

ANNUAL REPORT

Bringing Ideas to Life

17



VCU Innovation Gateway
VIRGINIA COMMONWEALTH UNIVERSITY

Bringing Ideas to Life

17 Annual Report

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Mission

To facilitate commercialization of university inventions for the benefit of the public; to foster a culture of innovation at the university; and to promote new venture creation.

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FACEBOOK: VCU INNOVATION GATEWAY

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Dear Colleagues and Friends,

We are happy to report that Innovation Gateway had a record-setting year in 2017. We remain committed to grow commercialization activities for the benefit of society as we focus in the areas where the university research strengths meet public need.

The VCU Inventor of the Year for 2017, Dr. Frank Gupton, is a good illustration of the university commitment to public good. As VCU president Michael Rao said, "Our public university is a public good because our research and creative activity positively impact society. The purpose of our research is to advance society, to help people live longer, better lives. It's research with a social conscience. Thus, the research we do at VCU—as a public good—will profoundly affect the human experience." Dr. Gupton's research highlighted in this annual report is a telling example of research with a social conscience.

Innovation Gateway not only generated record licensing revenue but also had record numbers of invention disclosures, patent applications, issued patents, licenses, and industry engagements. Most importantly, two new products were introduced to market by start-up companies spun-off to commercialize VCU inventions. In January 2017, Sanyal Biotechnology began offering contract services in pre-clinical research for the development of therapeutics for NASH and other liver diseases. Global Lyme Diagnostics (GLD) was spun-off to exclusively develop Lyme disease diagnostics that detect the disease regardless of the geographic origin of the infecting strain. It operates a CLIA laboratory in the Research Triangle area and it launched its first commercial diagnostic test in the summer of 2017. These two companies are good examples of how Innovation Gateway helps bring ideas to life and are notable successes for VCU.

This year, we are celebrating Dr. Barbara Boyan, VCU's first inventor to be elected as a Fellow of the National Academy of Inventors (NAI). Dr. Boyan was inducted into the Academy in April 2017. In the following pages you will learn more about this well-deserved recognition of her accomplishments.

During the year, we also stepped up our strategic industry engagement program to showcase VCU innovations and research capabilities. We had a record number of industry visits. We were hard at work building collaborations with industry and other universities

to generate opportunities for translational research, licensing and commercialization. Industry engagement is a critical component of what we do and has proven to be a valuable source of proof-of-concept funding for VCU inventors.

We see an upward trend in the licensing activities and we expect that this growth to continue. Moreover, our licenses generate higher than the average income for our peer group as evident from the national licensing survey data. This achievement reflects not only the quality of invention disclosures and the improved recognition and national prominence of our university but also the high quality licensing deals that the Innovation Gateway team negotiates and executes.

This year's remarkable accomplishments would not be possible without the guidance from the VCU Commercialization Advisory Panel and without the exceptional support from the VCU leadership and the transformed innovation community in RVA. We value very much our partnership with the Activation Capital and the resources that it brings to the table to support innovation and entrepreneurship in the region.

We are grateful to you, VCU inventors. Your research and creativity are what make the impact on society by curing diseases, helping people live longer and improving lives.

With sincere gratitude,

Francis L. Macrina, Ph.D.
Edward Myers Professor of Dentistry and
Vice President for Research and Innovation

