



Research Overview - College of Engineering



VCU

ReDAC Meeting
August 4, 2019

Presentation goals and topics

Presentation topics

- Overview of Engineering
- How we support research and scholarship...with outcomes
- Examples of research efforts
- What's next?

The background of the slide features a group of eight business professionals standing in a modern office with large, curved glass windows. The scene is captured in silhouette against a bright, overcast sky, creating a professional and collaborative atmosphere. The individuals are dressed in business attire, and their reflections are visible on the polished floor.

Who we are

We have best collection of
people, ideas, and values



7
ACTIVE
R01s

21
ENDOWED
PROFESSORSHIP
AND CHAIR POSITIONS

12
NSF CAREER
AWARDS

83
Graduate Students
Funded by
Research Grants

55%
ACCEPTANCE RATE

TOP
25
NUCLEAR ENGINEERING
PROGRAM
- U.S. News & World Report

20
FACULTY
FELLOWS
(8-AIMBE)

24
COUNTRIES
REPRESENTED
- U.S. News & World Report

TOP
35
PUBLIC BIOMEDICAL
ENGINEERING PROGRAM
- U.S. News & World Report

3:2
PH.D. TO
MASTERS
- U.S. News & World Report

20%
WOMEN FACULTY

6
RESEARCH
CENTERS



Academic Programs in Engineering

Biomedical Engineering



288 Undergraduate Degrees

57 Graduate Degrees

17 Doctoral Degrees

Degree Programs:

- B.S. in Biomedical Engineering
- M.S. in Biomedical Engineering
- M.S. in Biomedical Engineering (with Honors)
- Ph.D. in Biomedical Engineering

Research Areas:

- Biomechanics
- Biomedical Materials
- Biological Systems
- Biomedical Imaging
- Biomedical Robotics
- Biomedical Electronics
- Biomedical Software
- Biomedical Systems

Computer Science



433 Undergraduate Degrees

60 Graduate Degrees

18 Doctoral Degrees

Degree Programs:

- B.S. in Computer Science
- B.S. in Computer Science (with Honors)
- M.S. in Computer Science
- Ph.D. in Computer Science

Research Areas:

- Algorithms
- Artificial Intelligence
- Computer Architecture
- Computer Graphics
- Computer Networks
- Computer Security
- Database Systems
- Software Engineering

Chemical & Life Sciences Engineering



206 Undergraduate Degrees

29 Graduate Degrees

16 Doctoral Degrees

Degree Programs:

- B.S. in Chemical Engineering
- B.S. in Chemical Engineering (with Honors)
- B.S. in Chemical Engineering (with a Minor in Life Sciences)
- M.S. in Chemical Engineering
- Ph.D. in Chemical Engineering

Research Areas:

- Bioprocess Engineering
- Chemical Process Engineering
- Chemical Reaction Engineering
- Chemical Thermodynamics
- Environmental Engineering
- Food Engineering
- Process Control
- Process Safety

Mechanical & Nuclear Engineering



590 Undergraduate Degrees

97 Graduate Degrees

22 Doctoral Degrees


Degree Programs:

- B.S. in Mechanical Engineering
- B.S. in Mechanical Engineering (with Honors)
- B.S. in Mechanical Engineering (with a Minor in Nuclear Engineering)
- M.S. in Mechanical Engineering
- Ph.D. in Mechanical Engineering

Research Areas:

- Fluid Mechanics
- Heat Transfer
- Thermodynamics
- Computational Mechanics
- Structural Mechanics
- Manufacturing
- Materials
- Energy Conversion

Electrical & Computer Engineering



321 Undergraduate Degrees

41 Graduate Degrees

19 Doctoral Degrees

Degree Programs:

- B.S. in Electrical Engineering
- B.S. in Electrical Engineering (with Honors)
- B.S. in Electrical Engineering (with a Minor in Computer Engineering)
- M.S. in Electrical Engineering
- Ph.D. in Electrical Engineering

Research Areas:

- Power Systems
- Control Systems
- Signal Processing
- Communication Systems
- Computer Systems
- Electronics
- Energy Conversion
- Manufacturing



Biomedical Engineering



Help transform healthcare through innovations in technology, design concepts and engineering.

