



# U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – ARMY RESEARCH LABORATORY

Army Research Office (ARO) - Overview

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# ARO'S MISSION



1

## Build the Future

Create and direct scientific discoveries for revolutionary new Army capabilities

2

## Solve Existing Problems

Drive science to develop solutions to existing Army technology needs

3

## Accelerate

Accelerate transition of basic research

4

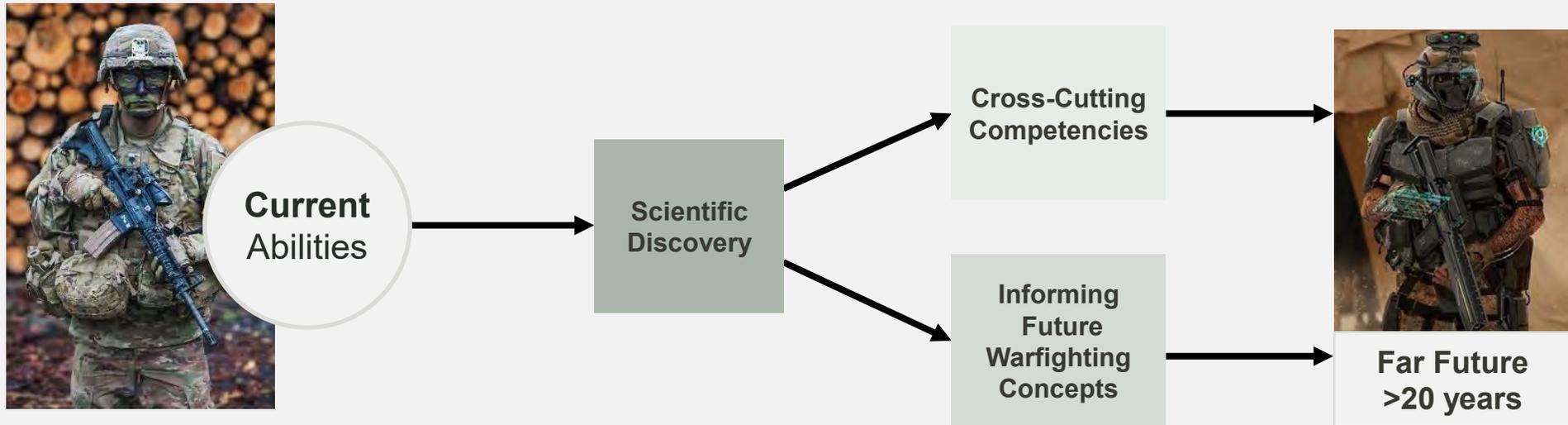
## Educate

Educate and train future Army Scientists & Engineers workforce

5

## Prepare

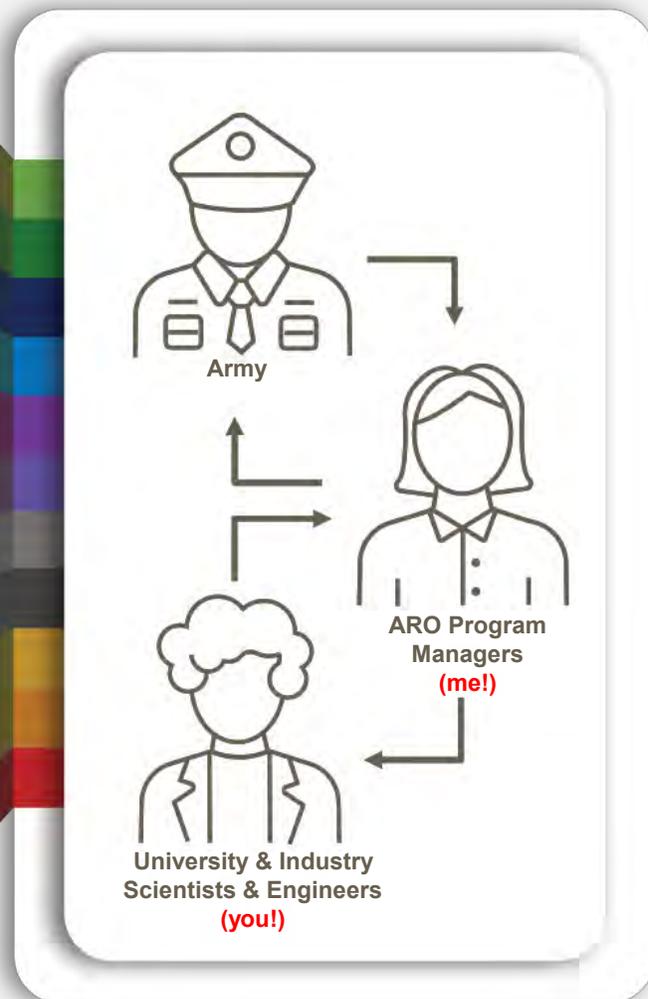
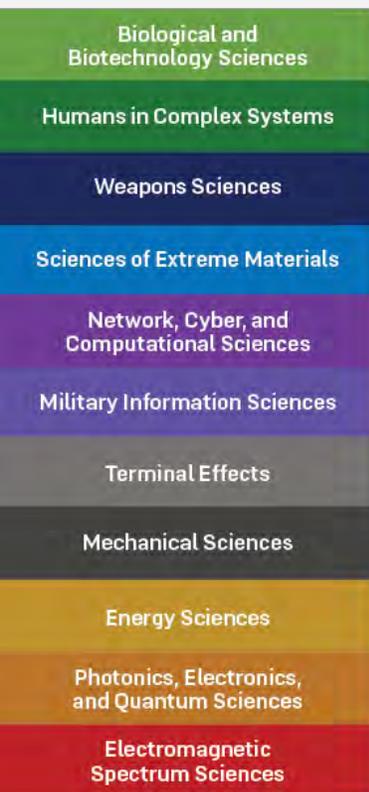
Create technological superiority for U.S. Forces, and prevent adversary technological surprises



A component of DEVCOM ARL, the Army Research Office contributes to Army modernization by focusing on **basic scientific research.**



