Fundamental Research in the DoD and International Collaboration

Department of Defense, Basic Research Office

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Topics of Discussion

- DoD's Philosophy with Respect to Basic Research
- The Role of OSD* in Basic Research
- The Approach to Basic Research
- The Mechanisms for International Basic Research
- The Opportunities for International Collaboration
- The Challenges for International Collaboration

*OSD: Office of the Secretary of Defense







Why is DoD Funding Basic Research?

- Mission-focused
- Explore possibilities
- Avoid surprises
- Build core expertise

Blend of early research, exploration, risk-taking, translation, and workforce development...



Donald Stokes: 'Pasteur's Quadrant'

UNCLASSIFIED



DOD's Definition of Basic Research: A Nomenclature



6.6 RDT&E Management Support

6.5 System Development Demonstration

6.4 Advanced Component Development Prototypes

6.3 Advanced Technology Development

6.2 Applied Research

6.1 Basic Research

Administrative & budgetary purposes

 May lead to the interpretation that this is a linear process – which it is not



Basic Research across DoD

DoD's basic research enterprise is made up of diverse perspectives





OSD Basic Research Office: Overall Mission

- Defines and shapes DoD's future technology priorities
- Ensures DoD's future capabilities by fostering collaborations with
 - Academia
 - Industry
 - Government partners
- Ensures the nation's workforce in critical technology fields for the DoD



• Establishes and strengthens alliances with international partners



U.S. DoD Basic Research Office Overview





DoD Basic Research Funding: Approach

DoD has a unique approach to fundamental research – tailored to its core mission

Opportunities <u>and</u> challenges for international collaboration.





Long-term Funding Allows Ideas to Evolve and Mature



Prof. Deji Akinwande's earliest funding was three Young Investigator Program (YIP) awards, then an NSF Career followed by an ARO PECASE

Technology"





Schematic of atomristor memory sandwich based on molybdenum sulfide (MoS2) in a form of a single-layer atomic sheet grown on gold foil.

2011

•ARO Young Investigator Awards:" •Program Manager: Pani Varanasi •Basic Research Discovery: Pave the way for developing futuregeneration applications, such as ultra-dense storage, neuromorphic computing systems, radio-frequency communication systems, and more



A sensor that can test for COVID-19 and the flu simultaneously (NSF funded)



Develop switches for future 6G devices (NSF funded) Nature Electronics

2012

DTRA Young Investigator Award: The unique properties of hexagonal boron nitride (hBN) twodimensional (2D) materials for acoustic vibrational sensing



PECASE Award, Patents



Strategic Planning and Use-Inspired Research = Innovation

Example: Defense Advanced Research Projects Agency

- March 2013: Funds \$1.4 M to Moderna to conduct basic research for proof of concept of an mRNA platform for mosquito-borne illness
- October 2013: Awards Moderna with \$25 M to develop the mRNA platform and conduct animal trials
- 2019: Moderna conducts trials on human subjects
- March 2020: Moderna starts clinical trials for SAR-COV-2
- October 2020: DARPA commits \$56 M to support COVID-19 vaccine development

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The unique role played by DoD program managers is critical for high-risk/high-reward research.





DOD Basic Research Funding: Main Programs

- "Core" grants by OXR (AFOSR, ONR, ARO):
 - Single-Investigator (SI), typically \$200–400K/year; 3 years
 - Designed for exploration, proof-of-concept
 - Proposals address broad research directions, set by DoD PMs
- MURI:
 - Small teams, multiple universities: \$1.5M/year; 5 years
 - Designed to solve hard multi-disciplinary problems
 - New topics each year, written by POs; cross-Service collaboration



"Large teams develop and small teams disrupt science and technology" https://doi.org/10.1038/s41586-019-0941-9

- VBFF:

- Single-Investigator: \$600K/year; 5 years
- Exploring far-reaching, high-risk, and very innovative ideas by top (tenured) faculty
- Broad topics, covering all scientific areas of DoD interest







DoD Basic Research: All the Tools





DoD International Collaboration: Global Benefits

- DoD is one of the few agencies that can directly fund researchers internationally
- DoD is an important driver in defining and setting international scientific and technology collaborations
- DoD funding has positive impacts on scientists globally
 - Winning awards
 - Advancing in government leadership
 - Starting companies
- DoD promotes open science and ethical rules of scientific conduct
- DoD promotes a diverse network of responsible international partners



DoD International Collaboration: STEM

- DoD cares deeply about the nextgeneration workforce
- International outreach
 is critical
- Talent exchange brings new ideas, bridges cultures, builds long-term relationships

Desirable to strengthen / facilitate personnel exchange





DoD International Collaboration: Policies

• Maintain Global Scientific Commons (GSC) – under threat from:

- Opaque national policies
- Inequitable data-sharing practices
- Non-disclosure agreement overreach
- New scientific journals with coercive practices
- Restrictions and rules on publications
- Maintain/strengthen scientific Integrity
- Address ethical concerns: AI, bio-technology, robotics...
- Address global challenges: climate change, social disinformation, resource management...
- and more...



DoD International Collaboration: Some Challenges

Challenge 1 - DoD has unique approach to basic research:

<u>Impact</u> - The traditional partners (MOD) have very different ones leading to potential mismatched expectations/"culture" gap

- The partnering organization may not be the equivalent to DOD <u>Mitigation</u> - It may take time to come to an understanding – dialogue is critical

Challenge 2 - DoD and partner organizations have different structures.

<u>Impact</u> - Confusion regarding authority, approval, funding source <u>Mitigation</u> - Requires frequent explanations or immersion to get over learning curve

Challenge 3 - Mismatched resources

<u>Impact</u> - One size fits all funding strategies may not fit varied requirements

Mitigation - Adaptable mechanisms







DoD International Collaboration: Summary

- Direct research grants
- Joint research teams (e.g., MURI)
- Joint research topics (e.g., BARI): gov.-gov. agreements
- Personnel exchange: sabbatical, fellowship, gov. visits/assignments...
- Joint policy agreements

We are in a highly connected world, and breakthroughs can occur anywhere, any time

We are always open to discussions





Thank You

- Additional Information:
 - OSD Basic Research:
 - https://basicresearch.defense.gov/About/
 - Air Force International:
 - https://www.afrl.af.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2282097/afosr-worldwide-offices/
 - Navy International:
 - https://www.nre.navy.mil/organization/onr-global
 - Army International:
 - https://arl.devcom.army.mil/collaborate-with-us/opportunity/international-collaborations/