Personalized Intelligent Living:
Human, Robot and Nature

Schedule

Day 1 June 28

Geometry, Mechanics and Materials

8:30 am

Randall Kamien

- Vicki and William Abrams Professor in the Natural Sciences, University of Pennsylvania, http://www.physics.upenn.edu/~kamien/kamiengroup/

- **Title: The Mathematics of Paper**

  Abstract: I will not be talking about doing math problems on paper. I will not be talking about the economics of selling newspapers in the internet age. I will talk, instead, about how there is some profound mathematics behind our everyday trouble with wrapping oddly-shaped gifts and making maps. The solution? A cousin of origami called kirigami allows us to solve these problems and more.
- **About the speaker: Randall D. Kamien** received his Ph.D. in Physics from Harvard University in 1992. From 1992-1995 he was a Member in the School of Natural Sciences at the Institute for Advanced Study. He was hired as a postdoc at Penn in 1995 and has stayed there since where he is now the Vicki and William Abrams Professor in the Natural Sciences. He uses geometry and topology to study the organization of soft materials. He is currently a Simons Investigator in Theoretical Physics.

9:15 am

Cynthia Sung

- Gabel Family Term Assistant Professor of Mechanical Engineering & Applied Mechanics, University of Pennsylvania, http://www.seas.upenn.edu/~crsung

- **Title: Origami robotics**

  Abstract: Origami is an ancient art that allows us to fold flat sheets into complex, three-dimensional structures. In the last few decades, we have developed the mathematics to design and analyze new fold patterns,

transforming origami from a form of recreation into a powerful engineering tool. In this talk, I will discuss some of these models in the context of action origami, origami structures that can continue to move after folding. We will look at how we can model these fold patterns as linkage mechanisms and combine them into new origami robot designs that can self-assemble, walk, and transform.

- **About the speaker:** Cynthia Sung is a Gabel Family Term Assistant Professor in the Department of Mechanical Engineering and Applied Mechanics (MEAM) at the University of Pennsylvania. Her research group focuses on computational methods for design automation of robotic systems with the aim of providing designers with intuitive computer-aided design tools for creating customized robots and behaviors. Their work involves developing techniques for representing, modeling, simulating, and fabricating these designs. Sung's research lies at the intersection of computational geometry, data driven methods, and rapid fabrication techniques such as 3D printing and origami-inspired assembly. She received a Ph.D. in Electrical Engineering and Computer Science from MIT in 2016 and a B.S. in Mechanical Engineering from Rice University in 2011.

10:00 – 10:30 am **Break**

10:30 am

Shu Yang

- Professor, Department of Materials Science and Engineering, University of Pennsylvania. http://www.seas.upenn.edu/~shuyang/
- **Title: Analyzing Biological Structures for Advanced Materials**

  Abstract: Bio-organisms with exquisite array of hierarchical organization with multiscale structures provides us fascinating examples with remarkable optical, mechanical, and surface effects as part of their evolved strategies to optimize water, heat, and light management in cope with their local habitat. Here, I will analyze several examples, including butterfly wings with dazzling iridescence and/or brilliant whiteness for camouflage and signaling depending on lighting, Cephalopod skins that change from transparency to red upon exposure to UV light for dynamic underwater camouflage, Tridacnid giant clams in the west Pacific presents the first geometric solution to utilize 100% of the solar energy for biofuel production, gecko foot hairs that can reversibly engage and release from a surface, and Namib desert beetle using bump shell for frog harvesting. Taking the cues from nature, I will discuss how materials scientists attempt to fabricate hierarchical structures via combination of top-

down and bottom up approaches to mimic the functions observed from nature for advanced materials.

- **About the speaker:** Shu Yang is a Professor in the Departments of Materials Science & Engineering, and Chemical & Biomolecular Engineering at University of Pennsylvania, and Director of Center for Analyzing Evolved Structures as Optimized Products (AESOP): Science and Engineering for the Human Habitat. Her group is interested in synthesis, fabrication and assembly of polymers, liquid crystals, and colloids with precisely controlled size, shape, and geometry; investigating the dynamic tuning of their sizes and structures, and the resulting unique optical, mechanical and surface/interface properties. Yang received her BS degree from Fudan University, China in 1992, and Ph. D. degree from Cornell University in 1999. She worked at Bell Laboratories, Lucent Technologies as a Member of Technical Staff before joining Penn in 2004. She received George H. Heilmeier Faculty Award for Excellence in Research from Penn Engineering (2015-2016). She is elected as Fellow of the Royal Society of Chemistry (FRSC) (2017), Fellow of National Academy of Inventors (2014), and TR100 as one of the world's top 100 young innovators under age of 35 by MIT's Technology Review (2004).