288

undergraduate students

57

graduate students

17

faculty members

Degree Programs:

- B.S. in biomedical engineering
- M.S. in biomedical engineering
- Ph.D. in biomedical engineering

Research Areas:

- Mechanobiology
- Regenerative medicine
- Imaging
- Molecular, cellular and tissue engineering
- Nanotechnology
- Biomechanics
- Human factors engineering



Chemical & Life Science Engineering



Create solutions to the grand technological challenges facing the 21st century.

206

undergraduate students

29

graduate students

16

faculty members

Degree Programs:

- B.S. in chemical and life science engineering
- M.S. in engineering (chemical and life science focus)
- Ph.D. in engineering (chemical and life science focus)

Research Areas:

- Mass and energy balances
- Unit operations
- Transport phenomena
- Thermodynamics
- Reaction engineering
- Biotechnology
- Process design and economics



Computer Science



Shape the computing involved in nearly every aspect of modern professional and personal life.

433

undergraduate students

60

graduate students

18

faculty members

Degree Programs:

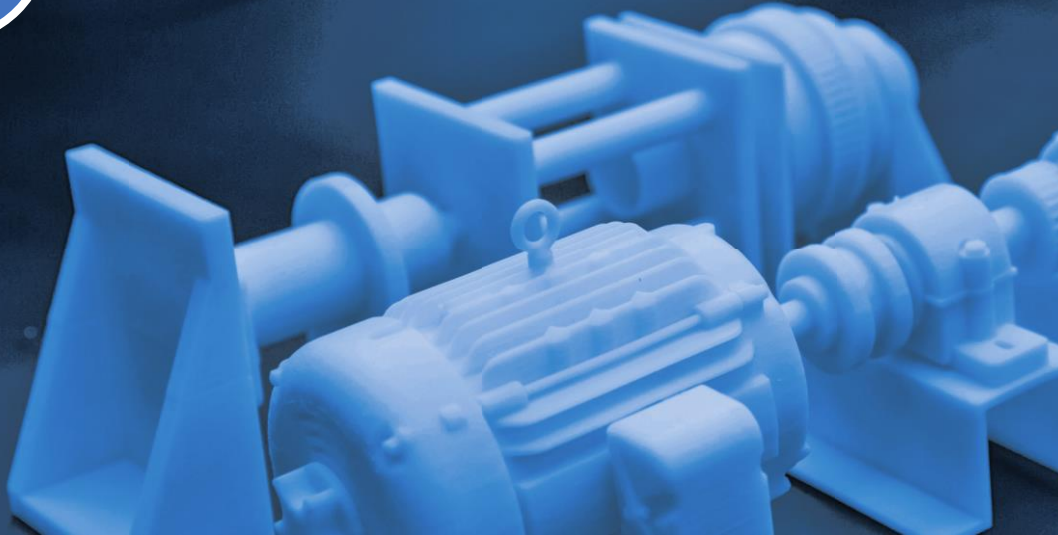
- B.S. in computer science
- M.S. in computer science
- M.S. in computer and information systems security (collaboration with VCU School of Business)
- Ph.D. in engineering (computer science focus)

Research Areas:

- Big data
- Cybersecurity
- Machine learning
- Data mining and science
- Quantum computing
- Bioinformatics
- Mobile computing
- Data structures



Mechanical & Nuclear Engineering



Master and improve how systems work — at the macro and the micro level.

590

undergraduate students

97

graduate students

22

faculty members

Degree Programs:

