



open
campus

Dr. Phil Perconti

Director (A)

U.S. Army Research Laboratory



U.S. ARMY
RDECOM

U.S. Army Research Laboratory

ARL



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Mission

DISCOVER, INNOVATE, and TRANSITION Science and Technology to ensure dominant strategic land power



Making today's Army and the next Army obsolete



U.S. ARMY
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RDECOM Organization



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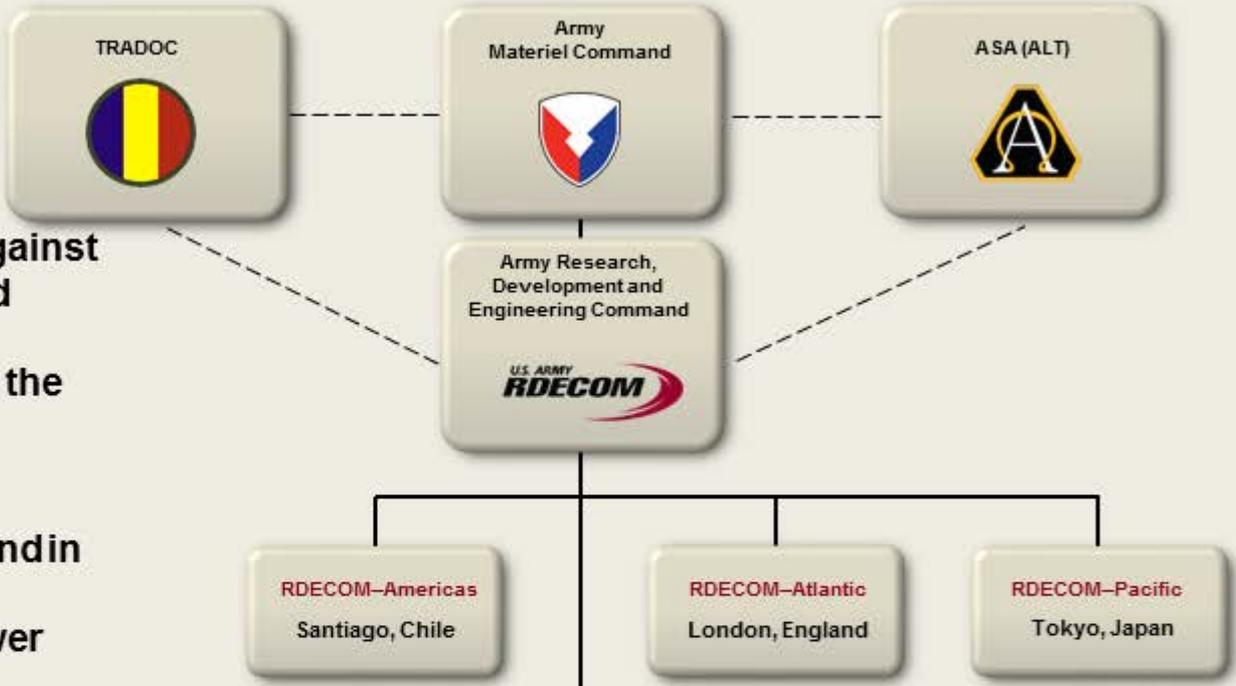


Mission

Provide innovative research, development and engineering to produce capabilities that provide decisive overmatch to the Army against the complexities of the current and future operating environments in support of the joint warfighter and the nation.

Vision

To be the Army's enabling command in the development and delivery of capabilities that unburden, empower and protect the Warfighter.



Dr. Phil Perconti

ARL
 ARL Director (A)

Mr. John Hedderich

 ARDEC Director

Mr. James Lackey

 AMRDEC Director

Mr. Henry Muller Jr.