Noon – 1:30 pm **Lunch**

Flexible Electronics Mechanics

1:30 pm

Yonggang Huang

- Professor of Civil and Environmental Engineering and Mechanical Engineering, Northwestern University

- **Title: Stretchable Electronics and Deterministic 3D Assembly**

  Biology is soft, elastic, and curved; silicon wafers are not. An electronics technology that overcomes this fundamental mismatch in mechanics and form will enable applications that are impossible to achieve with hard, planar integrated circuits that exist today. Examples range from surgical and diagnostic implements that naturally integrate with the human body to provide advanced therapeutic capabilities, to cameras that use biologically inspired designs to achieve superior performance. Sensory skins for robotics, structural health monitors, wearable communication devices, and other systems that require lightweight, rugged construction in thin, conformal formats will also be possible. Establishing the foundations for this future in electronics represents

an emerging direction for research, much different from the one dictated by the ongoing push toward smaller and faster devices that are still confined to the planar surfaces of silicon wafers.

Recent advances in mechanics and materials provide routes to integrated circuits that can offer the electrical properties of conventional, rigid wafer-based technologies but with the ability to be stretched, compressed, twisted, bent and deformed into arbitrary shapes. Inorganic electronic materials in micro/nanostructured forms, intimately integrated with elastomeric substrates offer particularly attractive characteristics in such systems, with realistic pathways to sophisticated embodiments. Mechanics plays a key role in this development of stretchable electronics by identifying the underlying mechanism and guiding design and fabrication. I will present our research on stretchable silicon [1] and its applications to stretchable and foldable circuits [2], electronic-eye camera [3,4], semi-transparent and flexible LED [5], epidermal electronics [6], dissolvable electronics [7,8], injectable, cellular-scale optoelectronics [9], and soft, microfluidic assemblies of sensors, circuits and radios [10]. Review of stretchable electronics has been published [11].

Mechanics also plays a key role in deterministic 3D assembly. Complex three-dimensional (3D) structures in biology (e.g., cytoskeletal webs, neural circuits, and vasculature networks) form naturally to provide essential functions in even the most basic forms of life. Compelling opportunities exist for analogous 3D architectures in human-made devices, but design options are constrained by existing capabilities in materials growth and assembly. I report routes to previously inaccessible classes of 3D constructs in advanced materials, including device-grade silicon [12]. The schemes involve geometric transformation of 2D micro/nanostructures into extended 3D layouts by compressive buckling. Demonstrations include experimental and theoretical studies of more than 40 representative geometries, from single and multiple helices, toroids, and conical spirals to structures that resemble spherical baskets, cuboid cages, starbursts, flowers, scaffolds, fences, and frameworks, each with single- and/or multiple-level configurations.

References

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2:00 pm

Milin Zhang

- Assistant Professor, Department of EE, Tsinghua University

2:30 – 3:30 pm **Coffee Break**

3:00 – 4:00 pm **Poster Presentation**

4:00 – 5:00 pm **Round Table Discussion and Q & A**

Day 2 June 29

Robotics

8:30 am

Dan Koditscheck

- Alfred Fitler Moore Professor of Electrical & Systems Engineering, University of Pennsylvania

9:15 am

Kostas Daniilidis

- Professor of Computer and Information Science, University of Pennsylvania

10:00 – 10:30 am

Brief group introduction & tea/coffee break

10:30 am

Frank(Shaojie) Shen

- Professor, Hong Kong University of Science and Technology (HKUST)

11:00 am

Yiming Zhang

- Intel Lab

11:30 am – 12:00 pm **Poster Spotlight**

12:00 – 1:30 pm **Lunch & Poster Presentation**

Sensors

1:30 pm

Feiyue Wang

- Professor, Chinese Academy of Sciences

2:00 pm

Gansha Wu

- CEO, Uisee Technology

2:30 – 3:30 pm **Coffee Break**

3:00 – 4:00 pm **Poster Presentation**

4:00 – 5:00 pm **Round Table Discussion and Q & A**

Day 3 June 30

Computer Vision & Machine Learning

8:30 am

Jianbo Shi

- Professor of Computer and Information Science, University of Pennsylvania

9:15 am

Hai Tao

- CEO, ViON Technology

10:00 - 10:30 am

Brief group introduction & tea/coffee break

10:30 am

Andy(Jingyi) Yu

- Professor, Shanghai Tech University

11:00 am

Jingtong Wang

- Microsoft Research Asia

11:30 am -12:00 pm

Poster Spotlight

Noon -1:30 pm

Lunch & Poster Presentation

1:30 pm

Yuanqing Lin

- Head of Vision Research, Baidu

2:00 pm

Zhouchen Lin

- Professor, Peking University

3:00 -4:30 pm

Break & Poster Presentation

4:30 -5:00 pm

Round Table Discussion and Q&A