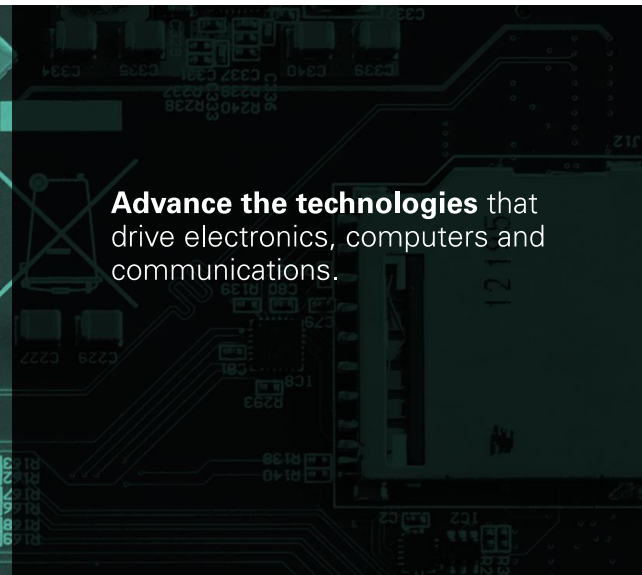
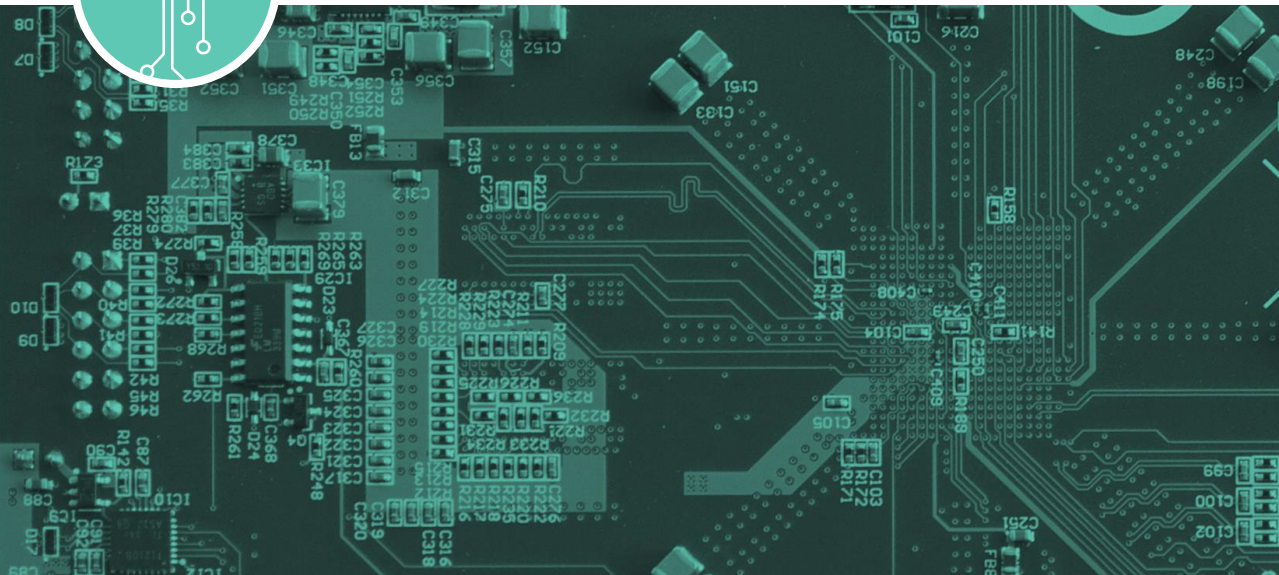
- B.S. in mechanical engineering (option for a nuclear concentration)
- M.S. in mechanical and nuclear engineering
- Ph.D. in mechanical and nuclear engineering

Research Areas:

- Product design
- Manufacturing
- Energy systems
- Heating and cooling
- Transportation systems
- Robotics
- Nanodevices
- Medical devices



Electrical & Computer Engineering



Advance the technologies that drive electronics, computers and communications.

321

undergraduate students

41

graduate students

19

faculty members

Degree Programs:

- B.S. in electrical engineering
- B.S. in computer engineering
- M.S. in engineering (electrical or computer focus)
- Ph.D. in engineering (electrical or computer focus)

Research Areas:

- Macro/microelectronics
- Computer system integration and design
- Power and controls
- Communications
- Cyber-physical systems

Engineering Facilities

Serving VCU students, faculty, and colleagues...

- East and West Halls, Biotech-One, Biotech-8
- New Engineering Research building
- Institute for Engineering and Medicine
- VMC & NCC
- The “Maker Garage”
- Innovation Lab

A photograph of several business professionals in suits, with their hands raised in a gesture of agreement or success. The image is partially overlaid by a blue diagonal graphic on the right side.

Our Future

- Shared goals
- Broad interests
- High Expectations
- Innovative & Entrepreneurial



BOOST

Teamwork

What is our biggest challenge?

What would VCU Engineering look like if we met this challenge in a significantly better way?