 CERDEC Director

Dr. Joseph Corriveau

 ECBC Director

Mr. Douglas Tamilio

 NSRDEC Director

Dr. Paul Rogers

 TARDEC Director

Preeminent leaders in research, development and engineering

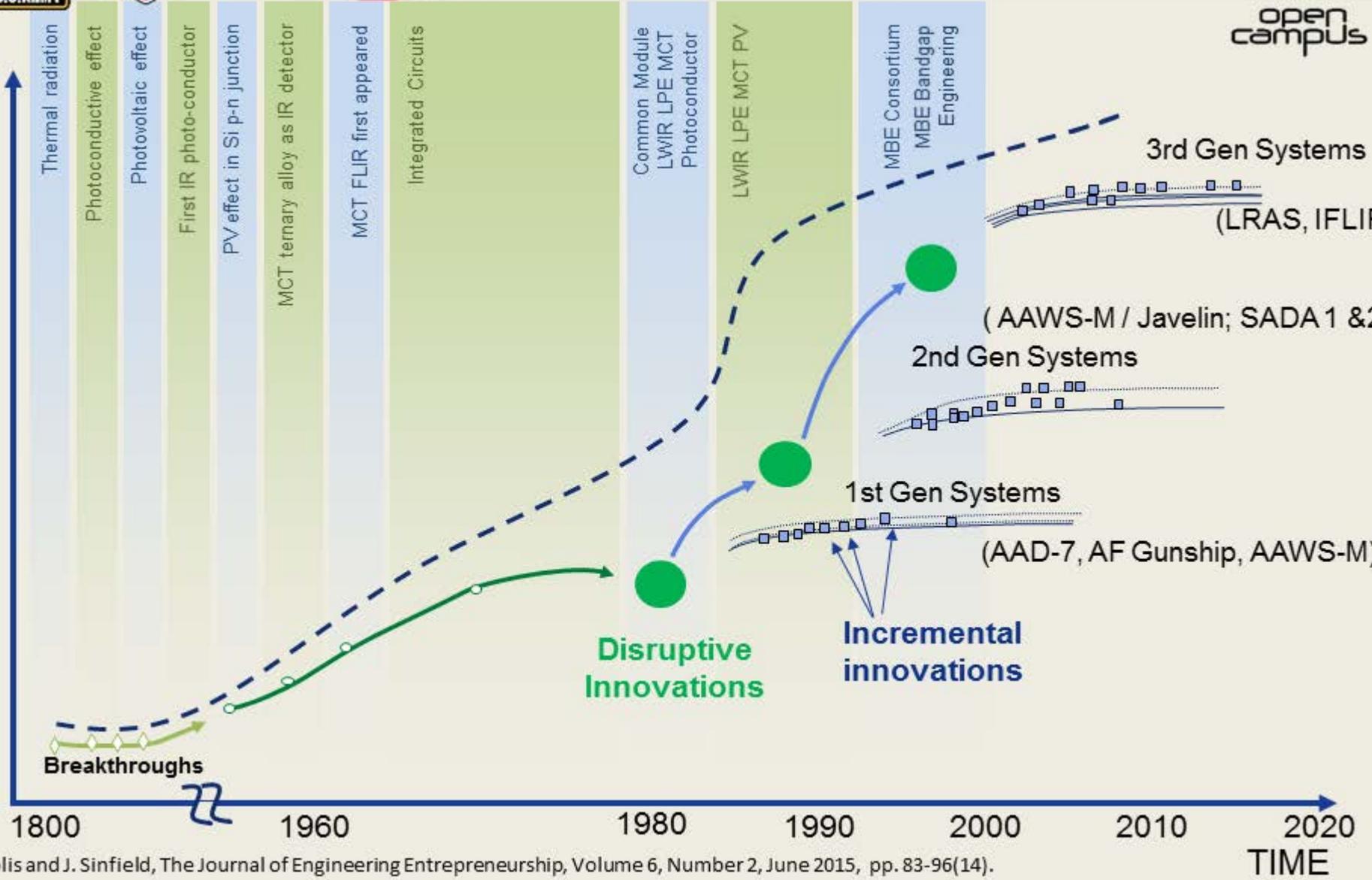
The Nation's Premier Laboratory for Land Forces