Ivelina Metcheva, Ph.D., MBA
Senior Executive Director
VCU Innovation Gateway

17 FISCAL YEAR AT A GLANCE

DEPARTMENTS WITH TEN OR MORE INVENTION DISCLOSURES

10 Electrical and Computer Engineering

10 Radiation Oncology

11 Internal Medicine

12 Mechanical and Nuclear Engineering

DEPARTMENTS WITH FIVE TO NINE INVENTION DISCLOSURES

5 Human Genetics

5 Microbiology/Immunology

6 Biomedical Engineering

8 Medicinal Chemistry

8 Chemical and Live Sciences Engineering

134
Invention Disclosures

18
Options/
Licenses

4
Start-Ups

165
Patents Filed

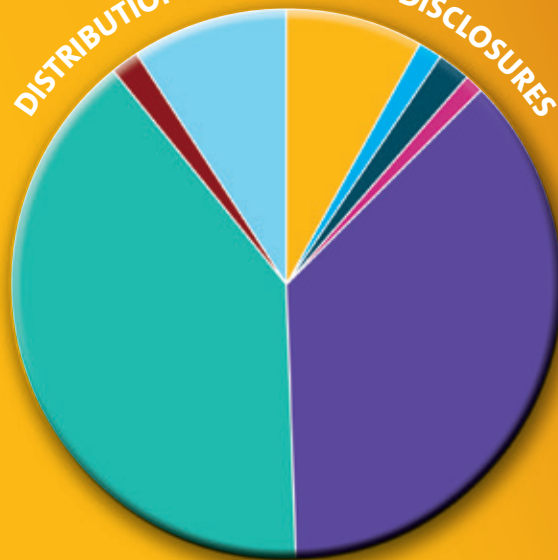
22
Patents Issued

2
Copyrights Filed

66
Industry Engagements

6.8
Million Licensing Revenue

DISTRIBUTION OF INVENTION DISCLOSURES



13

Distribution of Invention Disclosures

College of Humanities and Sciences

2

School of Allied Health Professions

3

School of Business

2

School of Dentistry

58

School of Engineering

62

School of Medicine

3

School of Nursing

14

School of Pharmacy

VCU PATENTS

3/21/17 Patent No. 9,598,384

Shijun Zhang, Ph.D., Sarah Spiegel, Ph.D.
3-(2-Amino-Ethyl)-Alkylidene-Thiazolidine-2,4-Dione and 1-(2-Amino-Ethyl)-Alkylidene-1,3-Dihydro-Indol-2-One Derivatives as Selective Sphingosine Kinase 2 Inhibitors

12/13/16 Patent No. 9,517,342

Richard Constanzo, Ph.D., Daniel Coelho, M.D.
Olfactory Implant System

12/20/16 Patent No. D774,700

Sonya Clark, Jordana Kron, M.D., John Reavey-Cantwell, M.D.
Radiation Protective Headwear

12/6/16 Patent No. D773,740

Sonya Clark, Jordana Kron, M.D., John Reavey-Cantwell, M.D.
Radiation Protective Headwear

11/1/16 Patent No. 9,480,692

Shunlin Ren, M.D., Ph.D.
Sulfated Oxysterol and Oxysterol Sulfation by Hydroxysterol Sulfotransferase Promote Lipid Homeostasis and Liver Proliferation

8/23/16 Patent No. 9,421,276

Hu Yang, Ph.D., Olga Zolotarskaya, Ph.D., Kenneth Wynne, Ph.D., Kristoffer Valerie, Ph.D.
Clickable Polyoxetane Carrier for Drug Delivery

6/27/17 Patent No. 9,687,037

Raymond Colello, Ph.D., Rebecca Caffrey, Ph.D.
Magnetic Football Helmet to Reduce Concussion Injuries

4/21/17 Patent No. 2,852,688

Dr. Jerome Strauss, M.D., Ph.D., Janette Mcallister, Ph.D.
Compositions and Methods Relating to DENND1A Variant 2 and Polycystic Ovary Syndrome

5/31/17 Patent No. 026683

Shunlin Ren, M.D., Ph.D.
A Novel Cholesterol Metabolite, 5-Cholesten, 3-,25-diol, Disulfate (25HCDS) for Therapy of Metabolic Disorders, Hyperlipidemia, Diabetes, Fat Liver Diseases, and Atherosclerosis

7/6/16 Patent No. ZL 201380019476.3

Shunlin Ren, M.D., Ph.D.
A Novel Cholesterol Metabolite, 5-Cholesten, 3-,25-diol, Disulfate (25HCDS) for Therapy of Metabolic Disorders, Hyperlipidemia, Diabetes, Fat Liver Diseases, and Atherosclerosis

4/14/17 Patent No. 6125610

Shunlin Ren, M.D., Ph.D.
A Novel Cholesterol Metabolite, 5-Cholesten, 3-,25-diol, Disulfate (25HCDS) for Therapy of Metabolic Disorders, Hyperlipidemia, Diabetes, Fat Liver Diseases, and Atherosclerosis

1/31/17 Patent No. 9,556,239

Richard Marconi, Ph.D., Christopher Earnhart, Ph.D.
Polyvalent chimeric OspC vaccinogen and diagnostic antigen

