NDSU | NORTH DAKOTA STATE UNIVERSITY

Celebrating the Present and Focusing the Future:
Research, Creative Endeavors, and Innovation at NDSU

Kelly A. Rusch, Ph.D., P.E., BCEE
Vice President - Office of Research and Creative Activity
Executive Director - North Dakota EPSCoR

June 4, 2018, Mayville State University,

NDSU's Position - Present and Future

- Research Landscape
- Creating Solutions to Complex Problems
- Nontraditional Funding Sources
- Faculty and Students
- Institutional Core Facilities
- Economic Development

Research Landscape

Research is an ecosystem that advances scientific inquiry, learning, and innovation

Research is core to a university's mission

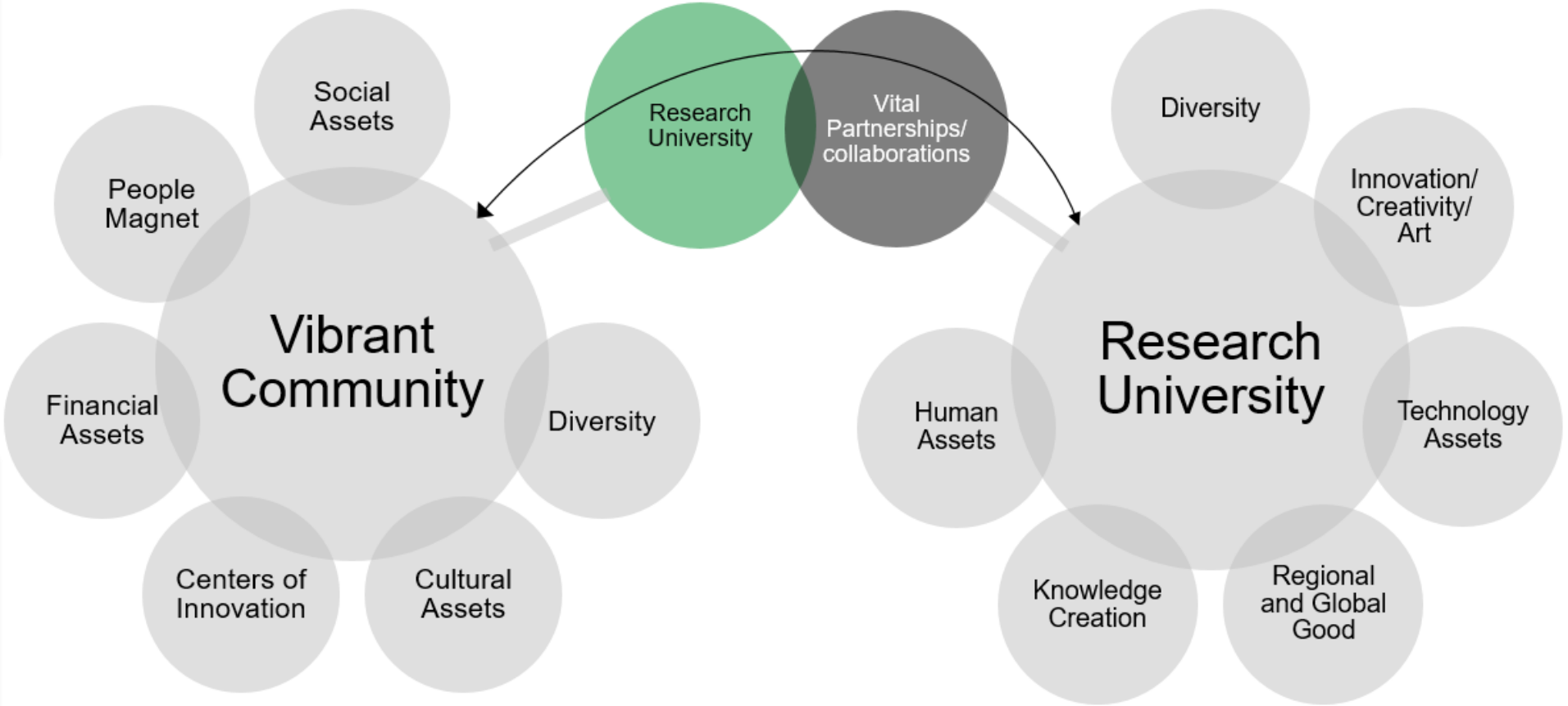
- Enhances student learning, retention and success
- Fosters faculty excellence
- Drives discovery and new knowledge [basic]
- Provides solutions to meet societal needs [user-inspired basic and applied]
- Facilitates knowledge/technology transfer
- Cultivates innovation
- Guides cultural learning

An ecosystem of deep thinkers, communicators, and collaborators

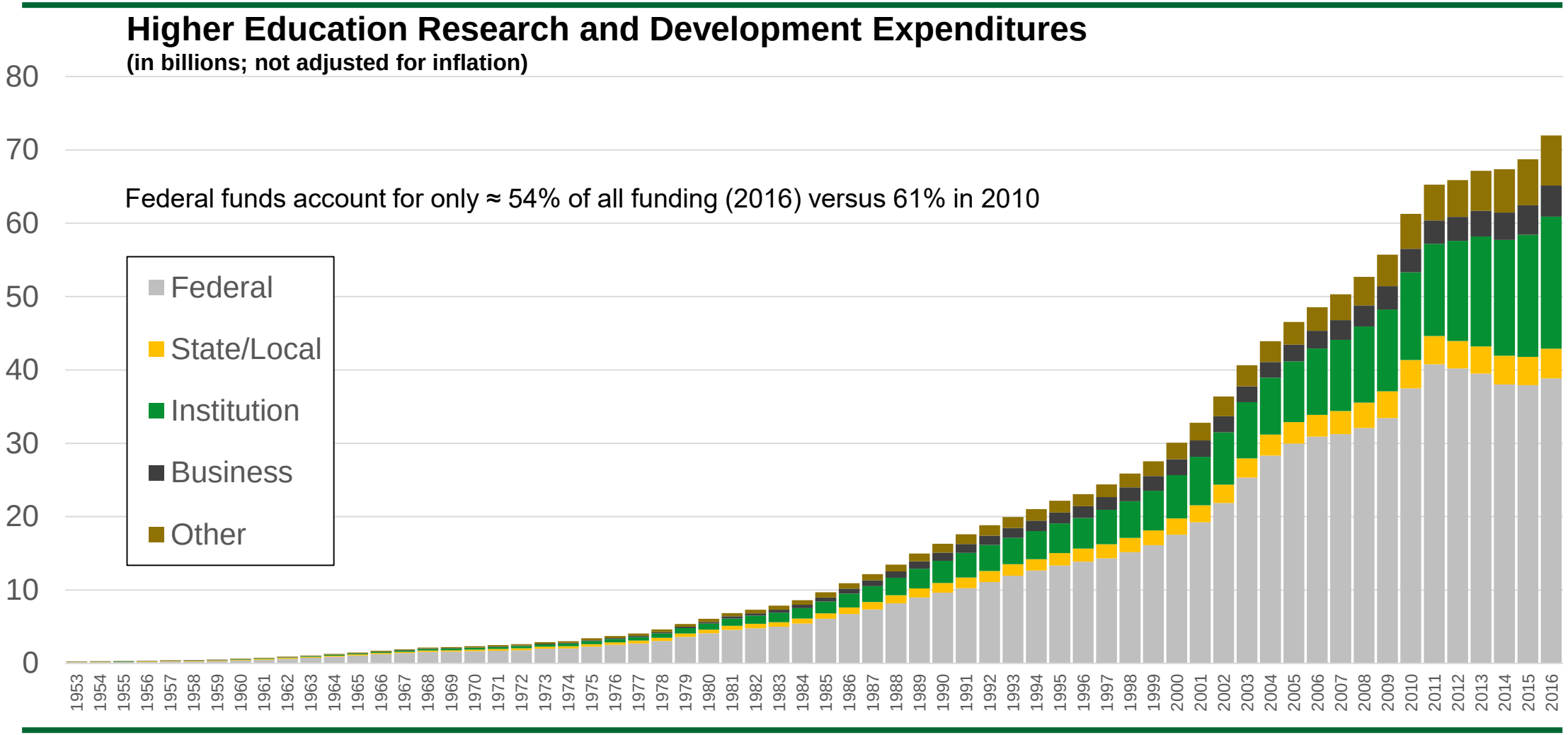
Today's Higher Education Landscape Relies on Strong Partnerships between Communities and Universities

