

# JHU ENGINEERING

WINTER 2018

## Coming of Age

Who knew water could be young, old, and in between?

## Targeting Metastasis

To put the brakes on cancer.

## Tech Venturers

Stepping up the game in technology transfer





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# TECH VENTURERS

Johns Hopkins has stepped up its game in technology transfer, with affordable new space, mentorship, and funding. Meet a cadre of entrepreneurial engineers who are at the forefront of commercializing their discoveries.

BY ALLEN ABEL

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1812 Ashland Avenue



This photo courtesy of Hanju Lee.

## “This is Disneyland for Scientists!”

Brian Stansky is proclaiming, in his hard hat, in the glass-walled lobby of 1812 Ashland Avenue, just north of the Johns Hopkins Hospital. Stansky, a former Wall Street investment manager, is showing off the newly hewn work spaces, wet labs, canteens, and conference rooms in the 23,000-square-foot building that is part and pride of the university’s recent commitment to translating basic laboratory research into real-world innovations, transformational inventions, and life-changing technologies.

The gleaming new center for the FastForward program of Johns Hopkins Technology Ventures is indeed a 21st-century theme park, where the fantasyland of a researcher’s brainstorm can be translated into a tomorrowland of new products ... if that brainstorm can thrive in the daunting frontier of venture capital and bare-knuckled competition.

In the past five years, Johns Hopkins University has stepped up its game in technology transfer. In October, the newest incubator opened in nearby Remington, atop a hipster eatery and within walking distance of Homewood campus. A spacious student design warehouse, called FastForward U, is expected across the street from the Remington incubator in spring 2018 (see pg. 2). With these and other ventures, Johns Hopkins engineers, clinicians, scientists, and students are being encouraged and expertly assisted with affordable space, services, mentorship, and funding opportunities as they strive to commercialize their discoveries in this new ecosystem. You could call

their battle to thrive in the open marketplace the new War of 1812.

“It’s about dreamers,” says Stansky, senior director of the FastForward entrepreneurship program. He is describing the accelerating startups and nascent businesses that are budding at the new location, which is part of a rapidly expanding spectrum of spaces in use and under construction across Baltimore, both on campus and off. “It’s about long hours. It’s frustrating. It’s crazy at times. It’s about finding out what you don’t know—trying new things, taking calculated risks. It’s about, ‘Who wants my product? What is it worth?’”

“Early on,” he says, “it’s all about the science, the intellectual property. Later on, it’s about team building. Our job is to help our scientists and engineers understand reality: Is there really a market for what you want to do?”

## A Solution Born of Cross-Talk

“When I came to Hopkins as a young faculty member about 15 years ago, the engineering school was limiting the number of provisional applications that could be filed each year; only very few disclosures moved to the filing stage,” recalls Materials Science and Engineering Professor Hai-Quan Mao. “Back then, success was primarily measured in how many papers you published and whether your peers recognized them as meaningful contributions,” he says. “Nobody really cared if you had a patent filed or not.”

Those days are long gone. The Whiting School in 2013 opened the university’s first business accelerator in the basement of the Stieff Silver Building, which it purchased in November.

Johns Hopkins then hired entrepreneur and investor Christy Wyskiel as a senior adviser to President Ronald J. Daniels. By August 2013, Daniels and School of Medicine Dean Paul B. Rothman formed the faculty-led Committee on the Innovation Ecosystem that, in 2014, concluded that the university and medical school needed to strengthen their commitment to innovation by providing space, funding, and services. Johns Hopkins anted up with a pledge of \$40 million in new innovation initiatives over five years.

Since the first accelerator opened, startups based on Johns Hopkins technologies have raised more than \$1.2 billion in follow-on funding. And over that same period, Johns Hopkins Technology Ventures has facilitated the creation of 85 startups, generated \$145.1 million in licensing revenue, and received 2,887 invention disclosures.

“You can build a flying bicycle in theory in your lab, but if no one knows how to build it and use it in the real world, then what use is it?”

- Hai-Quan Mao

One of the most promising of those new ventures, LifeSprout LLC, was founded by Mao and others in 2015 and is housed at FastForward 1812. It is based on research into human tissue growth using a biomimetic material developed by Mao.