7/26/16 Patent No. 9,399,027

Martin Mangino, Ph.D.
Organ Protection Solution and Its Method of Use

1/3/17 Patent No. 9,534,021

Richard Marconi, Ph.D., Christopher Earnhart, Ph.D.
Lyme Disease Vaccine

4/11/17 Patent No. 9,616,033

Phillip Gerk, Ph.D., William Barr, Pharm.D., Ph.D., Joseph Ritter, Ph.D.
Selective metabolic approach to increasing oral bioavailability of phenylephrine and other phenolic bioactives

8/16/16 Patent No. 9,416,016

Puru Jena, Ph.D., Gerd Gantefoer, Ph.D.
Hyperhalogens and Highly Electronegative Compounds

10/25/16 Patent No. 9,474,493

Dorin Todor, Ph.D., Aditya Bondal
3D tracking of an HDR source using a flat panel detector

9/6/16 Patent No. 9,433,588

Philip Worth Longest, Ph.D., Michael Hindle, Ph.D.
Delivery of submicrometer and nanometer aerosols to the lungs using hygroscopic excipients or dual stream nasal delivery

2/21/17 Patent No. 9,572,909

David Simpson, Ph.D., Gary Bowlin, Ph.D., Raymond Colello, Ph.D., Woon Chow, M.D., Ph.D., Balendu Jha, Ph.D.
Electrospun nerve guides for nerve regeneration designed to modulate nerve architecture

10/4/16 Patent No. 9,457,163

Kevin Ward, M.D., Curtis Sessler, M.D., Mary Jo Grap, Ph.D., Laurence Dinardo, M.D., Bruce Spiess, M.D., Rao Ivatury, M.D., Cindy Munro, RN
Prevention of ventilator associated pneumonia (VAP)

3/14/17 Patent No. 2,721,162

Gary Bowlin, Ph.D., David Simpson, Ph.D., James Bowman, M.D., Stephen Rothwell, Ph.D.
Electrospun Dextran Fibers and Devices Formed Therefrom

7/26/16 Patent No. 9,399,082

Gary Bowlin, Ph.D., David Simpson, Ph.D., James Bowman, M.D., Stephen Rothwell, Ph.D.
Electrospun dextran fibers and devices formed therefrom

The 2017 Billy R. Martin Innovation Award

Medicines for All

VCU President Michael Rao, Ph.D. once asked, “So ideas are wonderful, but how do we take those ideas and put them in an environment in which they will benefit a maximum number of people in the world?”

VCU’s researchers are making ideas real. Just look to B. Frank Gupton, Ph.D., the Floyd D. Gottwald Jr. Chair and chair of the Department of Chemical and Life Science Engineering. Since 2014, Gupton has championed cutting the cost of AIDS treatments by accelerating more efficient ways of synthesizing the active ingredients in medications. His efforts signal a dramatic change in future pharmaceutical manufacturing technologies, including medicines that treat malaria and tuberculosis in developing countries.

Last year, the VCU School of Engineering was awarded \$25 million from the Bill & Melinda Gates Foundation to establish the Medicines for All Institute and to fund the institute’s work on a wide range of essential global health treatments. Over the previous four years, the Gates Foundation had awarded nearly \$15 million to Medicines for All.

This past November, Gupton was honored by VCU Innovation Gateway with the 2017 Billy R. Martin Award for Innovation for Gupton’s work to drive down costs of essential medicines in developing countries. Gupton credits his success at VCU to “the collaboration I was able to establish in the 10 years I’ve been here.”

Billy Martin, who died in 2008, was the chair of the Department of Pharmacology and Toxicology, a ground-breaking researcher, a prolific inventor, and a world-renowned neuropharmacologist.

“The Innovation Gateway at VCU has been a great partner with my research group, particularly in the area of the new catalysts that we have developed. They have allowed us to secure what we expect will be valuable intellectual property in the future that we can share with our industrial pharmaceutical partners.”