Change is the new normal - need to be contemporary and non-traditional in strategies to move forward

Innovation, agile, hub, networks, partners, entrepreneur, changed boundaries, fluidity, systems thinking, flexibility, actionable data, courage, synergy, adaptive, trust

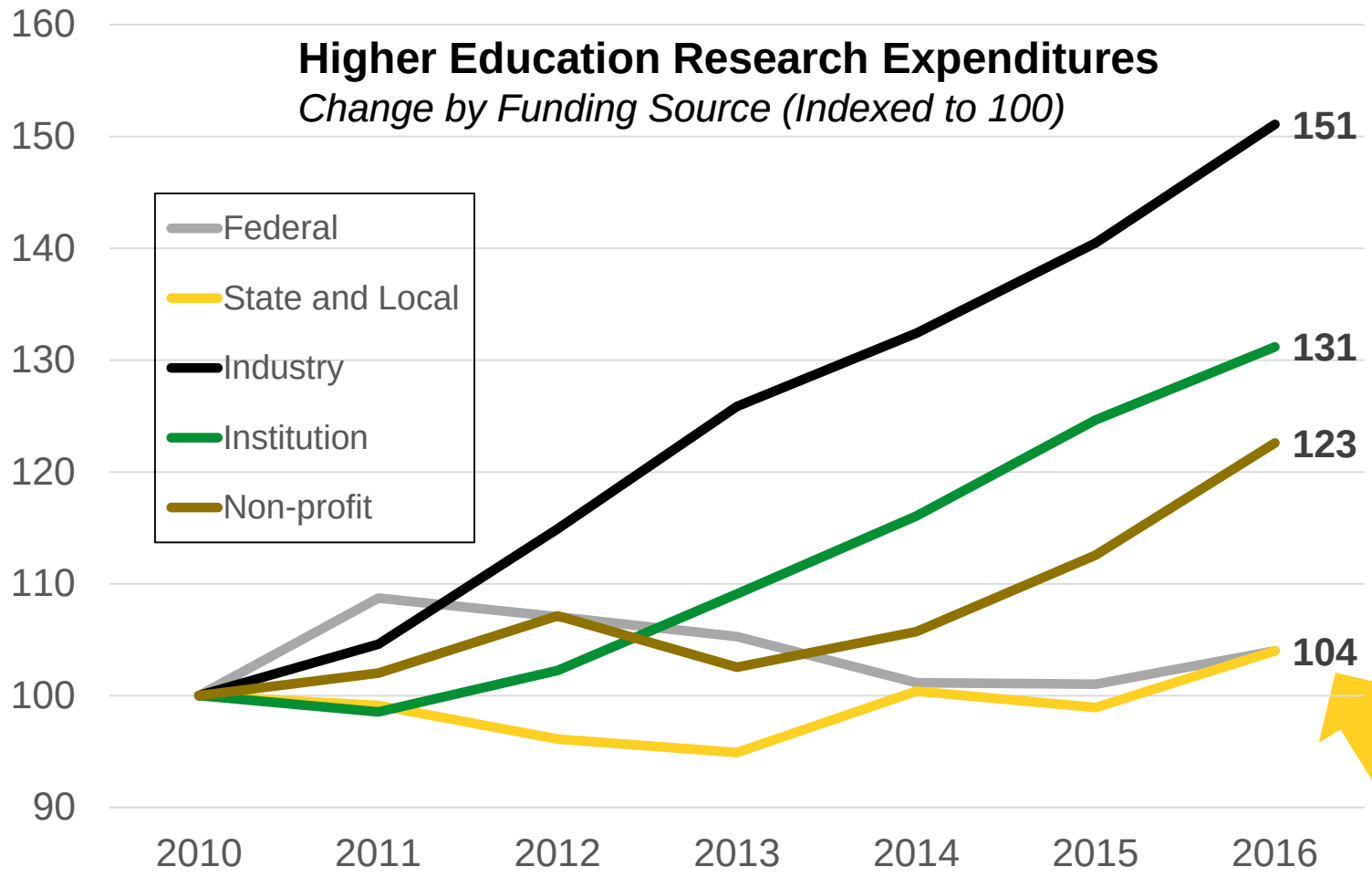


The Landscape has Changed



Source: NSF Higher education R&D expenditures, by source of funds: FYs 1953–2016

The Landscape has Changed



Implications & Opportunities

- Institutional funding - unstable
- Federal agencies – look for diversification opportunities
- Industry – opportunities exist
- Nonprofits – opportunities exist [including philanthropy]

Actions

- Support and training for researchers to pursue nonfederal funding sources – more outcomes based
- Align strengths with new federal opportunities
- Strengthen G-U-I-F partnerships

$ for basic research dropped from 68% to 64% (2010 vs. 2016)
$ for applied research increased from 25% to 28% (2010 vs. 2016)

Source: EAB, 4 Things CROs can Learn from Higher Ed R&D Survey, January 30, 2018

Today's Greatest Challenges are More Complex

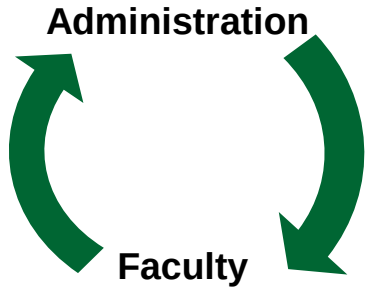
- How we think about faulty hires

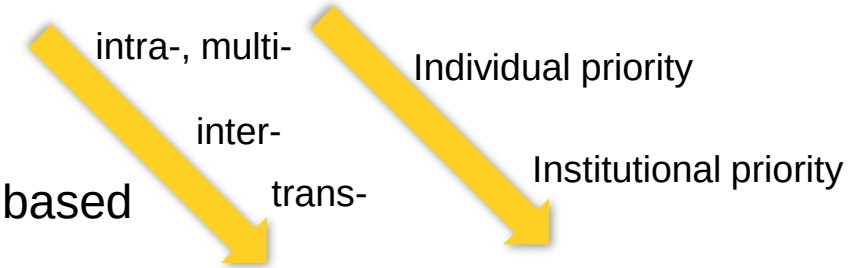
term partnerships

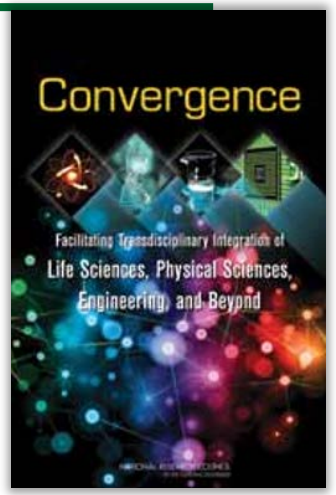
Moving University Research Forward

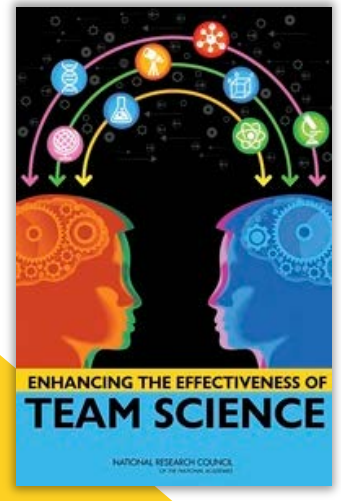
Individual investigation will always be an important part of an university, but it can no longer alone sustain the research enterprise