Are we consistent or intense?
Neither?



Engineering Research & Scholarship Initiatives

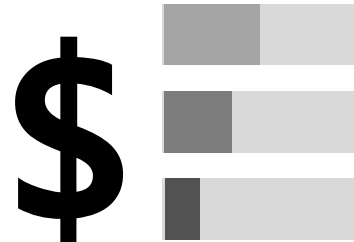
“Every accomplishment starts with the decision to try”. *John F. Kennedy*

INITIATIVES	DESCRIPTION
Graduate Student Support	Travel Grants, Dissertation Assistantships, new funding model
DERI, DURl, REU	Prospective students (HS, UG, UG)
Aggressive Goal Setting	Research productivity benchmarking (\$\$\$)
Research Converge Council	Faculty leadership Group
Investment in infrastructure	Increase equipment access, expand capacity
Workshops and training	Fellowship Competitions, Research Ethics

Grad. Students
400-500

Student Experiences
Travel, Training,
Fellowships

Research Funding
\$30 M



Priority: Increase Research

2014

Res. Exp: \$6.3M

\$/PI: \$69K

HEETF Awards: \$350k

Expenditures



What happened???

- *Good hires*
- *Leadership*
- *Strategic Planning*
- *2X GS support*
- *Capital Investments*

2019

Res. Exp: >300%

\$/PI: >300%

HEETF Awards: >2X

Ranked Programs

Richmond, VA



We strive to be

- Internationally recognized
- Nationally ranked
- Locally impactful

Richmond, VA



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- Internationally recognized
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ACCESS TO MEDICATIONS REIMAGINED

TARGET MOLECULE IDENTIFICATION

The Bill & Melinda Gates Foundation establishes priorities based on market projections and established therapies for HIV/AIDS drugs and other neglected drugs.



ACTIVE INGREDIENT OPTIMIZATION

Medicines for All (M4ALL) works with academic partners to discover cost-saving techniques for manufacturing an active drug ingredient.



CONTINUOUS MANUFACTURING

M4ALL designs a continuous, automated manufacturing platform for the process. This reduces cost and environmental impact.



BATCH MANUFACTURING

Once M4ALL finds a low-cost batch process, they send it to the Clinton Health Access Initiative. They implement it rapidly to reduce the cost by 10–30%.



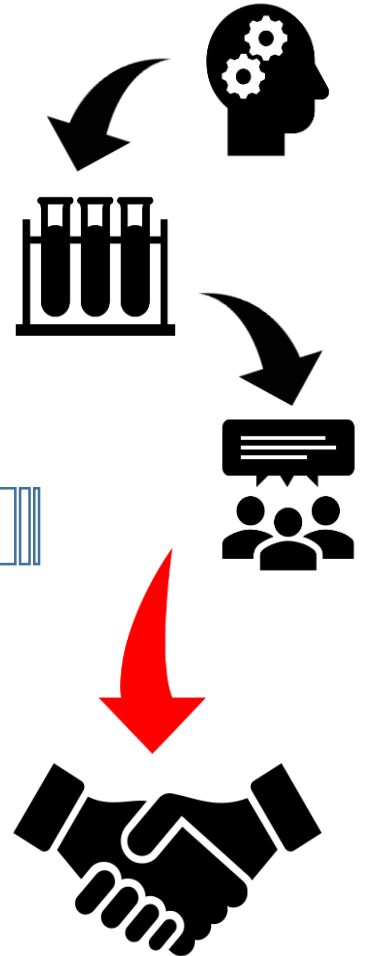
DISTRIBUTED MANUFACTURING APPROACHES

M4ALL develops reconfigurable platforms that can rapidly manufacture medicines to enable regional and in-country manufacturing capabilities.



REINVENT SUPPLY CHAIN

The Clinton Health Access Initiative coordinates distribution to underserved populations.





VCU Center for Analytics and Smart Technologies (VCAST)

Addressing social challenges using technology...

Smarter RVA

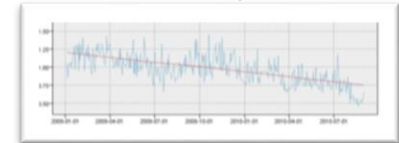
Smart Richmond is a vibrant and sustainable ecosystem where entrepreneurs, researchers and the city authorities collaborate together to use technology to build a smarter city supporting citizens services, job creation and innovation.