B. Frank Gupton, Ph.D.
*Professor and Chair
Department of Chemical
and Life Science Engineering*



B. FRANK GUPTON, PH.D.
MICHAEL RAO, PH.D.
FRANCIS L. MACRINA, PH.D.

PHOTO COURTESY OF
VCU SCHOOL OF ENGINEERING MARKETING
AND COMMUNICATIONS, DANIEL WAGNER



VCU's First NAI Fellow

She has 23 issued U.S. patents to her name, is co-founder of four companies, has served on the boards of both publicly traded and venture-funded companies and currently sits on the boards of three others. Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Chair and dean of the VCU School of Engineering is no stranger to pioneering her way through the world of innovation.

Boyan's latest achievement, becoming VCU's first fellow in the National Academy of Inventors, draws our university into the spotlight as well. This honor adds to her list of fellowships in organizations including the American Association for the Advancement of Science, American Institute for Medical and Biological Engineering and World Congress of Biomaterials, as well as being elected to the National Academy of Engineering. Boyan was inducted as an NAI fellow in April 2017 at the John F. Kennedy Presidential Library and Museum in Boston.

"One of the reasons I came to VCU was the personalized approach used by the Innovation Gateway team to foster development of VCU's technology," Boyan said. "Under the directorship of Dr. Ivelina Metcheva, the office works with inventors to ensure that their intellectual property is protected, and that it is moved toward commercialization. This is a win-win for faculty, staff and student inventors and for the university."

Recognized internationally by peers with over 480 peer-reviewed publications, Boyan's efforts are focused on treating musculoskeletal defects by using the body's own healing power of regeneration. Her inventions include a micro-nanoscale surface technology for dental and spine implants, as well as a biodegradable technology for regenerating bone and cartilage.

The president of National Academy of Inventions, Paul R. Sanberg, said "Boyan has demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development and the welfare of society."

The NAI spans more than 240 institutions, and is growing rapidly. It was founded in 2010 to recognize and encourage inventors with patents issued from the U.S. Patent and Trademark Office enhance the visibility of academic technology and innovation, encourage the disclosure of intellectual property, educate and mentor innovative students and translate the inventions of its members to benefit society.

"Even more rewarding than an issued patent is seeing the ideas they represent result in technologies that make people's lives better."

Barbara D. Boyan, Ph.D.
Dean
School of Engineering

Barbara D. Boyan, Ph.D.



Treating the Painful Side Effects of Substance Abuse

Opioid addicts face daily uphill battles, from overcoming dependency to coping with debilitating side effects of the opioid addiction or the treatments designed to bring comfort.

Yan Zhang, Ph.D., a medicinal chemistry professor at the VCU School of Pharmacy, is working with VCU School of Medicine professors Kurt Hauser, Ph.D. and Dana Selley, Ph.D. to target a patient's opioid receptors that help combat neural HIV, opioid addiction and harsh side effects that accompany substance abuse.

One of the most common and painful side effects of long-term opioid use is constipation. According to Zhang, over-the-counter laxatives have little effect on Opioid Induced Constipation (OIC) and typically only prolong a patient's suffering. Chronic constipation could lead to a punctured colon, which can result in septic shock and death.

In 2015, the National Institutes of Health renewed funding of \$1.9 million for Zhang and collaborators' drug development research. Most recently, the team was awarded a \$2.72 million grant by the NIH National Institute on Drug Abuse.

Zhang's opioid receptor research has also led to potential preventatives and treatment for irritable bowel syndrome and neurodegenerative disorders including Alzheimer's disease.

"As the US is facing an opioid crisis now, our novel mu opioid receptor modulators will provide a unique tool to fight against it. The VCU Innovation Gateway has been so supportive to us and their hard work is essential for our future success."

Yan Zhang, Ph.D.
Professor
Department of Medicinal Chemistry

Every unconscious patient in an emergency room is at risk for serious medication errors, even death. In these moments of trauma, clinicians must act fast. However, all too often both patient and doctor are at the mercy of a family member's memory to know what's in the patient's medicine cabinet. With no way to access true medical histories, and the possibility of over 1,500 FDA approved prescription medications, that kind of guesswork isn't good for anyone.

Medication reconciliation is the cross-checking of home medications—including drug name, dosages and frequency—with treatments a patient may desperately need whether or not they're able to speak up. In emergency settings, there's been no fast or accurate way of performing this procedure, until now.