- Financially
- Problems are growing too complex
- Public pressure for impact and benefit
- Alternative funding sources are outcome based





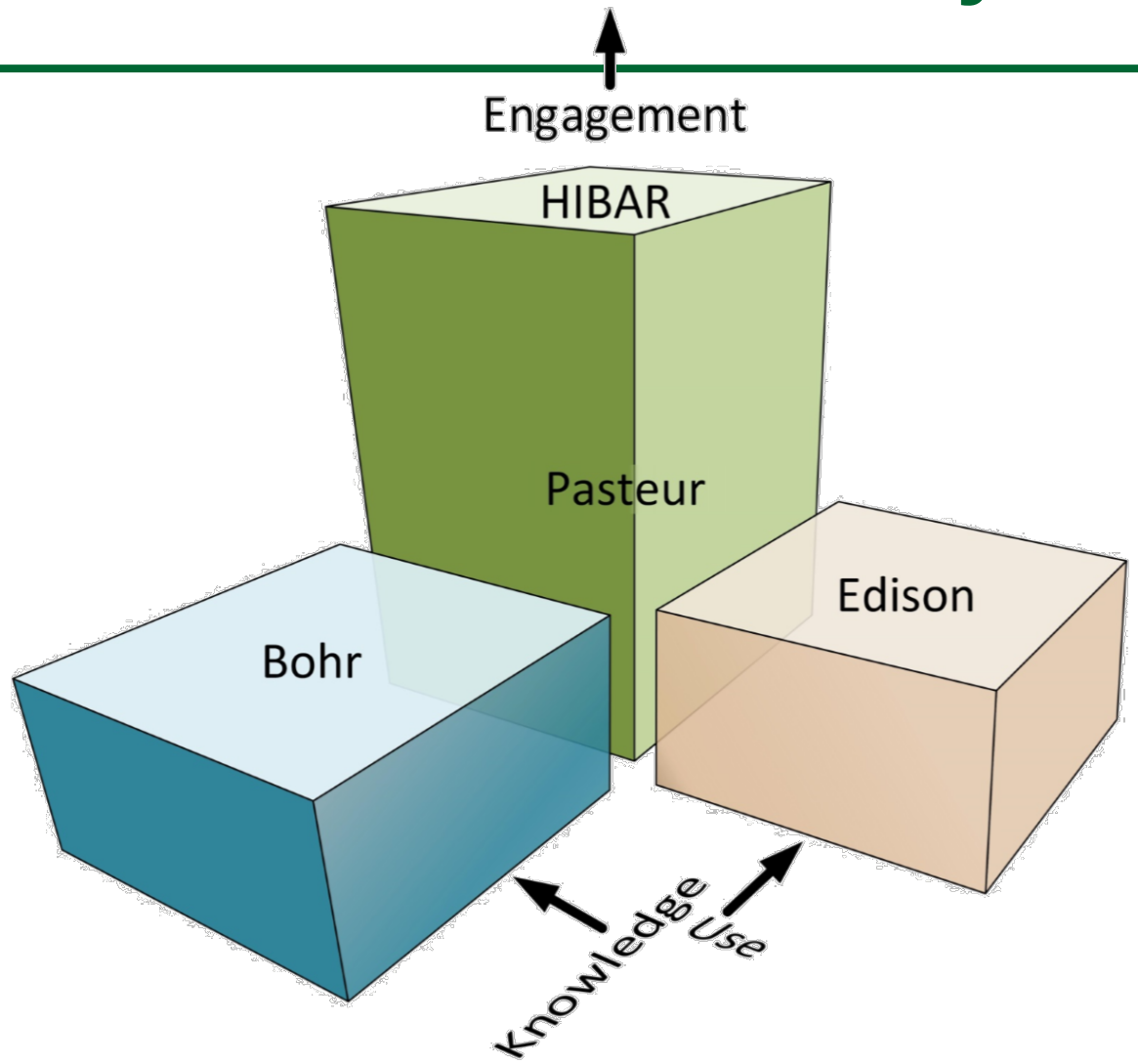




Basic research is a bedrock of the research enterprise

How do we catalyze and develop collaborations to create sustainable and impactful efforts?