# ARO CONNECTS THE ARMY TO EXTRAMURAL RESEARCH



## ARO is the Army's primary face to the academic scientific community.

Program Managers translate between the future technology needs of the Army and scientific breakthroughs of academia.

They play an *active* role in creating and directing new science by brokering Army-academic relationships and collaborations.

## Program Managers are subject matter experts who have funding authority.

They want to fund the most cutting-edge science that may be otherwise unexplored, and can choose to fund *higher-risk, higher-reward proposals*.



ARO's work with basic scientific research drives toward the Army's **far future capabilities** 20, 30, 40 years from now.



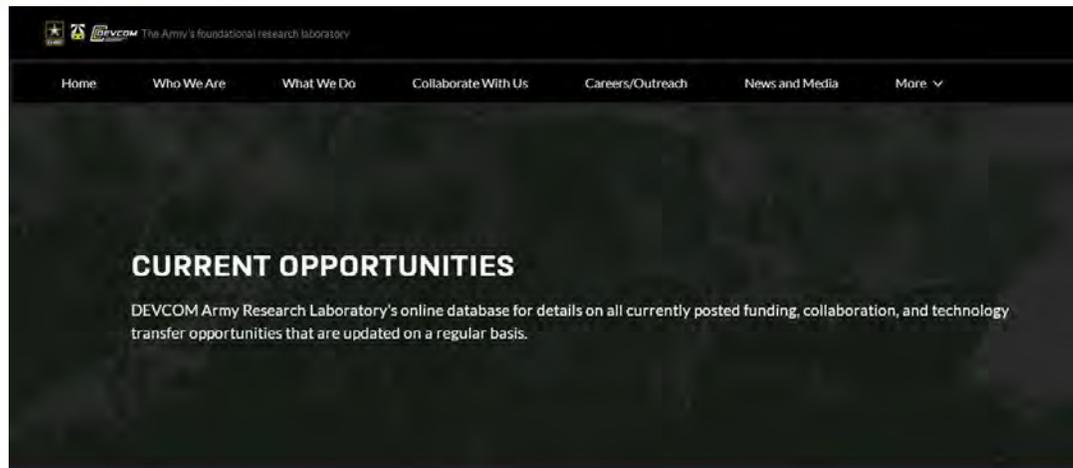
# ARO AND OTHER BROAD AGENCY ANNOUNCEMENTS