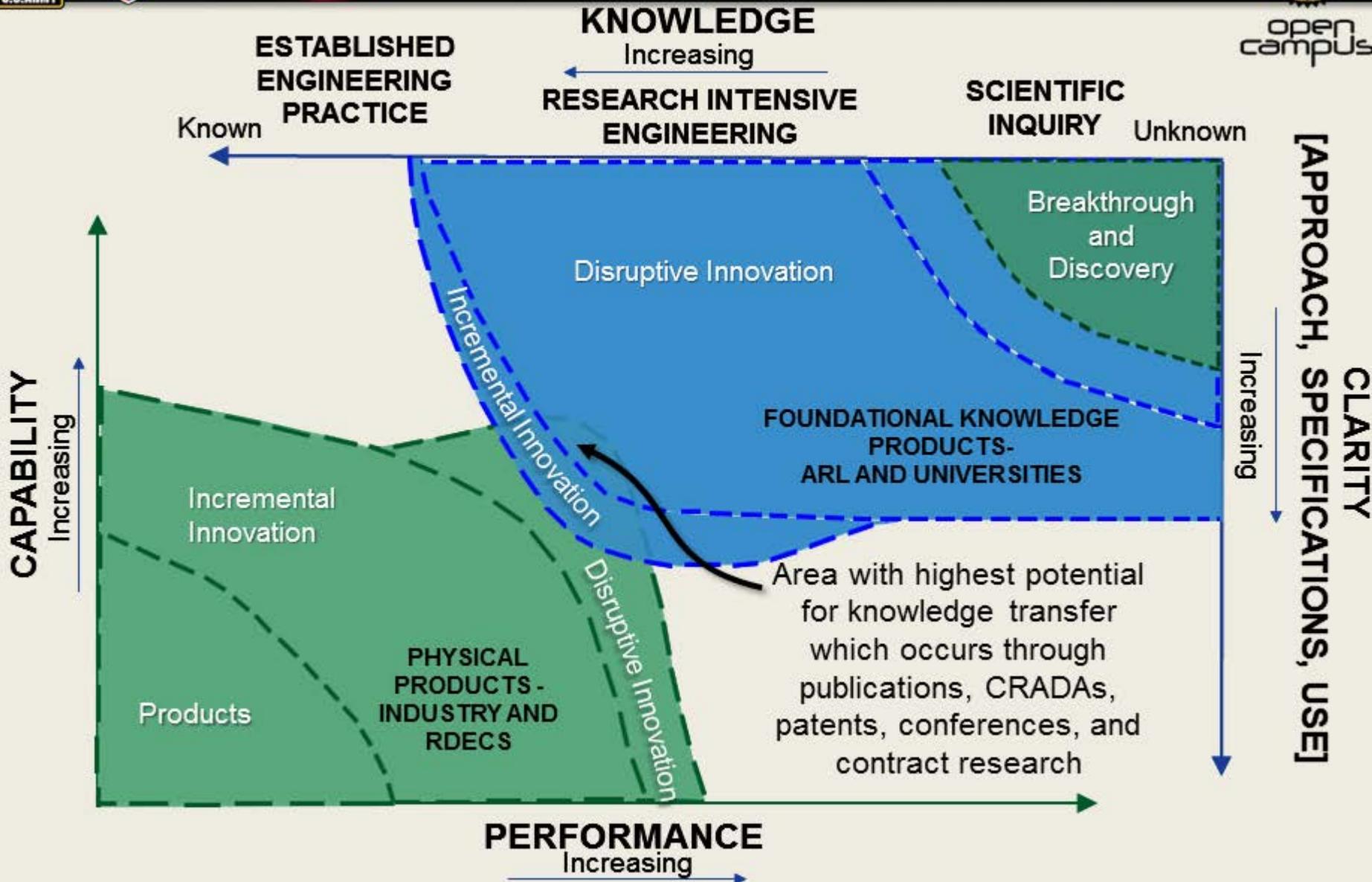
Army IR Innovation



IMPACT



F. Solis and J. Sinfield, The Journal of Engineering Entrepreneurship, Volume 6, Number 2, June 2015, pp. 83-96(14).





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ARL S&T Campaigns

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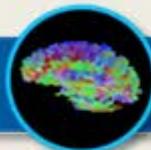