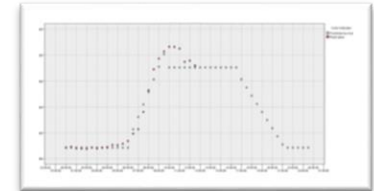
- Optimization
- Forecasting
- Simulation
- Predictive Modeling
- Driving New Economic Models
- Collaborative R&D
- Skills Developments and Growth
- Competitive Advantage

- Economic growth
- Reduced waste
- Reduced energy consumption
- Efficient transposition system
- Resource optimization
- Structural management

Gain Insights



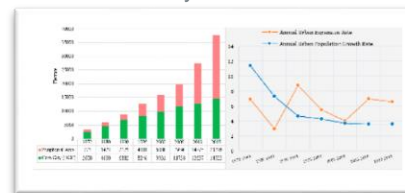
Build Models



Decision Support



City Growth



Richmond, VA



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- Locally impactful



Effect of space flight on bone and muscle

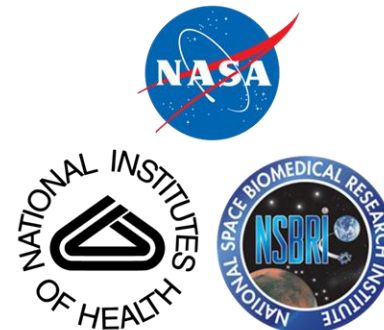
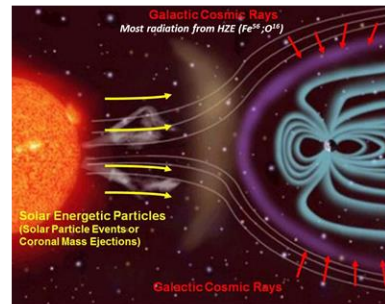
Henry J. Donahue, Ph.D.

 Bone Engineering and Science Laboratory (*BEST Lab@VCU*)


Questions

- What is the relationship between bone and muscle loss in response to simulated microgravity and space radiation?
- What is the cellular and molecular mechanism of bone and muscle loss?
- What role does genetics play?
- Will countermeasures that prevent bone loss prevent muscle loss and vice versa?
- How well do ground based analogs simulate actual space flight?

Microgravity induces bone and muscle loss in astronauts ...and in hind limb suspended mice