LifeSprout LLC was one of the first recipients of early-stage innovation funds provided by Johns Hopkins “to link basic scientists with clinical partners,” says Mao, referring to several new initiatives including the Johns

Hopkins-Coulter Translational Partnership, Cohen Translational Engineering Fund, and Louis B. Thalheimer Fund for Translational Research. The Abell Foundation and TEDCO also pitched in funds, bringing the seed investment to \$1 million.

“The requirements,” Mao explains, “are that your work has to be translation-focused, and it has to be able to survive in the business world. You can build a flying bicycle in theory in your lab, but if no one knows how to build it and use it in the real world, then what use is it?”

LifeSprout’s product is a unique—and patent-pending—regenerative composite matrix of biodegradable nanofibers integrated in a natural sugar hydrogel. It can be used as space-fillers in a wound or at a surgical site.

“We developed the first fully synthetic and off-the-shelf material that mimics the architecture and function of the natural matrix surrounding the cells in the soft tissue. We ask this biomimetic substance to hold the space and promote the surrounding tissue to grow in,” Mao explains. The hydrogel and nanofibers then degrade harmlessly into the body, eliminating the need to insert—and later remove—plastic or silicone implants.

The genesis for LifeSprout came when Johns Hopkins Medicine clinicians and company co-founders Justin Sacks and Sashank Reddy came to Mao, looking for soft tissue reconstruction solutions after surgery.

“The old approach would have been that if I had an idea, I developed it in my lab and then went out to see if anybody could use it. At the same time, there would be people like Sacks and Reddy who were identifying unmet clinical needs. But it would be difficult for them to invent or design solutions. Now, the conversation is, ‘If you make it, I will definitely use it,



Hai-Quan Mao, top, pictured here in the lab with Russell Martin, PhD '15, collaborated with Johns Hopkins clinicians to develop a novel regenerative material that can be used as a space-filler in a wound or surgical site. He and his team at LifeSprout LLC are planning ahead to spin off other products such as stem cell delivery and drug delivery composites.



Hai-Quan Mao has office space in the new 1812 Ashland Avenue building on the Johns Hopkins East Baltimore campus.

and here are the requirements.' This cross-talk is what makes Hopkins special."

Mao's founding team at LifeSprout was rounded out with Silicon Valley transplant Russell Martin, who graduated from Stanford University with a bachelor's in chemical engineering, and then came east to study under Mao, earning his PhD in materials science and engineering at Johns Hopkins in 2015. He had gotten his feet wet working for two West Coast startups. "I was thinking I would go back to that California biotech startup world after graduate school—that was the default path—but the biomed scene at Hopkins was really a huge draw." Martin recently purchased a house in Baltimore.

Because the LifeSprout matrix encourages host-tissue ingrowth including blood vessel infiltration, the team is planning ahead to spin off other products such as stem cell delivery and drug delivery composites.

In this new ecosystem of discovery, disclosure, and capital investment, the pressures to produce something provably useful now—to get it right the first time—are vastly different from what they were just 10 years ago.

"As a scientist, I can take my time," says Mao. "But once people start giving you money, they're watching you by the hour. If there's no time for sleep, you don't sleep."

## Past the Tipping Point

Nothing in Hai-Quan Mao's distinguished CV nurtured him to be a businessman. To prepare him and other new-age entrepreneurs at Johns Hopkins for an initial public offering—should the demand for LifeSprout's discoveries prove strong enough—the FastForward enterprise includes intensive mentoring and assistance from experts such as Brian Stansky.

Stansky spent nearly 30 years at T. Rowe Price and as managing director at Integral Capital Partners. He knows that a successful startup needs more than whiteboards and coffee bars.

"People focus on the space, but it isn't just space," Stansky says. "What kills startups is not that their technology doesn't work but that you're making stuff that no one wants to buy." To remedy this, FastForward has 15 mentors-in-residence—business leaders who confidentially advise fledgling JHTV entrepreneurs on balance sheets, profit-and-loss, personnel management, going public, and meeting a payroll.