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Functional Campaigns

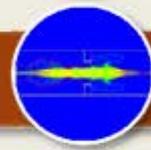
Cross Cutting Campaigns

SOLDIER



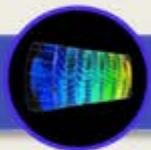
Human Sciences

SHOOT



Sciences for Lethality & Protection

MOVE



Sciences for Maneuver

COMMUNICATE



Information Sciences



Extramural Basic Research



Computational Sciences



Materials Research



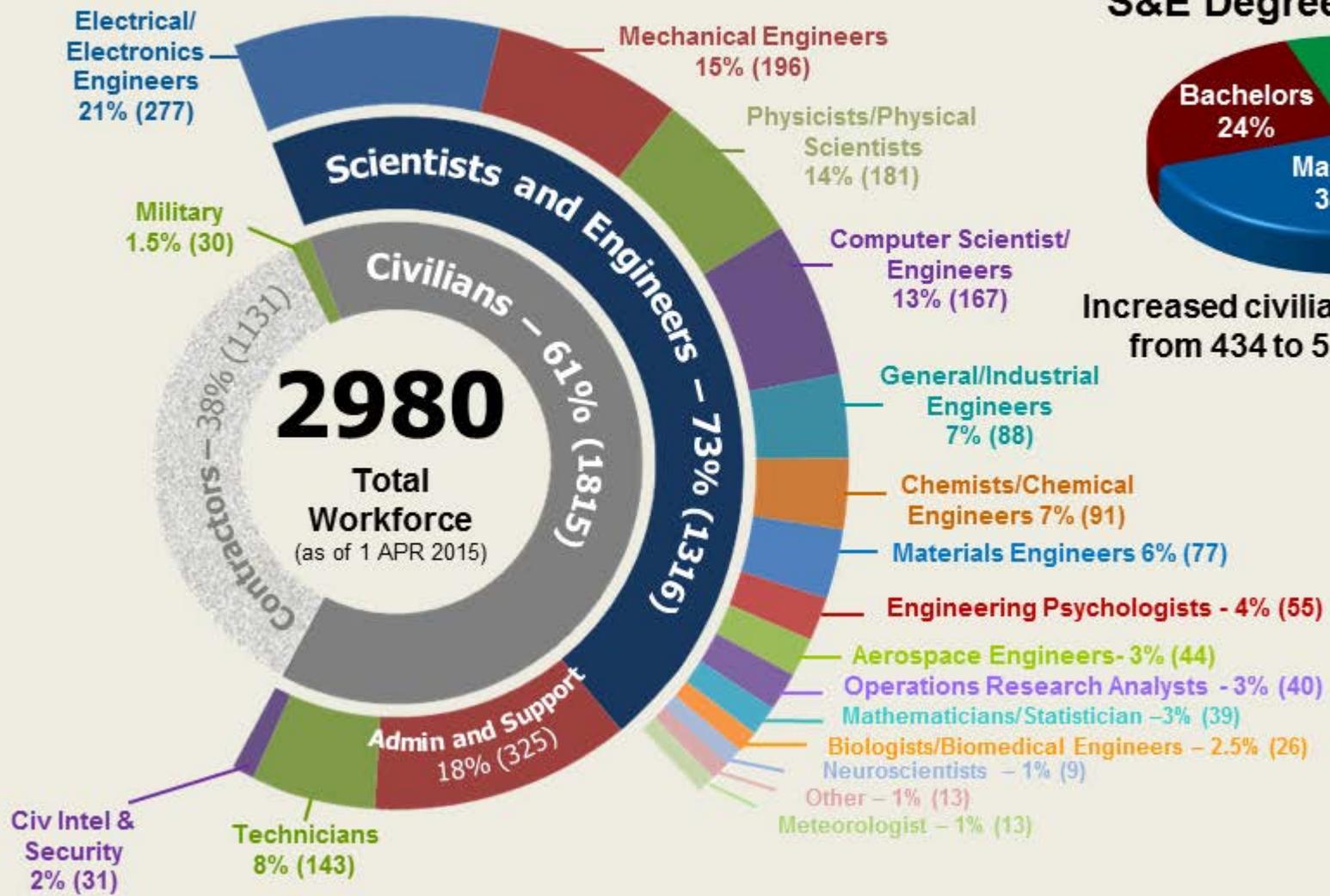
Assessment and Analysis

- **A coherent understandable strategy**
- **Ultimately leading to new warfighter capabilities**