New Pathways Forward



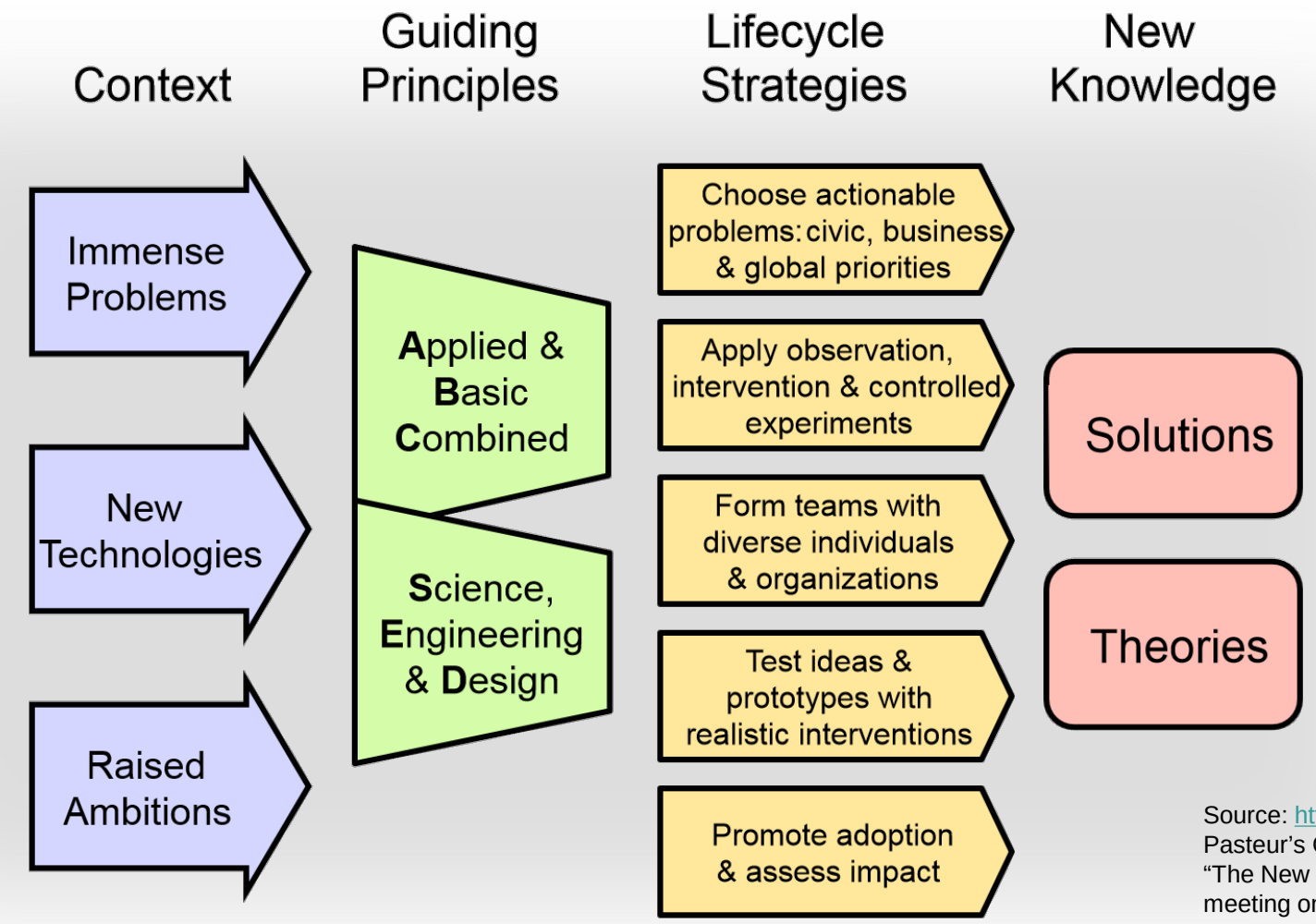
Research, Science & Technology

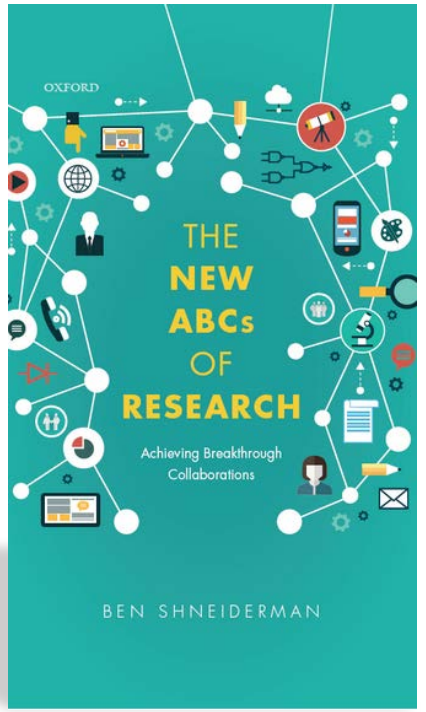
HIBAR: Transforming Research

The Highly Integrative Basic and Responsive (HIBAR) Research Alliance is a network of research leaders who believe that universities can improve research outcomes and increase benefits to society by engaging theory with practice for transformative solutions.

Source: Whitehead, L. “HIBAR Research and Grand Challenges – Introductory Remarks” presented at APLU, November 12, 2017

The New ABCs of Research

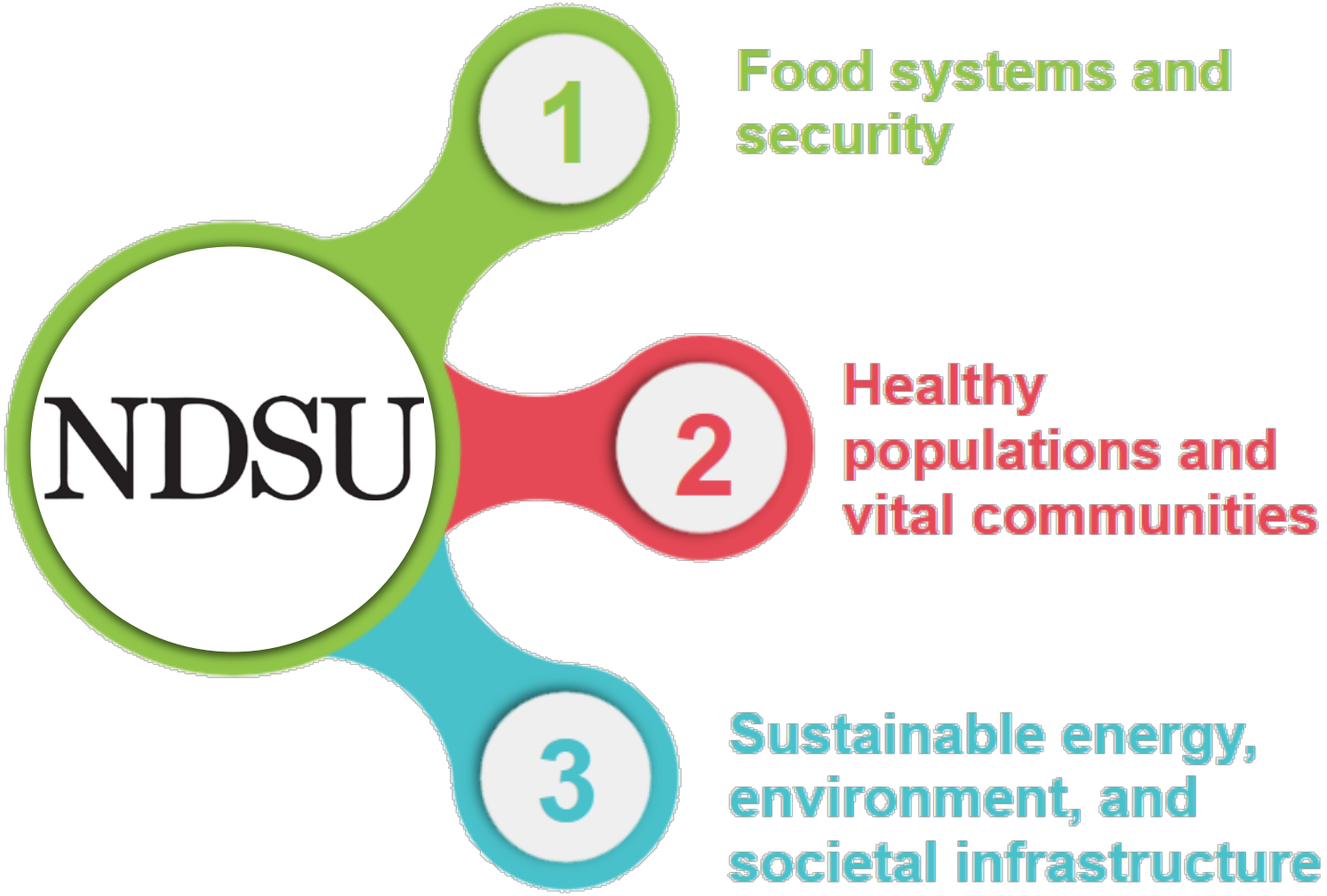




Source: http://www.aplu.org/members/councils/research/; Stokes, D.E. 1997. Pasteur's Quadrant – Basic Science and Technological Innovations; Schneiderman, B. "The New ABDCs of Research" presented at Coalition for Networked Information meeting on 12/13/16

Creating Solutions to Complex Problems

Creating Solutions to Complex Problems



Nanotechnology for Healthier Food

STUDY: Center for Technology Research for Agricultural Food Safety and Security under Changing Global Climate

- Approximately 2 million people across the globe suffer from iron deficiency with the majority being women in reproductive age
- This study has produced tangible results in terms of producing new nano-based fertilizers that can fortify crops with Fe, Zn, and Se (much needed micronutrients in human diet)

Center for Engineered Cancer Test Beds

Challenge

Current drug delivery techniques do not work once cancer has metastasized. Developing new drug delivery therapies is very time consuming.

Solution

Develop and implement engineered cancer test beds combined with advanced scientific modeling to reduce development time of new drug therapies