Award Type	Target	Funding
<b>Single Investigator (SI)</b>	Single-laboratory projects	~\$141K/year for ~3.4 years avg
<b>Short Term Innovative Research (STIR)</b>	Very high-risk pilot projects	\$60K for 9 mo.
<b>Early Career Awards (formerly Young Investigator Program)</b>	Early-career PIs	\$120K/year for 3 years
<b>Conferences / Workshops / Symposia</b>	Academic State of Science	\$10K–\$30K
Presidential Early Career Award for Scientists and Engineers (PECASE)	Promising future leaders	\$200K/year for 5 years
Defense University Research Instrumentation Program (DURIP)	Instrumentation	~\$200K/year average
Multidisciplinary University Research Initiative (MURI)	Large multidisciplinary programs	~\$1.5M/year up to 5 years
<b>Historically Black College/University and Minority Institution (HBCU/MI)</b>	Minority serving institutions	~\$140K/year for 3 years
Small Business Technology Transfer (STTR)	Multi-phase awards bridging academia & industry	\$150K (6 mo.) to \$1M (24 mo.)
Small Business Innovative Research (SBIR)	Multi-phase research for industry transition	\$150K (6 mo.) to \$1M (24 mo.)



# CONNECTING WITH DEVCOM ARL - ARO

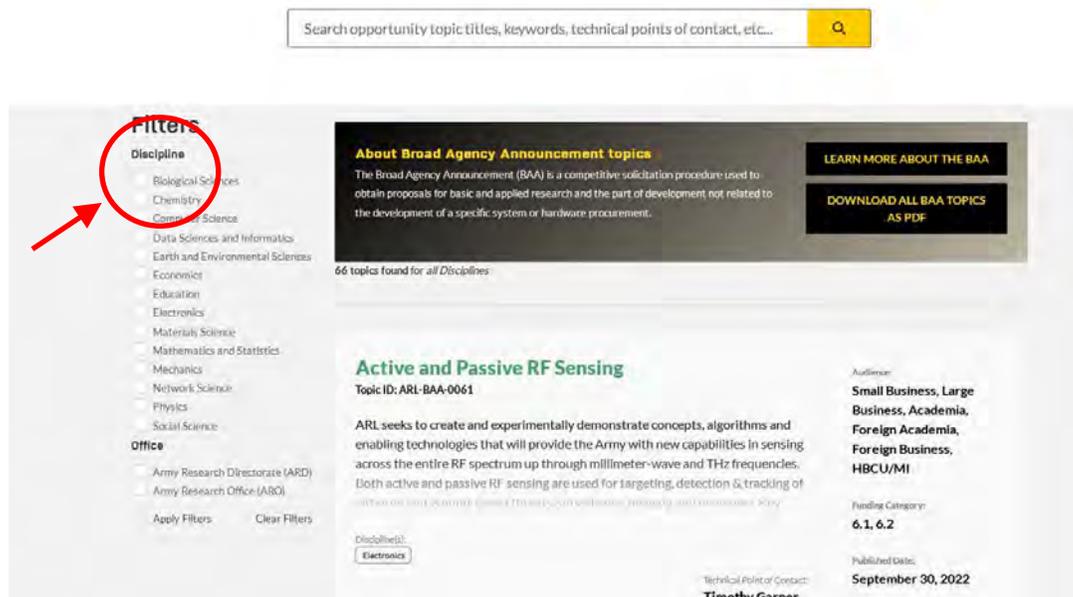


## ARL/ARO BAA

<https://www.arl.army.mil/collaborate-with-us/>

## ARO Disciplines

- |                                  |                            |                 |
|----------------------------------|----------------------------|-----------------|
| Biological Sciences              | Economics                  | Mechanics       |