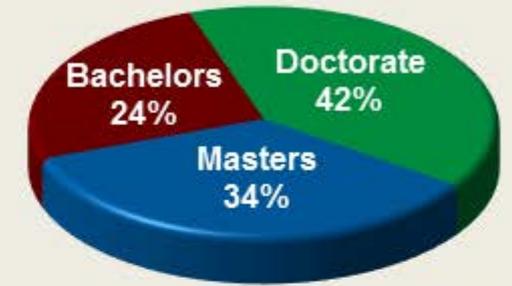
ARL Campaign Publications <http://www.arl.army.mil/publications>



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S&E Degree Distribution



Increased civilian S&Es with PhDs from 434 to 555 (FY06-FY15)



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Open Campus Initiative

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Past: Current Defense Laboratory Model

Gates and high walls provide 20th century security, but are barriers to 21st century innovation



Defense laboratories relatively unchanged since inception (NRL 1923)

Present & Future: Open Campus Initiative

Reduction in barriers to facilitate collaboration with academia, industry, and small business



Less
bureaucracy
and paperwork



Open areas for
researchers and
access to existing
facilities



Collaboration
between ARL and
external scientists



Career path
for students
and scientists



Hub and
Spoke
Model



Collaborator
presence
through
EUL



Novel staff
opportunities

An enhanced defense research environment that fosters discovery and innovation through collaboration on fundamental research

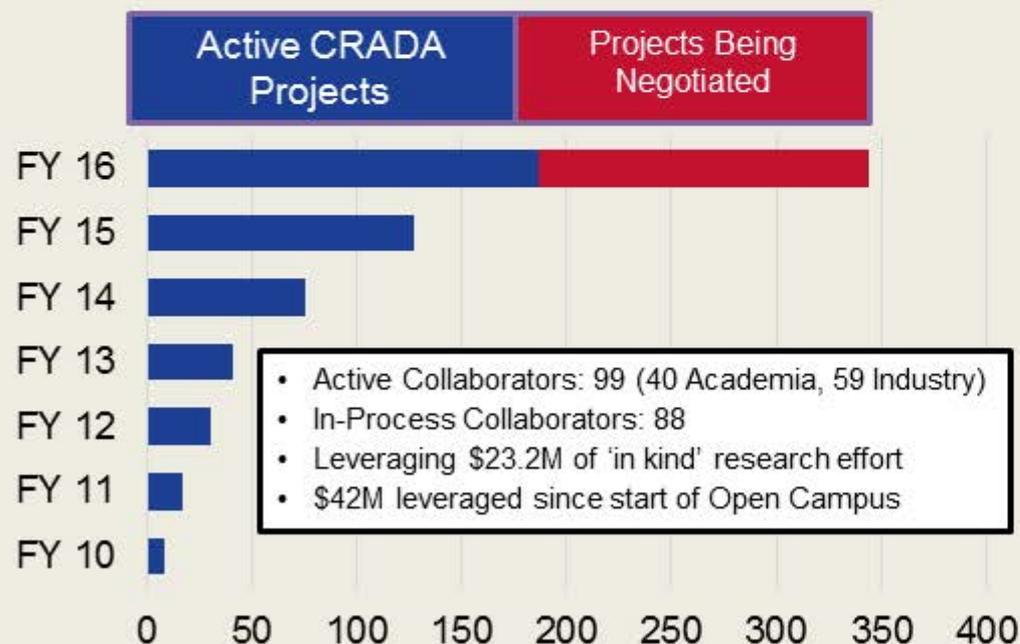
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Open Campus: Route for Collaboration

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Collaborative Mechanisms

- Cooperative Research and Development Agreements (CRADAs)
- Patent License Agreements
- Educational Partnerships
- Partnership Intermediary Agreements



International CRADAs

- Three Active
- Eight Pending

Australia - University of Wollongong

Bulgaria & Ukraine –

Bulgaria Defense Institute,
Chernihiv National University of Technology,
National Technical University of Ukraine