Sudha Jayaraman, M.D. and Dayanjan "Shanaka" Wijesinghe, Ph.D. have developed a novel blood test that can rapidly and accurately identify critical medications when incapacitated patients arrive at the hospital to ensure a more precise and safe treatment. The CDC notes that there are roughly 130 million ER visits per year in the US. Of these, 37 million are for trauma. A total of 12 million get admitted to the hospital and 1.5 million are admitted directly to the intensive care unit.

Jayaraman is Associate Professor of Surgery, VCU School of Medicine and Co-Director of the Program for Global Surgery at VCU. Wijesinghe is Assistant Professor of both the VCU School of Pharmacy and Department of Pharmacotherapy & Outcomes Sciences. The pair are also recent recipient of the Quest Commercialization Fund which is dedicated to advancing VCU inventions and improving their chances of commercialization.

"VCU Innovation Gateway and the Commercialization Fund helped us get vital initial support to get our blood test invention to a proof-of-concept and move towards the market. Our test can potentially affect millions of lives. We are very excited for the future."

Sudha Jayaraman, M.D., MSc., FACS
Associate Professor
Department of Surgery

Sudha Jayaraman, M.D., MSc., FACS
Dayanjan "Shanaka" Wijesinghe, Ph.D.



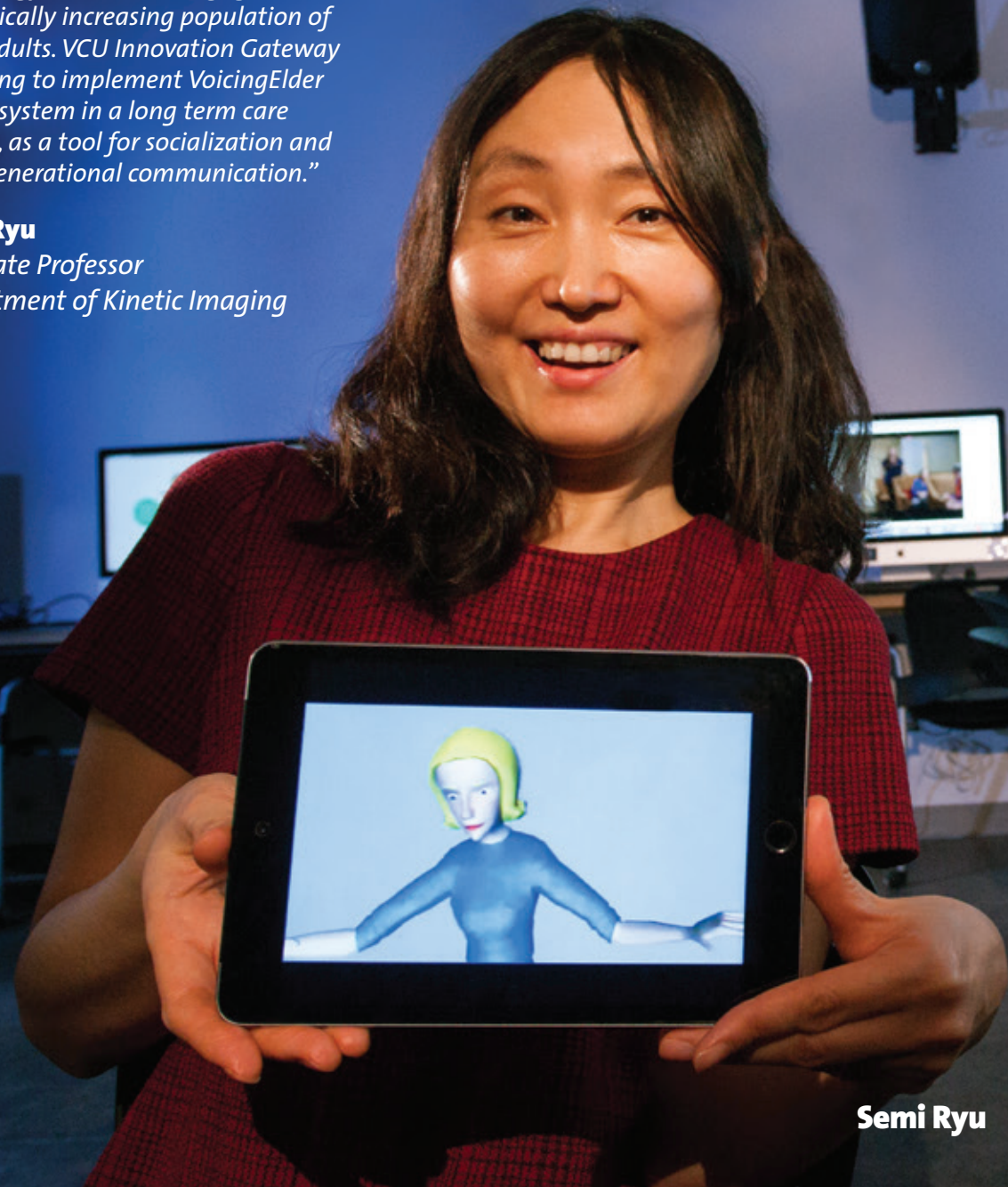
*Speaking Up for
Trauma Patients*

Taking a Virtual Walk Down Memory Lane

“VoicingElder has been an exciting trans-disciplinary project between art, technology and health, engaged with dynamically increasing population of older adults. VCU Innovation Gateway is helping to implement VoicingElder avatar system in a long term care setting, as a tool for socialization and inter-generational communication.”

Semi Ryu

Associate Professor
Department of Kinetic Imaging



Semi Ryu

Semi Ryu sees herself as a media artist. Now, in something of a second act, she helps elderly audiences step into stories of their own. She believes what they see will be a real performance to remember.

Ryu, an associate professor of kinetic imaging in the VCU School of the Arts, collaborated with Stefano Faralli of University of Mannheim, Germany, to develop interactive technology for her virtual puppetry. VoicingElder is an avatar