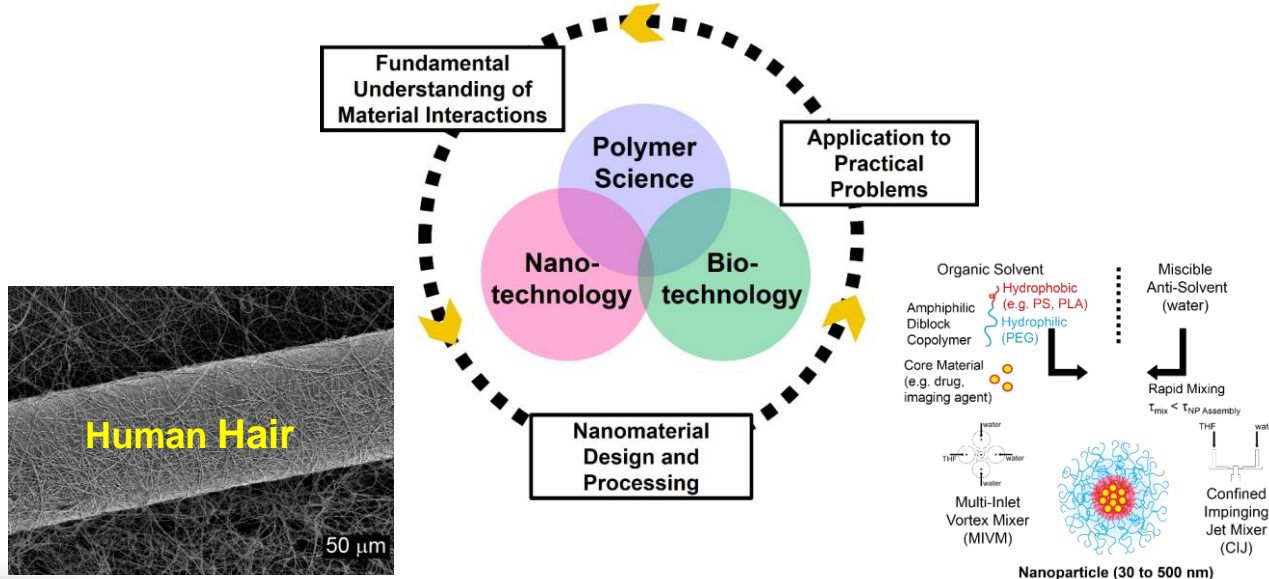
Tang Research Group

Polymer Nanomaterials Lab



Dr. Christina Tang

We focus on processing and characterization of functional polymer materials with applications in biomedical and environmental engineering. Our goal is innovation in improved polymer materials processing and enhanced material performance.



Functional Materials for Energy, Environment & Human Health

Principle Investigator: Dr. Weining Wang | Graduate Students: Xiang He, Zan Zhu | Interns: VIP, DURl, DERl, RMEP, Work-Study



Graduate student positions available, please contact Dr. Wang: Email: wnwang@vcu.edu, Tel: 804-827-4306

For more information about research at Dr. Wang's laboratory, please visit: <https://wnwang.wordpress.com/>

Richmond, VA

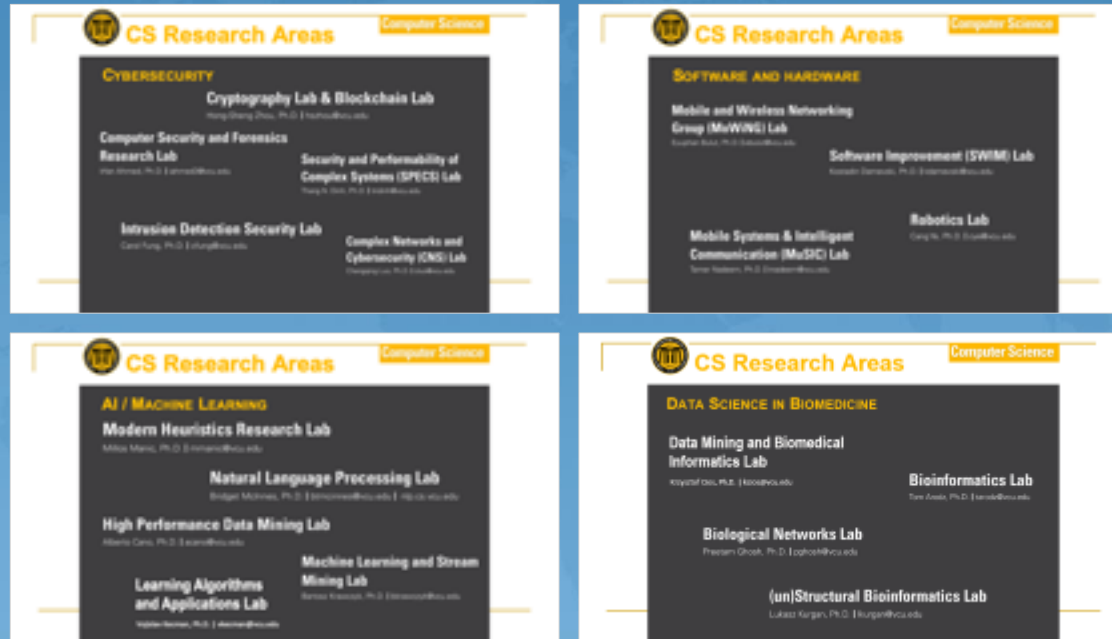


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Cyber and Digital Influences