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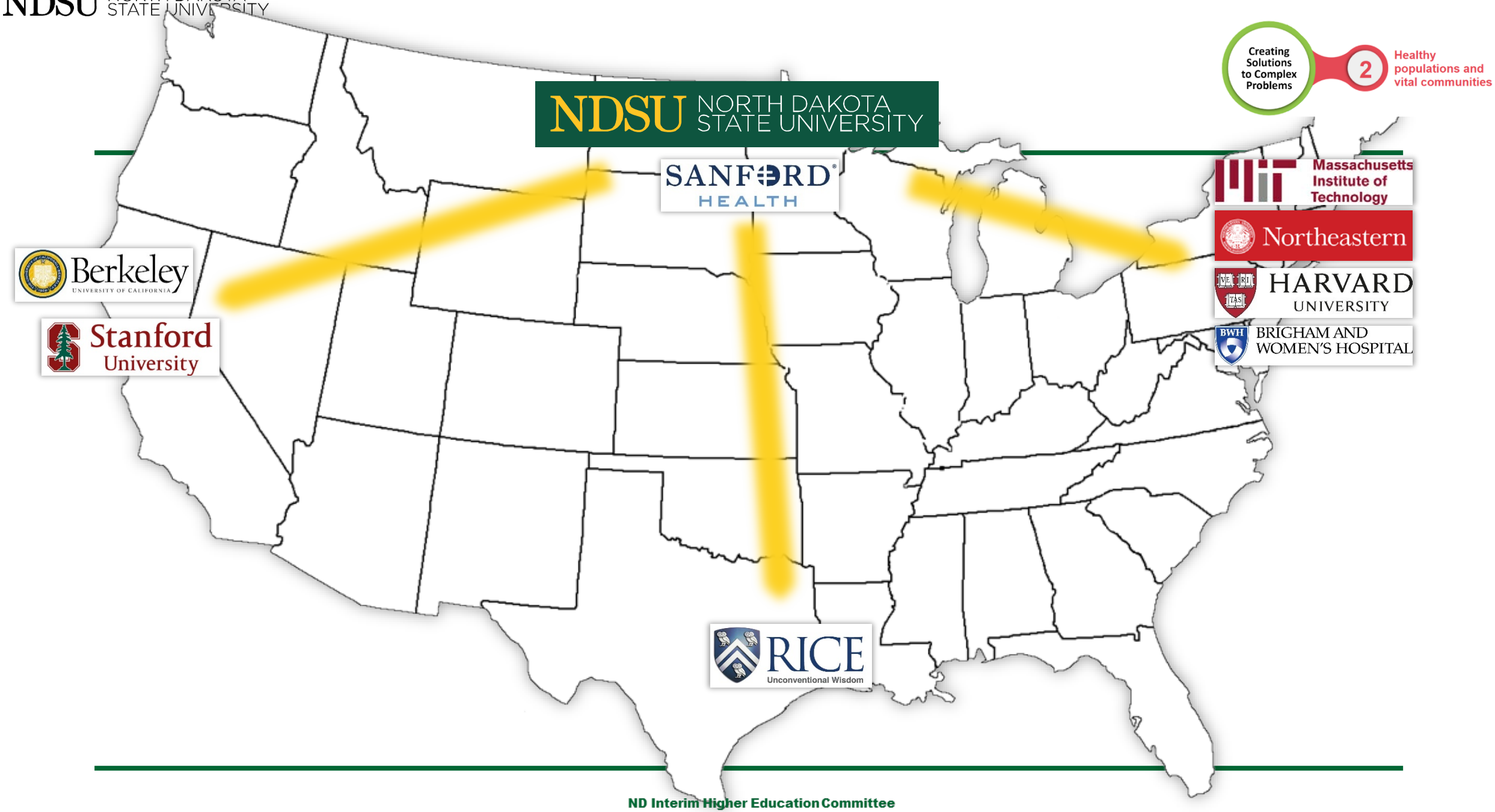
Center for Engineered Cancer Test Beds

Creating Solutions to Complex Problems 2 Healthy populations and vital communities


Creating Solutions to Complex Problems
2
Healthy populations and vital communities
NDSU NORTH DAKOTA STATE UNIVERSITY
SANFORD HEALTH
Berkeley UNIVERSITY OF CALIFORNIA
Stanford University
Massachusetts Institute of Technology
Northeastern
HARVARD UNIVERSITY
BWH BRIGHAM AND WOMEN'S HOSPITAL
RICE Unconventional Wisdom

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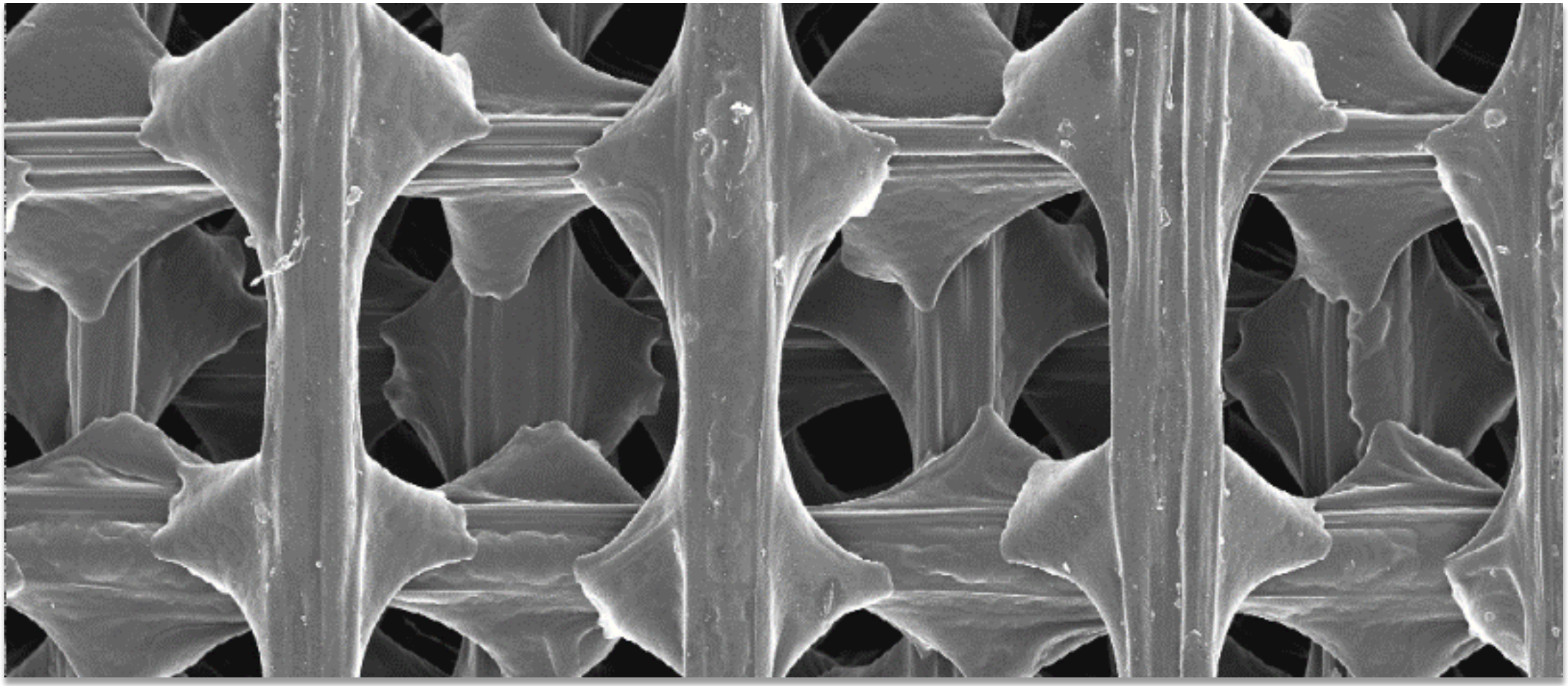
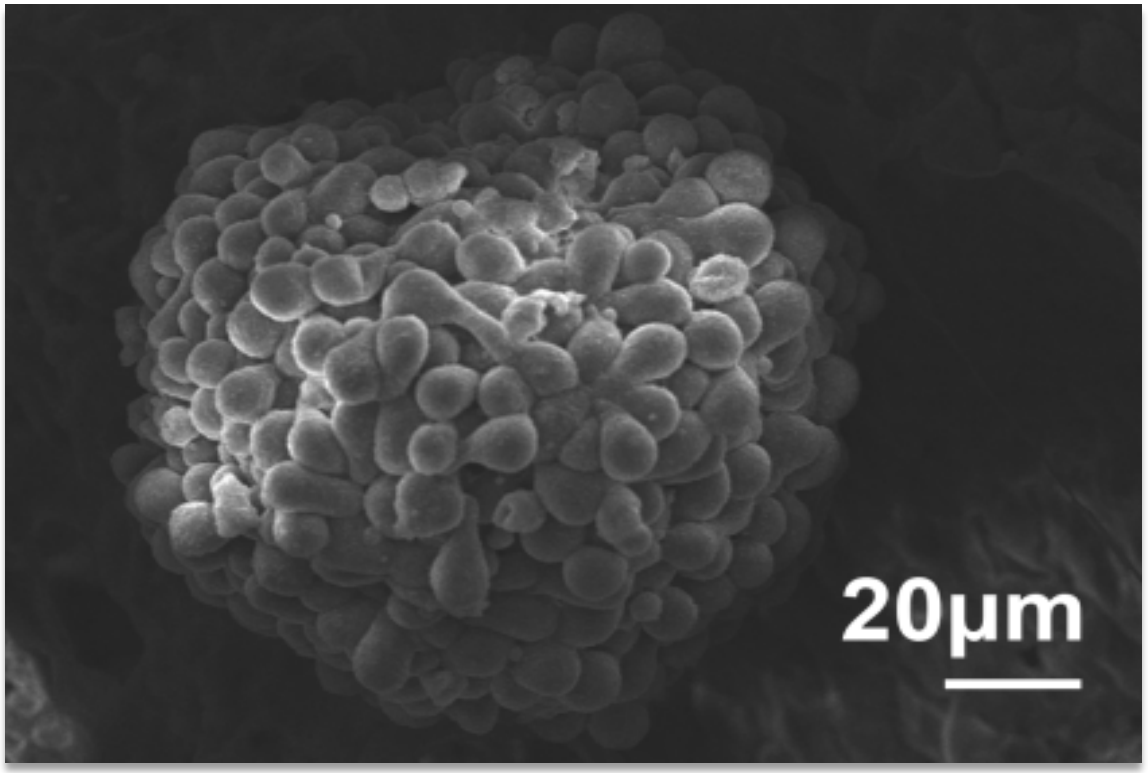
Center for Engineered Cancer Test Bed