| Chemistry                        | Education                  | Network Science |
| Computer Science                 | Electronics                | Physics         |
| Data Science and Informatics     | Materials Science          | Social Science  |
| Earth and Environmental Sciences | Mathematics and Statistics |                 |



## Technical POC: Name, Email, Phone



# QUESTIONS TO CONSIDER WHEN FORMULATING RESEARCH IDEAS



## Is it basic research?

- What's the scientific question?
- What foundational knowledge is not currently available about the workings of the universe?
- Proposals focused on specific devices/components/technologies are beyond the scope of ARO's mission.

## Is it hard?

- If an "old" question, why haven't we found an answer yet?
- If a "new" question, where's the sticky part?

## Why you? Why now?

- What's been done before? Why wasn't it successful?
- What's novel about your skills/abilities/approach that makes you think there's a shot at an answer?
- What new advance provides opportunity to make new progress?

## So what? Who cares?

- What impact will the research make on the scientific community?
- What papers will be written because of your efforts? What papers will stop being written?
- What are the potential implications for the future of technology?

## Where's the risk?

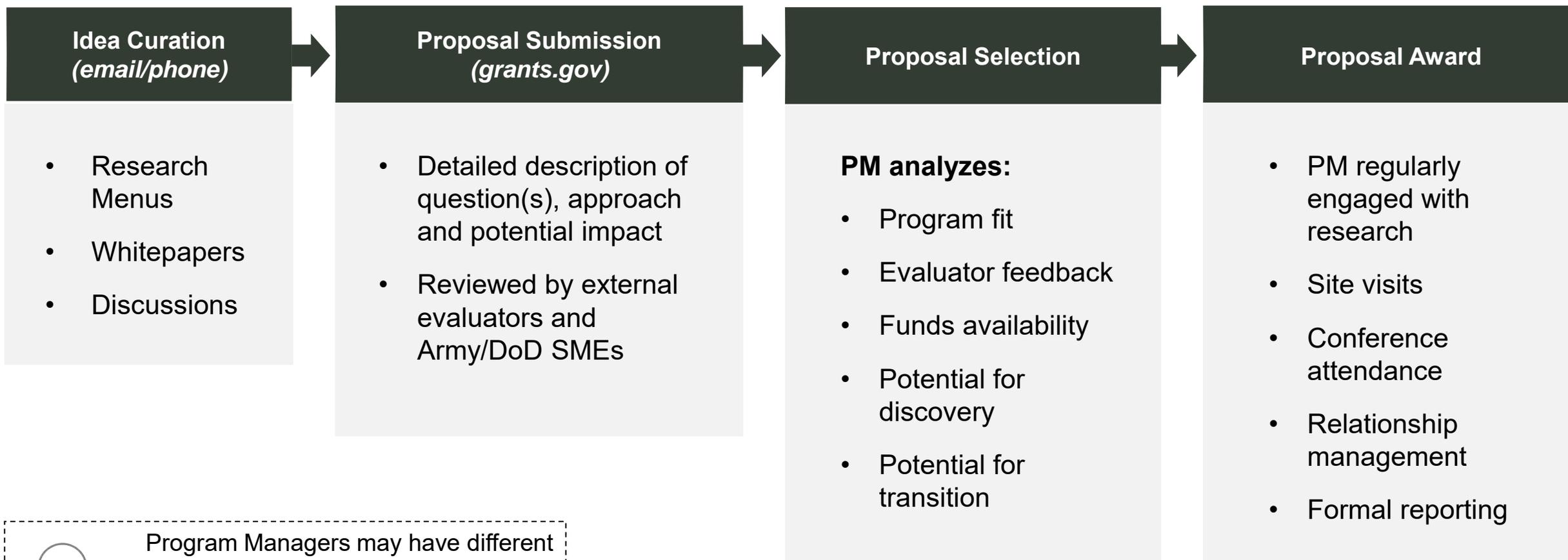
- How confident are you that you're asking the right question?
- How will you know when you have an answer? If you find a different answer, will you still learn something?