"JHU does not invest in the startups," Stansky notes. "We provide early-stage grants for prototyping, early study, proof-of-concept, and so on. Also, FastForward has a person dedicated to building relationships with investors and connecting our startups with them.

"As a scientist, I can take my time. But once people start giving you money, they're watching you by the hour. If there's no time for sleep, you don't sleep."

- Hai-Quan Mao

"It's not enough to say you have a plan," says Stansky. "The really important thing is the team you build around you. I'll always take a 'B' idea if it has 'A' management."

Ed Schlesinger, Benjamin T. Rome Dean of the Whiting School, is an enthusiastic proponent of this push toward commercialization of engineering research. "In the not-too-distant past, you graduated with your degree and you went to work for one of a few big companies," he says. "But the world has changed.

"At Johns Hopkins Engineering, we are working to create an environment that is conducive to the broad range of careers our students are pursuing, including entrepreneurial activities. We also are working to give our faculty the economic resources and support they need to be successful in this area. I think we are past the tipping point now, and I am going to continue to push this forward."

## "Would You Like to Start a Company?"

Beside Interstate 95, a cavernous warehouse, once the maintenance center for Baltimore City buses, is now City Garage, a techie idea factory turning out everything from skateboards to glass chandeliers. It is operated in partnership with Plank Industries (i.e. Under Armour's Kevin Plank) and Sagamore Development.

In the center of the building is a burgeoning community of robots—not the ambulatory humanoids of fiction, but sturdy metal arms that can cut, clamp, squeeze, and manhandle a tool or a product without actually being a man.

"We've created technology that makes it drastically easier for manufacturers to deploy robots to the factory floor," says Kel Guerin MS '12, PhD '15, co-founder and chief technology officer of READY Robotics Corp., the Hopkins-nurtured startup that leases space here. "While robots are fairly ubiquitous at places like Ford and General Motors, there are many manufacturing companies that have yet to adopt them. Our initial question was: How do we make it faster and simpler for a factory to leverage robotic automation?"

"Hopkins as an institution cultivated our ability to think about this as a commercially viable venture. Once I got my PhD, it's not like Hopkins said, 'Have a nice day.'"

- Kel Guerin

Guerin's answer, first formulated when he was a Johns Hopkins PhD student and postdoc studying computer science under Greg Hager, executive director of the Malone Center for Engineering in Healthcare, was to design what he calls "a Swiss Army knife for robots." It is a combination of hardware and software that makes it fast and straightforward to kit out a mechanical arm with grippers, cameras, and other peripherals—and more importantly to furnish clients with a patented user interface that allows even a novice to program a robot in minutes.

Today, the company's product is called the TaskMate: a mobile stand that combines READY's proprietary hardware with a third-party collaborative robot arm and a selection of grippers. The system can operate any

number of tools, including mills, lathes, and injection molding systems. It is portable and adaptable enough to meet the shorter production cycles of smaller companies.

Guerin was well on the way to developing the viability of TaskMate before he left campus to found READY Robotics in 2016. Already, the company has attracted nearly \$4 million in venture capital from New York, with a workforce at City Garage that grew from four to 14 in less than a year and that could well expand to 30 before the spring.

"Hopkins as an institution cultivated our ability to think about this as a commercially viable venture," says Guerin. "Once I got my PhD, it's not like Hopkins said, 'Have a nice day.' Their approach was to say 'Hey, Kel, you've got these great ideas: Would you like to start a company?'" Johns Hopkins even encouraged Guerin to consider the City Garage space because it would best suit the company's needs.

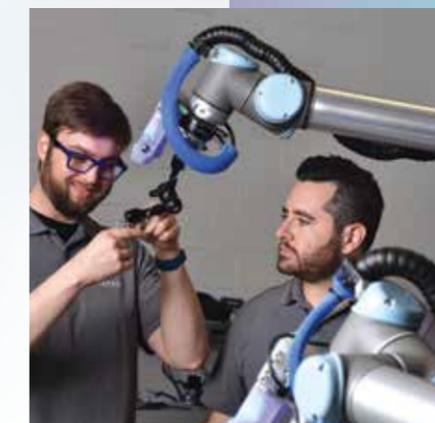
Ben Gibbs, A&S '05, an economics grad, spent the last several years working at Johns Hopkins Technology Ventures before joining READY Robotics, where he is now CEO. "Many years ago, it was not nearly as easy for researchers to commercialize discoveries," Gibbs says. "But today, if you have a good idea, there are any number of resources available to you in the Hopkins ecosystem, from educational courses on entrepreneurship to translational funds and office space at JHTV's FastForward startup incubators."