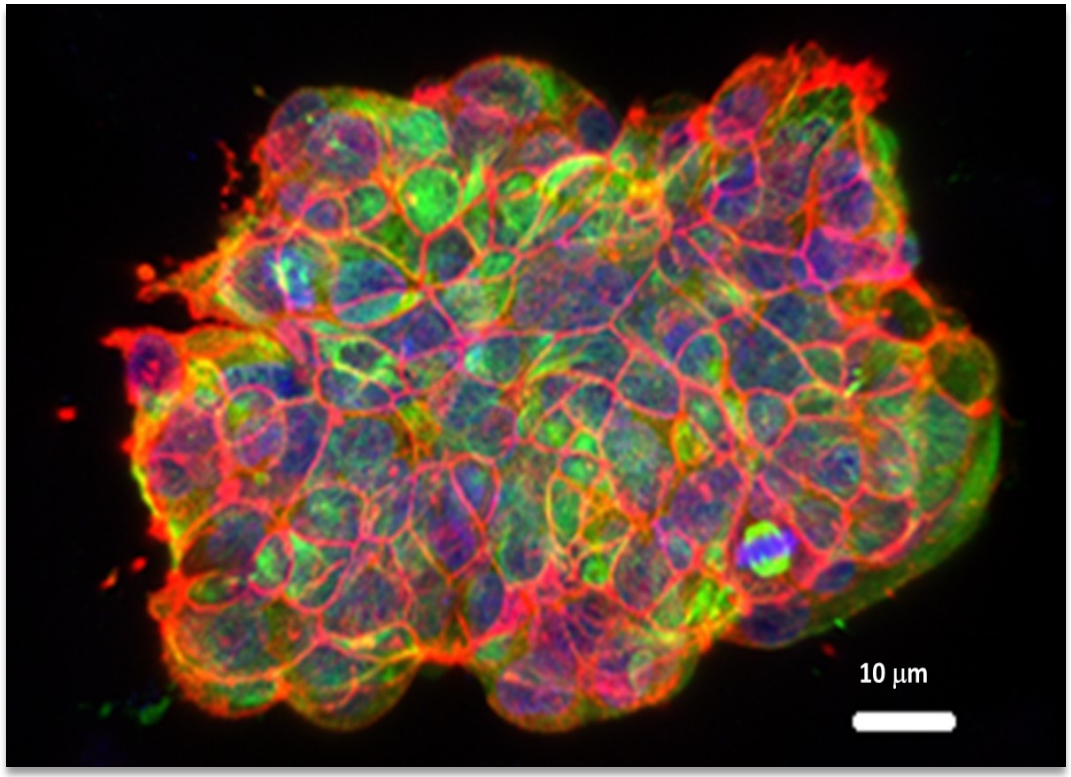
Creating Solutions to Complex Problems

2 Healthy populations and vital communities



In vitro Creation of Prostate Cancer Metastasis

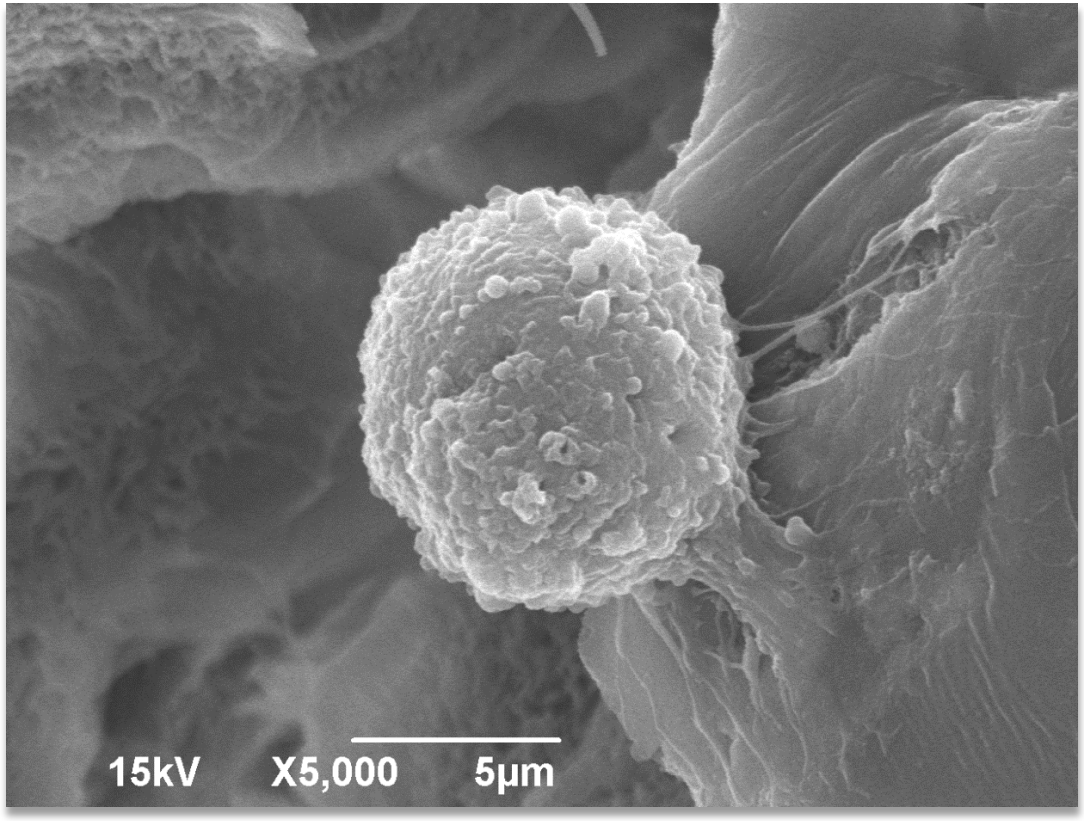


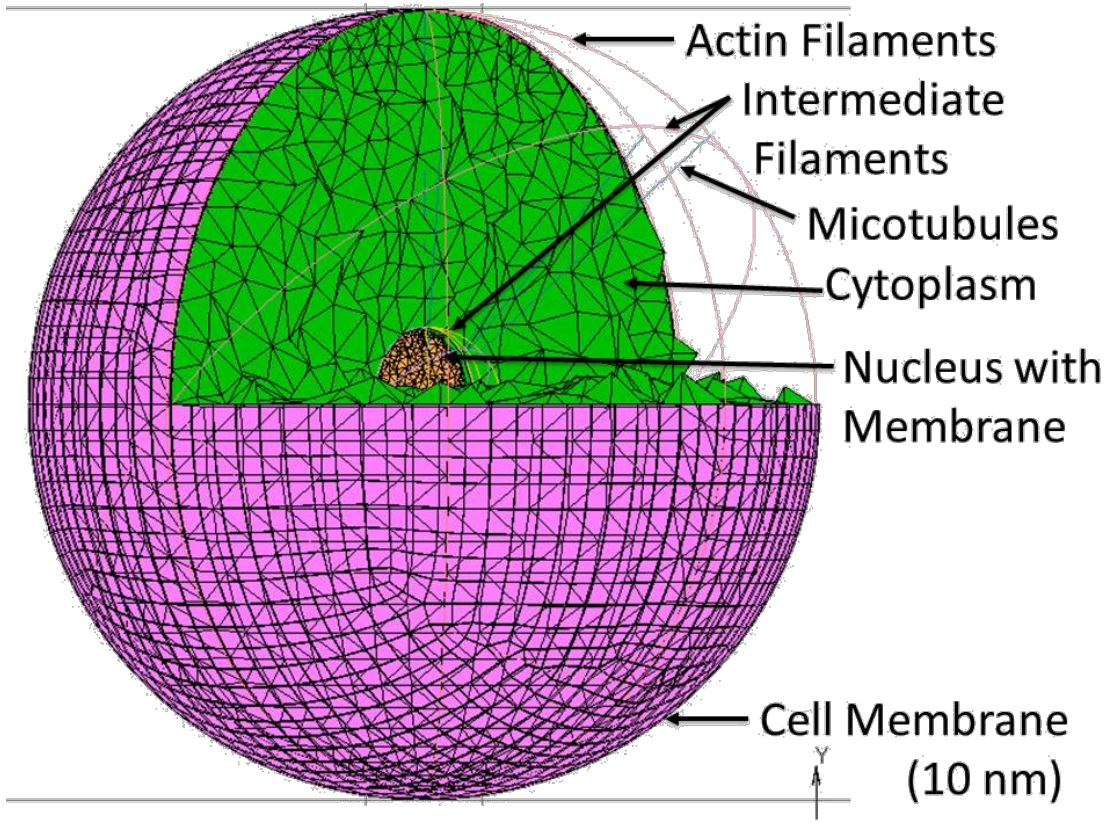


Prostate cancer tumor on bone site - Different components of cytoskeleton in a tumoroid

Katti KS., Molla MD S, Karandish F, Haldar MK, Mallik S and Katti DR, Journal of Biomedical Materials Research A, 2016; 104(7):1591–1602

Single Cancer Cell on Scaffold





Katti, D., and Katti, K. (2017). "Cancer cell mechanics with altered cytoskeletal behavior and substrate effects: A 3D finite element modeling study." **Journal of the Mechanical Behavior of Biomedical Materials**, Volume 76, Pages 125-134

Creating Solutions to Complex Problems

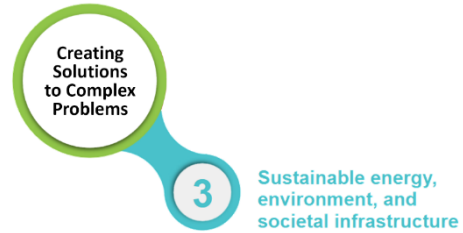
3 Sustainable energy, environment, and societal infrastructure

NDSU INSTITUTE FOR CYBER SECURITY EDUCATION AND RESEARCH

LEADING THE HERD

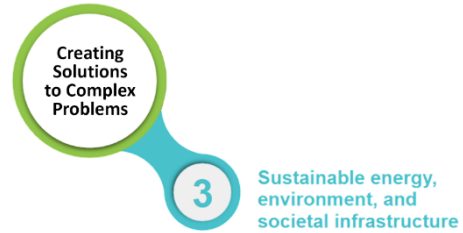
Sharing strategies, best practices, and innovative solutions to address today's challenges in cyber security

Cybersecurity Research Capabilities at NDSU



- Cyber range operational
- Contained and secure experimental facility
- First of its kind in North Dakota
- Remotely accessible from anywhere in state
- Supports a wide range of experimental cybersecurity research
- 100+ experimenters can simultaneously use the Cyber Range