Research Expenditures **DOUBLED** since 2016





CS Research Areas

Computer Science

CYBERSECURITY

Cryptography Lab & Blockchain Lab

Hong-Sheng Zhou, Ph.D. | hszhou@vcu.edu

Computer Security and Forensics Research Lab

Irfan Ahmed, Ph.D. | iahmed3@vcu.edu

Security and Performability of Complex Systems (SPECS) Lab

Thang N. Dinh, Ph.D. | tndinh@vcu.edu

Intrusion Detection Security Lab

Carol Fung, Ph.D. | cfung@vcu.edu

Complex Networks and Cybersecurity (CNS) Lab

Changqing Luo, Ph.D. | cluo@vcu.edu



CS Research Areas

Computer Science

SOFTWARE AND HARDWARE

Mobile and Wireless Networking Group (MoWiNG) Lab

Eyuphan Bulut, Ph.D. | ebulut@vcu.edu

Software Improvement (SWIM) Lab

Kostadin Damevski, Ph.D. | kdamevski@vcu.edu

Mobile Systems & Intelligent Communication (MuSIC) Lab

Tamer Nadeem, Ph.D. | tnadeem@vcu.edu

Robotics Lab

Cang Ye, Ph.D. | cye@vcu.edu



CS Research Areas

Computer Science

AI / MACHINE LEARNING

Modern Heuristics Research Lab

Millos Manic, Ph.D. | mmanic@vcu.edu

Natural Language Processing Lab

Bridget McInnes, Ph.D. | btmcinnes@vcu.edu | nlp.cs.vcu.edu

High Performance Data Mining Lab

Alberto Cano, Ph.D. | acano@vcu.edu

Learning Algorithms and Applications Lab

Vojislav Kecman, Ph.D. | vkecman@vcu.edu

Machine Learning and Stream Mining Lab

Bartosz Krawczyk, Ph.D. | bkrawczyk@vcu.edu



CS Research Areas

Computer Science

DATA SCIENCE IN BIOMEDICINE

Data Mining and Biomedical Informatics Lab

Krzysztof Cios, Ph.D. | kcios@vcu.edu

Bioinformatics Lab

Tom Arodz, Ph.D. | tarodz@vcu.edu

Biological Networks Lab

Preetam Ghosh, Ph.D. | pghosh@vcu.edu

(un)Structural Bioinformatics Lab

Lukasz Kurgan, Ph.D. | lkurgan@vcu.edu

Summary

We are growing. It's being noticed. We are positioned to keep going..

ASEE FIRST BELL

Good morning K

LEADING T



HIGHER EDUCATION



Department "Bureau national security w

Court Invalidate
[Reuters](#) [f](#) [t](#) (11/2
D. C. September

HIGHER EDUCATION



worry that opening up put students at risk." T higher education need Betsy DeVos have arg what qualifies as high

RESEARCH AND DEVELOPMENT



National Science Foundation STEM grants for rural student majoring in" STEM subjects a financial need at West Virginia

NSF Gives UMass Resea

ASEE FIRST BELL

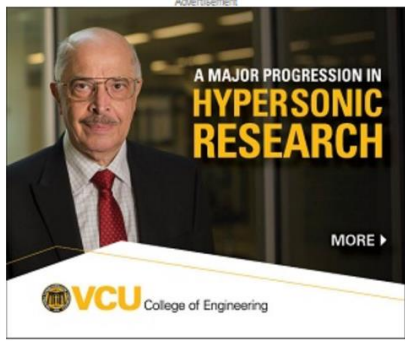
Good morning Kendra Gerlach

LEADING THE NEWS

HIGHER EDUCATION



Poughkeepsie, New York. The center accessible to members of the IBM Q n following the IBM unveiling the Q System



California Gives CTE Grant.

The [Fresno \(CA\) B](#) has announced that for its career and te use the \$1 million to Technology and W robots, welding sim will train up to 100 for the job market."

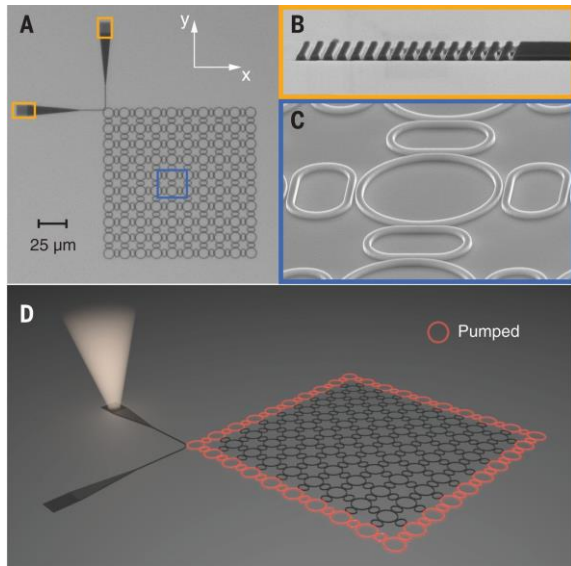
The [Fresno \(C](#) the funding was ob Arambula (D), and for such classes as

technology. Arambula made the announcement at a press conferen [KFSN-TV](#) [f](#) [t](#) Fresno, CA (10/9) and [KGPE-TV](#) [f](#) [t](#) Fresno, CA