## What will it take?

- What resources (time, money, infrastructure, personnel, partnerships) are required to pursue the research?



# PROPOSAL PROCESS: FROM IDEA TO POST-AWARD



Program Managers may have different processes for how they handle idea curation. **I recommend reaching out to the PM first with an email introduction.**



# ARO YEAR IN REVIEW







## ARO

## YEAR IN REVIEW



U.S. Army Combat Capabilities Development Command (DEVCOM)  
 Army Research Laboratory (ARL) • Army Research Office (ARO)  
 P.O. Box 12211 • Research Triangle Park, NC 27709-2211  
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## ESD Engineering Sciences Division

[Electronics Branch](#)   
 [Materials Science Branch](#)   
 [Mechanical Sciences Branch](#)

### SOLID MECHANICS PROGRAM

**Program Manager**  
**Dr. Denise Ford**



Dr. Ford completed her undergraduate studies at the University of Wisconsin-Madison, receiving her B.S. in Chemical Engineering in 2007. She trained as an engineer at the Fermi National Accelerator Laboratory and Northwestern University, receiving her Ph.D. in Chemical Engineering 2013.

She came to ARO in 2019 as the Program Manager for the Solid Mechanics.

### Current Scientific Objectives

- 1** | Uncover the physical processes responsible for deformation, damage initiation and propagation, and failure of material systems that, if successful, could lead to the creation of ultra-resilient, lightweight, and durable Soldier and system protections.
- 2** | Develop computationally efficient, robust, and predictive models that, if successful, could substantially reduce the time and cost required to develop new material systems.

**This success was made possible by:**

Dr. Denise Ford, Mechanical Sciences Branch

Dr. Ralph Anthenien, Mechanical Sciences Branch

**Citations:**

Chandler, D. L. "Machine-Learning Tool Could Help Develop Tougher Materials," MIT News. (2020).

### SUCCESS STORY

#### A Nature-Inspired Library for the Design of Lightweight Impact-Resistant Materials

A library of nature-inspired structures for material design is being developed through new methods utilizing artificial intelligence (AI) to predict the physical and mechanical properties of and fracture processes in materials.

**CHALLENGE**

Nature offers a wealth of inspiration for high-performing systems that combine strength, stiffness, toughness, and low weight; however, researchers have had a difficult time mimicking these properties in synthetic systems. In particular, the complex 3D shapes and hierarchical structures found in nature create a vast design space, multiscale challenges to property evaluation and prediction, and challenges to correlating structural features to properties and performance.

**ACTION**

Program managers at ARO realized that AI-based methods could drastically speed up material property predictions, if properly trained, and could be applied to extremely complicated systems. Recognizing Professor Markus Buehler at the Massachusetts Institute of Technology as a leader in the field, Dr. Ralph Anthenien, former acting Program Manager for Solid Mechanics, encouraged him to submit a proposal to create an analysis technique for and property database of triply periodic minimal surface (TPMS) structures, a family of structures found in lightweight, thermally conserving, impact-shielding butterfly and beetle wings. Some examples of TPMS are shown in Figure 1. To achieve these goals, theory, computation, and experiment

"Lab tests or even detailed computer simulations to determine their exact properties, such as toughness, can take hours, days, or more for each variation. Now, a new artificial intelligence-based approach developed at MIT could reduce that to a matter of milliseconds."

- From Chandler (2020)

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<https://www.arl.army.mil/who-we-are/aro/>



**Thank you! Questions?**