- Containment technology to avoid experiments running out of control
- Project on secure storage to ensure privacy of records is underway
- Support from Department of Defense, Cisco, NDSU ITD

Graduate Certificate in Cyber Security



- Collaboration with Minot State University, the University of North Dakota, and NDSU to provide a graduate certificate in cyber security
- Provides students a broad foundation of cyber security training
- Composed of three core courses, one at each of the collaborating institutions, and one elective course
- Designed for working practitioners or to be pursued concurrently with other graduate studies

NDSU UAS Projects

College of Agriculture, Food Systems, and Natural Resources, Experiment Station, and Extension Service

Remote sensing in precision agriculture

- Plant emergence and populations
- Nutrient management
- Weed and pest infestations
- Disease detection
- Livestock management

Department of Visual Arts

Aerial Photography Course Offered first time fall 2017

Department of Geosciences

Researchers use unmanned aircraft for survey of a rock glacier in Great Basin National Park

Department of Biological Sciences and USDA National Wildlife Research Center

Researchers studying use of UAS as a nonlethal hazing tool to disperse flocks of blackbirds from sunflower fields

Photograph by Dr. Page Klug

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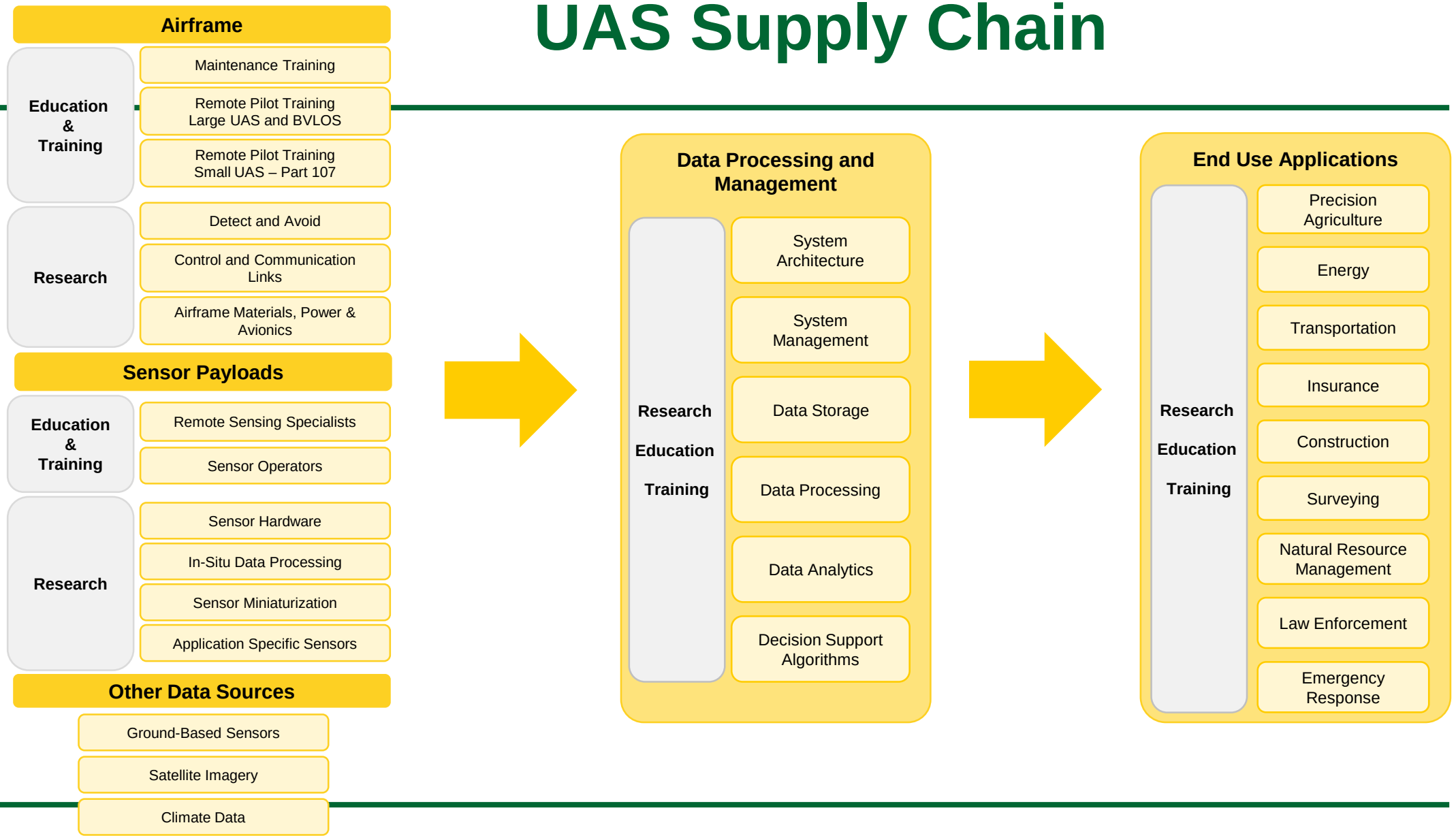
UAS Supply Chain