Instead of graduates migrating en masse to the corporate workforce, or to other high-tech hubs such as Boston or Silicon Valley, promising startups such as READY Robotics are becoming the workforce, observes Gibbs.

Guerin himself turned down several offers with top tech companies to help jumpstart Baltimore's high-tech scene with READY Robotics. "We're very close to declaring success," he says. "The trick now is to keep all our ducks in a row to be able to grow really fast."



City Garage



Kel Guerin, top, and his team at READY Robotics Corp., including Ben Gibbs A&S '05, above, are developing TaskMate, "a Swiss Army knife for robots," in space they lease at City Garage.



## An Ecosystem of Innovation

Like Hai-Quan Mao, Jennifer Elisseff remembers a time before the university's encouragement of commercialization. "It has been a night and day shift," says Elisseff, director of the Johns Hopkins Translational Tissue Engineering Center. "I started my first company in 2004 and when I think about it now, the number of people telling me not to do it was absurd. They said things like, 'Well, maybe you want to leave the university and go to California to start a company.'"

Rather than flee westward, Elisseff elected to remain in Baltimore and help create what she calls "the new ecosystem of innovation."

"We got a little basement lab in the Stieff Building and that became the incubator," she remembers. "It was nothing like today, when there are so many resources to commercialize your technology, to help you translate from bench to bedside."

In 2017, the Stieff Building (former home to Stieff Silver) retains its original, 1930s vintage clock on the pediment above the entrance. But the interior of the venerable factory has been completely transformed into another state-of-the-art suite of labs and conference rooms for tomorrow's infant Teslas and Microsofts. And Elisseff is not only a renowned clinical researcher (she holds the Morton Goldberg Chair at the Johns Hopkins Wilmer Eye Institute), she also is the interim CEO of Aegeria Soft Tissue LLC.

Aegeria, named for the Roman nymph of regeneration, is the corporate venture that markets the Elisseff team's latest advance in soft-tissue reconstruction—a sterile regenerative material invented by Elisseff in her Biomaterials and Tissue Engineering Laboratory that mimics and replaces the adipose cells that are removed during surgery or lost through traumatic injury.

Elisseff, whose daughter serves in the U.S. Army, partnered with the military for the first-phase trials of her advances in soft-tissue replacement. This work grew out of research that Elisseff and her colleagues conducted with Kythera Biopharmaceuticals, which involved co-developing a new wrinkle filler.

"Combining that partnership with our lab research on stem cells and what types of environments they need to develop tissue," she says, "we designed an acellular adipose technology that combined basic science. In fact, our collaboration with Kythera led to my interests in the immune system and our current pursuit of regenerative immunotherapies ... There is always a question of, When do we transition a technology out of the lab?" How do you hand it off and hand it off smartly?

"Think about the passing of the baton in a relay race—at a certain point, both the runner who is passing the baton and the runner who is receiving it are both in motion. It's the time when they both are running together that is key—or else the baton is dropped.

"Industry collaboration makes me a better researcher," she says. "As a biomedical engineer, we're looking for things that can impact human health. Maybe I'm idealistic, but I think that if you focus on doing the best science possible and providing solutions for clinical challenges, success will eventually happen."

## A Tough Tolerance for "No's"

The second floor of the repurposed Blakeslee Building on Charles Street in Baltimore's Mount Vernon neighborhood has been a bare-walled hatchery of world-changing ideas, equipped with a supply of Keurig cups, one small dog, and half a dozen dreamers.

Here, things are moving so fast that the corporate name on the doorbell already is obsolete.

This is the headquarters of a startup called FactoryFour, formerly Fusiform, initially a Johns Hopkins engineering student's "wacky, wake-up-in-the-middle-of-the-night idea" that mobility devices and prosthetic appliances should be so easy to manufacture and re-manufacture, even in remote areas, that they could virtually "grow" along with the patients who wear them.