system with four different development stages: childhood, teenage years, young adulthood and older adulthood, with four female and four male avatars.

Her participants speak with lip-sync technology, giving the illusion that a virtual puppet is the storyteller. She found that in many cases older adults were more comfortable speaking through an avatar, reducing the embarrassment factor around the nursing home.

“They can easily talk about an emotional story ... with more safe distance,” Ryu said. For three months, Ryu recorded each session and then turned it into a movie for residents. All wanted copies of the film to share with family.

Ryu also collaborated with Tracey Gendron, Ph.D., an associate professor in the VCU Department of Gerontology who serves as the department’s director of community engagement and research. People with all kinds of memory loss and PTSD could benefit from the program.

She has won the VCU Presidential Research Quest Fund and is the recipient of VCU Arts Faculty Award of Distinguished Achievement in Research, and VCU Arts Dean’s Faculty Research Grant Award. Ryu recently hosted a TEDx Talk on Han, a Korean concept defined as an extreme state of grief, but with great hope to overcome.

Protecting Organs and Saving Lives

Martin J. Mangino, Ph.D. has a clinical interest in saving both organs and lives. Mangino, a professor at VCU's School of Medicine, is also a Laboratory Director and Research Director of the VCU Trauma Center. Mangino's team has two main objectives.

The first is preserving and protecting ischemic organs that would normally be damaged and therefore, not suitable for transplants. Their novel approaches have a range of benefits from growing the organ donor pool and bringing organs back to life, to countering organ rejection.

The second is extending the Golden Hour, that crucial window of time a patient has to get to the hospital for survival after hemorrhagic shock. They are experimenting with solutions that increase capillary flow in the event of blood loss, ultimately reversing the shock state shortly after resuscitation. For trauma patients, this means safer and longer transport times and a much greater survival rate.