Singapore - Nanyang Technological University

Australia - Australia National University

Australia - University of Sydney

Budapest - Budapest University of Technology and Economics

Germany - Fraunhofer

Israel - Ben Gurion University

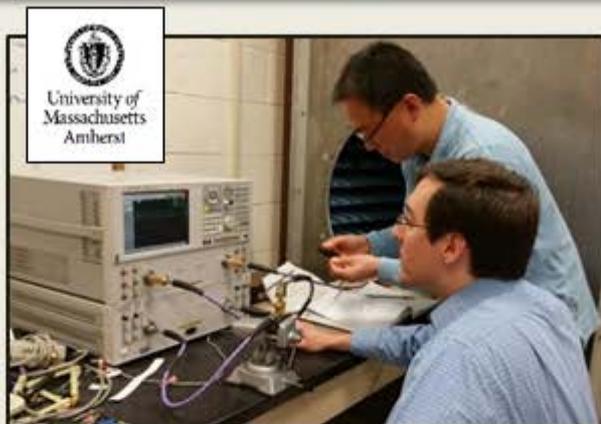
New Zealand - University of Auckland

Switzerland - ETH Zurich

Norway - University of Oslo

**Prof. Patrick Mather, Syracuse University**

One year sabbatical at ARL to investigate the rate dependent mechanics of polymer blends

**Dr. Steven Keller, ARL**

Three year detail at UMass Amherst on conductive textile and flexible antenna research and fabrication

**Brittany Beidleman, USC**
Undergraduate Student

Summer '16 project focused on visualizing terrain in augmented reality



Australian Government
Department of Defence
Defence Science and
Technology Organisation

Debra and Brendan Patton, ARL

One year detail beginning October 2016 to Australia's Defence Science and Technology Laboratory.

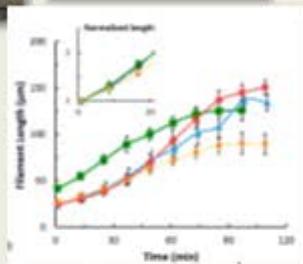
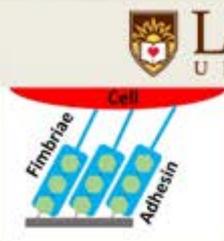
Ms. Patton is supporting the design of research protocols to investigate the cognitive and behavioral implications of novel training technologies and proposed military equipment

Mr. Patton's focus covers weapon guidance technologies, assessment of both weapons and combat systems, tactical information exchange, physical force protection and national security to provide the ability to meet key drivers in the weapon and combat systems domain

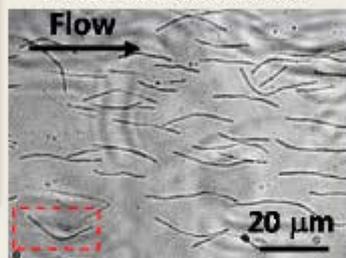
> 724 People Into and Out of Laboratory Under Open Campus Pilot So Far Including 58 from 21 countries including China, India, Germany, Turkey, South Korea, Iran



Measurement & setup
with waveguide in
microfluidic channel



Elongated bacterial
filaments grown under
shear flow conditions



Materials Discovery: Bacterial Filaments

- Collaboration with Lehigh University's Prof. Cheng, on sabbatical at ARL
- Microfluidic channel experimental expertise enabled recent publication in *Molecules* highlighting:
 - Engineered cell adhesion under shear flow conditions dramatically increased control over filament length.
 - "Living" filaments could lead to new sensing, actuating, or self-healing structures
 - Research could also lead to better understanding of immune system response to long, narrow structures

Collaborators: Dimitra Stratis-Cullum (ARL)
and Xuanhong Cheng (Lehigh)

Human Variability Research

- Continuous Multi-faceted Soldier Characterization for Adaptive Technologies initiated at Open Campus Open House 2014
- Joint development and testing of a system for collection and real-time analysis of multiple simultaneous streams of information from body-worn and environmental sensors
- Provides computational infrastructure for future studies at ARL and at UMass-Amherst (NIH funded MD2K Center)

POC: Amar Marathe (Human Sciences)



Diagram of computational infrastructure
currently under development



UMassAmherst
The Commonwealth's Flagship Campus



open campus

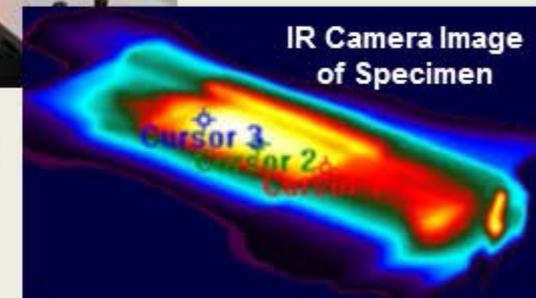
Advanced High Temperature Ceramics for Propulsion Applications