"We want to create the Internet of Manufacturing, making it easy to connect every component of the manufacturing process with software so that manufacturers can keep up with the digital revolution."

—Param Shah

The senior undergrad putting nearly all of his energy into what he calls "an opportunity to disrupt everything in manufacturing," is Param Shah, 21, an engineer's son from Irvine, California. Five years ago, during a high-school service trip to the Himalayas, Shah witnessed the plight of young people with disabilities whose precious leg braces and replacement limbs already were too small by the time they arrived—if they arrived at all.

"The core problem was that every device was made by hand, the orders came in by fax, the software was archaic, and none of the parts of the manufacturing and distribution system talked to each other," Shah recalls. In response, Shah and his co-founder, biomedical engineering grad Alex Mathews '17 began to tinker with the concept that—in an age of wireless communication, cheap data, and 3-D printing—even the Himalayas could be conquered in real time.

It took them less than eight months to design and build a prototype leg brace. The process, Shah says, "was 70 percent guts and 30 percent Google, a high tolerance for risk and an even tougher tolerance for 'No's.'"

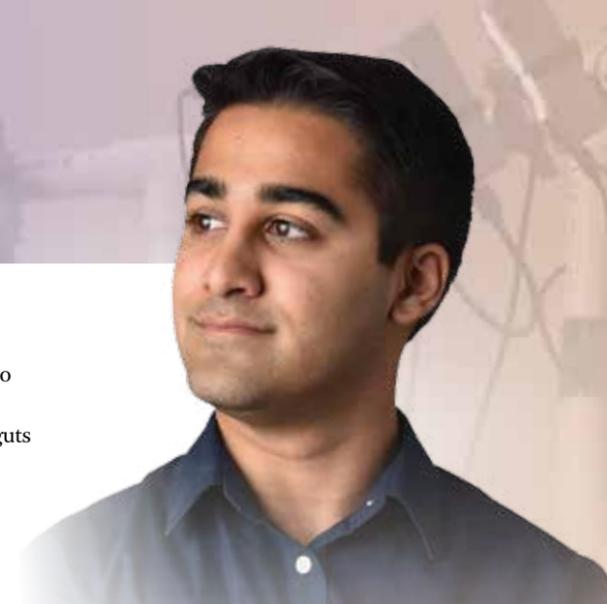
And this breakthrough was followed by a potentially even more important idea: FactoryFour coders, including upward of 20 Johns Hopkins undergrads and alums, are busy writing software in the startup's Mount Vernon digs that could streamline and modernize the way all manufacturing is done, in every country.

"Digital manufacturing is the future, but nearly every manufacturer still suffers from manual processes that don't let them take advantage of new technology," Shah says. "We want to create the Internet of Manufacturing, making it easy to connect every component of the manufacturing process with software so that manufacturers can keep up with the digital revolution."

It's hard to imagine a bigger dream than that.

"I have a firm belief that when I see a company come along because they only see an opportunity to make money, they almost always fail," Shah says. "But if there is a person behind it who has a [true] 'this is real' moment—and if that moment comes from pure passion—that company will succeed.

"We can rely on the quality of education that Hopkins provides to gather us the talent that we need for our company," Shah says, looking toward the future, balancing the prospects of success with the risks of failure. "If I go down at this time, I have my family to support me, and I have my school to support me. There's not a better time in my life to do this." ■



The Blakeslee Building in Mount Vernon



Param Shah, left, with Matt Lerner, MSE '17, right. The Factory Four team (including as many as 20 Johns Hopkins undergrads and alums), works out of a townhouse in Baltimore's Mount Vernon neighborhood. They are creating software that could streamline and modernize the way all manufacturing is done.

## Started a Startup?

Share your startup stories with other Whiting School alumni. Submit your ideas to: <http://bit.ly/WSEAlumniUpdate>



FastForward R. House



Jennifer Elisseff, top, who is pushing the boundaries of soft tissue reconstruction through Aegeria Soft Tissue LLC, says, "Industry collaboration makes me a better researcher."