feedback control systems for autonomous tracking/imaging using nanotechnology to minimize energy consumption.

"Through analyzing several of the body's functions — how human pulmonary artery vascular smooth muscle cells contract or relax, for example -- we will attempt to transfer this fine-scale design ecology to the macro-scale design of adaptive building skins," said Yang said. "Our hope is that buildings may one day respond to environmental factors like heat, humidity and light and respond to them most efficiently."

The proposal represents a unique, avant-garde model for sustainable design via the fusion of the architectural design studio with laboratory-based scientific research. In turn, this will benefit a diverse range of science and technologies.

The research is considered particularly important as it represents a fusion of disciplines working towards a common goal for the public interest. The hope is that research of this nature will allow scientists and designers to engage the public in the excitement of new technologies and the basic research that bears them out, as well as offering an effective tool to recruit and train students.

Provided by University of Pennsylvania

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