- Boeing developed Gas Turbine Engine exhaust ceramic matrix composite materials. ARL tested these materials at its Vehicle Research Laboratory.
- Preliminary investigations on Ox-Ox ceramic matrix composite materials show promise for use in future gas turbine engine exhaust and nacelle structures.
- Ongoing collaboration will impact disruptive levels of high power density, durability, reliability and reduced life cycle cost of future, ultra-efficient, Army rotorcraft engines.



Burner Rig

Anindya Ghoshal (Sciences for Maneuver)/ Dan Driemeyer and Vann Heng (Boeing)



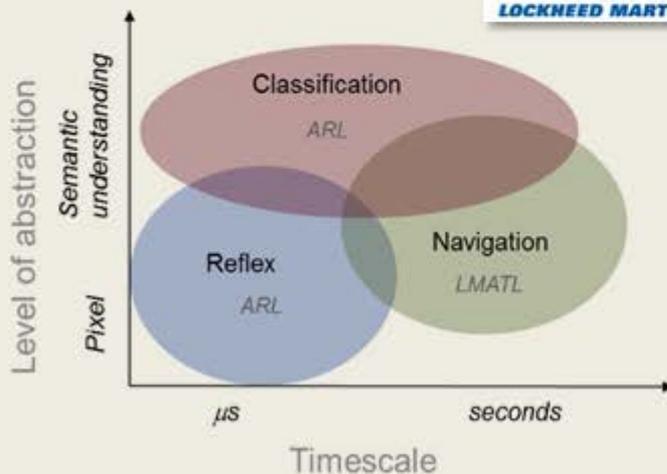
IR Camera Image of Specimen



Neuromorphic Computing for Adaptive Control of Robotic Systems

- New start in FY17; ARL growth area; LMATL researcher approved for a one year research sabbatical to ARL
- Will develop sensors and embedded methods to extract salient information from the sensed environment to enable high-speed autonomous vehicle operation, improved soldier-borne localization, and real-time adaptive model learning and refinement in unknown environments.

ARL POC: Allison Mathis (Sciences for Maneuver) / Brian Satterfield LM(ATL)





ALC Open Campus



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- On approximately two (2) acres, a 75,000 SF building will consist of flexible laboratory space in support of collaborative research
- Located proximate to ARL's world class laboratory facilities
- Enhanced Use Lease (EUL) Acquisition.
 - ❖ *Engages private sector to fund construction or renovations on federal property by allowing a private developer to lease underutilized property.*
- ALC EUL Timeline
 - U.S. Army Corps of Engineers working to develop Request for Proposal (RFP)
 - Advertisement of RFP is anticipated for early 2017
 - Award expected in the summer of 2017



**New Construction
Open Campus Phase 1
Opening 2019**



Open Campus Vision for APG



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IOC: Building the Ecosystem

- Positive control of international partners (established shuttle routes)
- Security measures and protocols enabling freedom of movement within ARL space
- Utilize proven concepts of the DA Open Campus Pilot successfully established at US Army Adelphi Laboratory Center
- Open Campus seating for 70 partners

FOC: Research Park-like Setting

Construct new facilities to support the freedom of movement to:

- Share/leverage resources, unique facilities & expertise
- Share unique data sets
- Shared High Performance Computing facility
- Co-develop & share IP
- Incubate small businesses

- **APG Innovation Hub - Army Research Laboratory Open Campus**
 - Strong pull for collaborative foundational research in the public domain
 - Planned new Facilities for Unclassified High Performance Computing and research in Human Sciences, Sciences for Maneuver, and Materials Sciences
- Accelerate Army innovation, facilitated by proximity, using collaborative partnerships between government, industry & academia within a global network at **APG**
- Serve as Incubator for S&T innovations and technology transition

Accelerate technology transition to benefit the Warfighter, our partners & the Nation