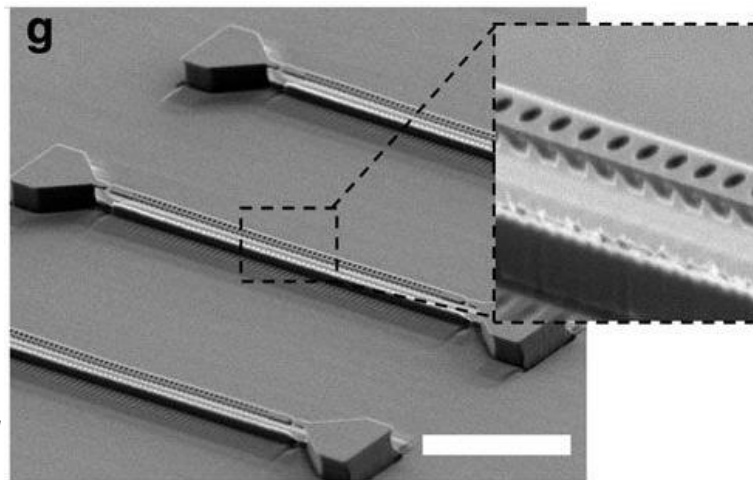
What's next for Engineering...

Breakthrough Devices



Photonic Topological Insulating Laser

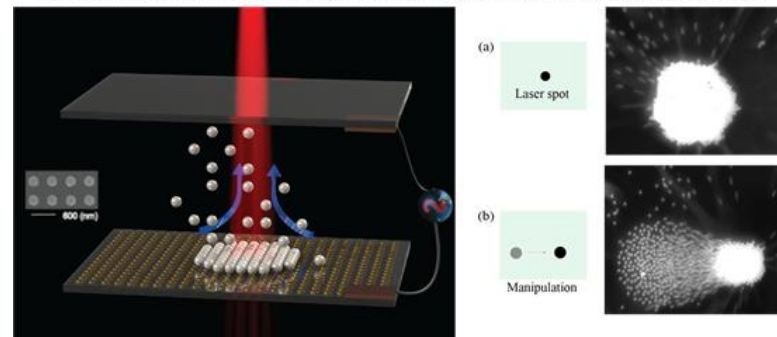
Christodoulides-Segev Group, *Science*, 2018



Integrated Quantum Network in Diamond

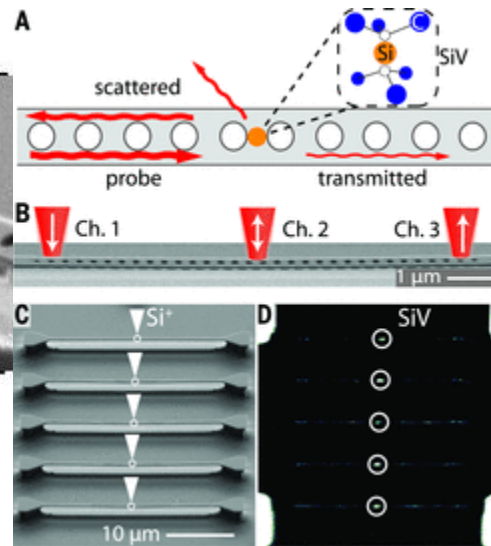
Loncar-Lunkin Group, *Science*, 2016

Versatile Plasmo-fluidic Device for On-chip trapping, sorting and dynamic manipulation of particles



Fast and Precise Nanoparticle Positioning

Boltasseva Group, *Nature Nanotechnology*, 2017



National Prominence

- Research infrastructure expansion (strategic)
- Faculty development (larger grants)
- Convergence research
- Enrollment growth
- Research partnerships (new areas)
- Faculty and student diversity
- **Open to partnerships!!**