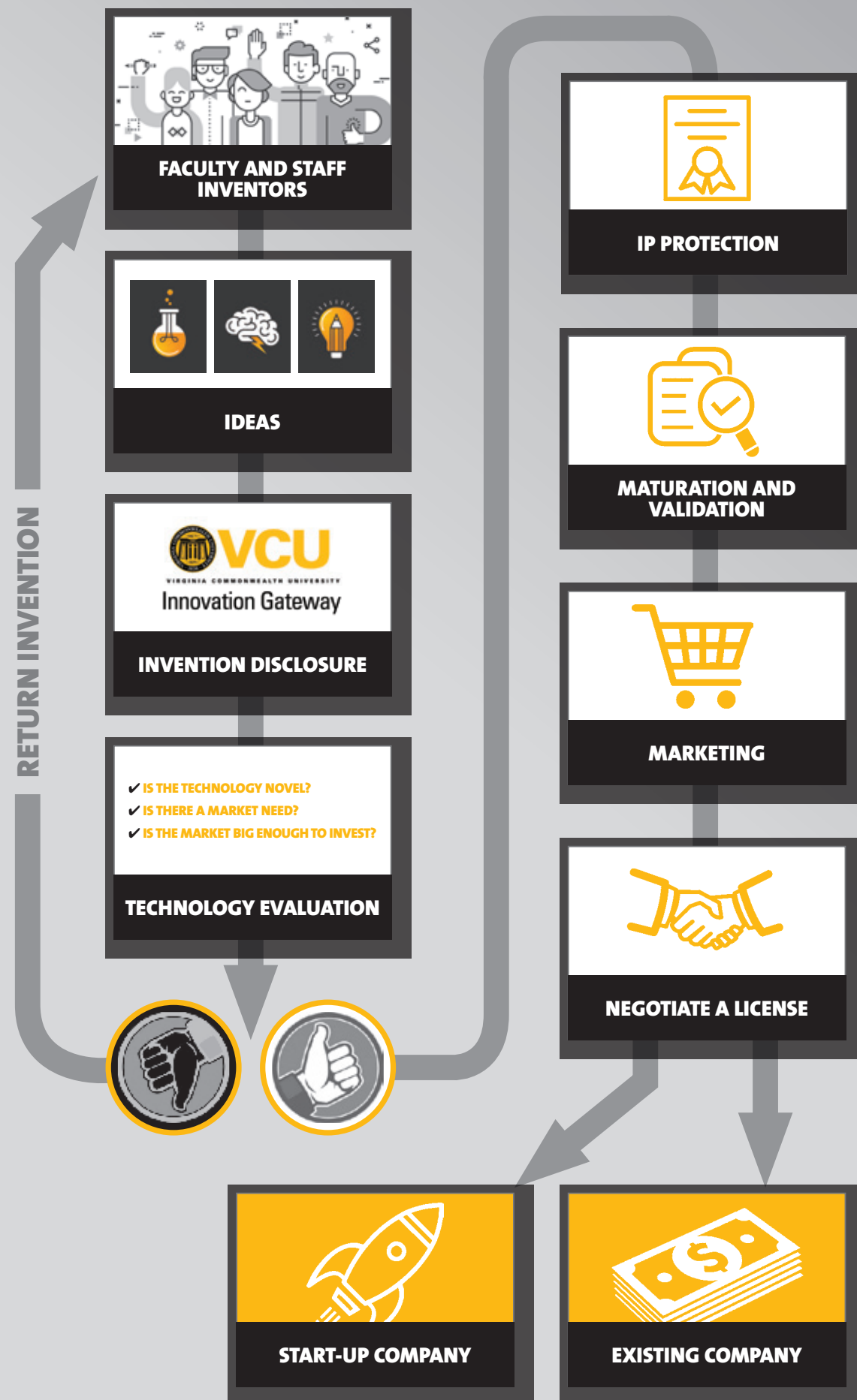
By all indications, Dr. Mangino's mission to create Golden Hours of opportunity is a success. His team's research is currently being funded by the National Institutes of Health and the Department of Defense, specifically in exploring life-saving solutions for battlefield care where every second counts.

Martin J. Mangino, Ph.D.

"Resuscitation from lethal hemorrhagic shock with these new solutions increases the golden hour 10 fold compared to what we currently use. VCU Innovation Gateway is making it possible to successfully translate these findings into life-saving clinical products."

Martin J. Mangino, Ph.D.
Professor
Department of Surgery

The VCU Technology Transfer Process



VCU Innovation Gateway Team

Sitting From Left:

BRENT FAGG
LIVIA HORTON
MAGDALENA MORGAN
ZENA SINGH

Standing From Left:

ANN BOELZNER
MICHAEL MANCINI
IVELINA METCHEVA
TYLER FERRO
AFSAR MIR



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L. Franklin Bost
Executive Associate Dean for
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Industry Expert

Brian Carney
Principal
Harbert Venture Partners

William H. Daughtrey
Industry Expert

Alex Euler
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CIT Gap Fund

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Pilot Health Advisors LLC

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Director of Investments
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Hunton & Williams, LLC

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