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ARL's New Research Centers

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Adelphi, MD

- Cyber Research Center (CRC)
- Center for Extreme Batteries (CREB)
- Center for Semiconductor Materials and Device Modeling (CSDM)
- Intelligent Systems Center (ISC)
- Network Science Research Laboratory (NSRL)
- Semiconductor Research Nanofab Center (SRNC)



**Center for Agile
Materials Manufacturing
Science (CAMMS)**

**Center for Semiconductor
Materials and Device
Modeling (CSDM)**

**Center for Research
in Extreme Batteries
(CREB)**

**Semiconductor
Research Nanofab
Center (SRNC)**

**Network Science
Research Laboratory
(NSRL)**

Aberdeen Proving Ground, MD

- Center for Agile Materials Manufacturing Science (CAMMS)
- Center for Adaptive Soldier Technologies (CAST)
- Center for Impact Physics (CIP)
- Expeditionary Manufacturing Science Center (EMSC)
- Novel Energetics Research Center (NERC)

White Sands Missile Range, NM

- Atmospheric Sciences Center (ASC)



Open Campus Activity:

- CREB Center established with 5 core members
- Non-profit CREB consortium in negotiation
 - To be funded by industry, academic, and government members
 - Interest expressed by over 300 organizations
- ARL, UMD, and NIST funded initial cohort of 4 Post-docs (including two international researchers), led to larger ARPA-E grant



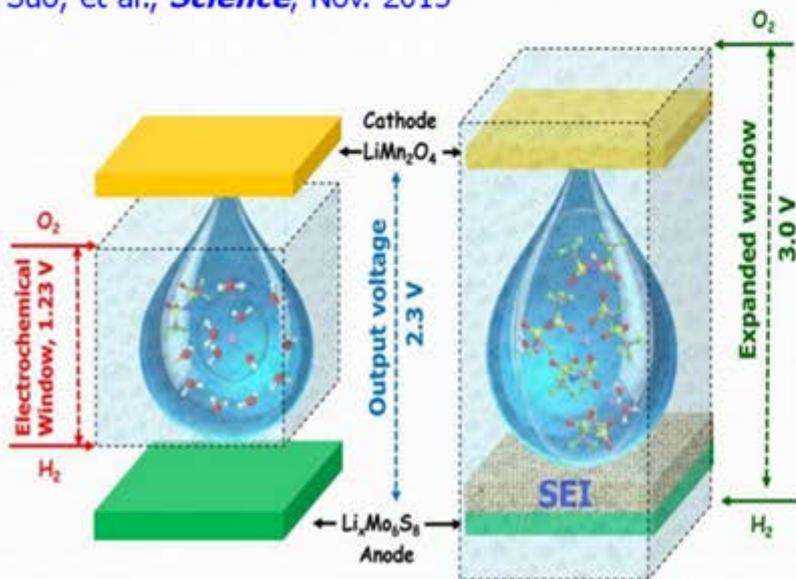
National Institute of
Standards and Technology



NEW YORK BATTERY
AND ENERGY STORAGE
TECHNOLOGY CONSORTIUM



L. Suo, et al., *Science*, Nov. 2015



Technical Accomplishments:

- “Water-in-salt” electrolytes dramatically **increase electrochemical stability to 3 V** over previous state of the art (1.23 V)
- **Li-ion equivalent 200 Wh/kg** energy density demonstrated using completely non-flammable/non-toxic electrolyte (43% increase over previous state of the art)
- Joint ARL/UMD patent filed
- High impact publications including *Science*, *Nature Energy*, *Angewandte Chemie*



Developing a Hub and Spoke S&T Global Network



**ARL WEST***Opened April 13, 2016***Focus: Human Information Interaction**

How humans generate & interact with data to effectively & efficiently make decisions

ARL CENTRAL*Under Development***Focus: Materials, Mechanisms, & Computing**

Impact physics, quantum science, high performance computing, materials for weapons & protection

ARL SOUTH*Opened November 16, 2016***Focus: Materials & Manufacturing**

Additive manufacturing, biosciences, energy & power, energetic materials, cyber science

Goals:

- Establish regional laboratories to jointly solve Army technology needs
- Establish close ties with academia, start-ups & established companies
- Access large pool of subject matter experts from academia & industry
- Capitalize on strong academic institutions & graduates with regional preference