Nontraditional Funding Sources

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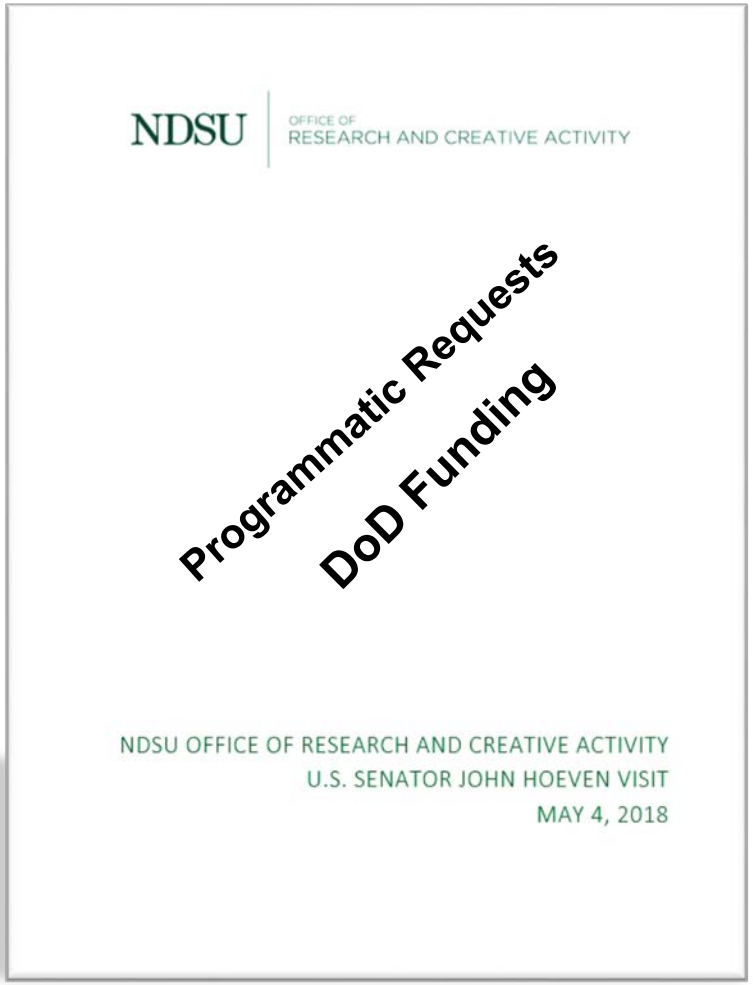
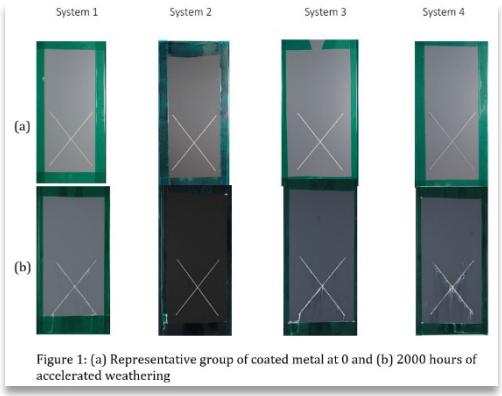
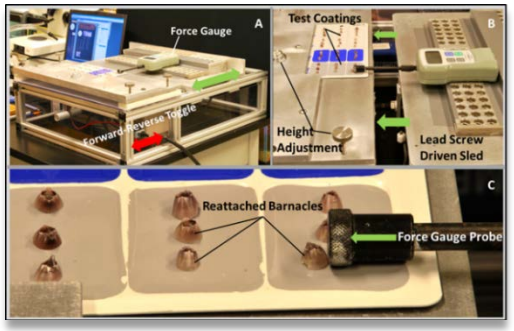
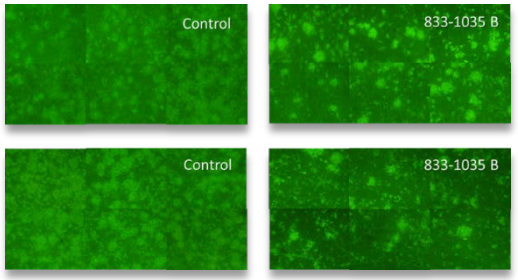




Integrated Corrosion Testing System



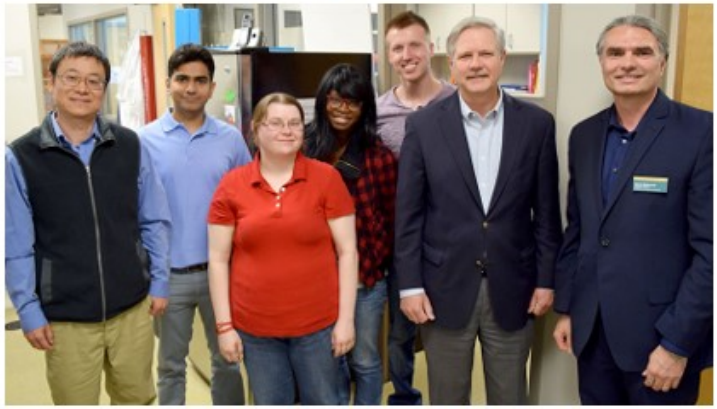
Development of amphiphilic, siloxane-based fouling release coatings

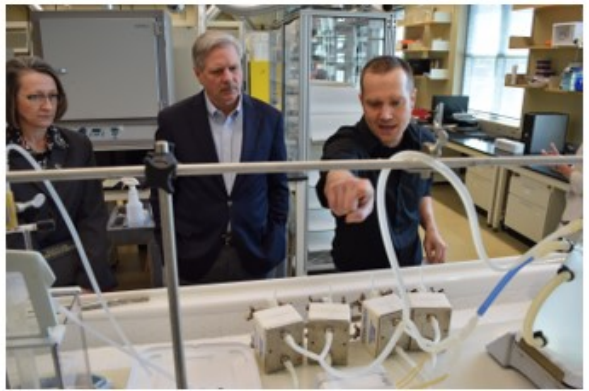


Gray water fouling research

High performance bio-based non-isocyanate polymer material systems


BIOHAZARD





Faculty and Students

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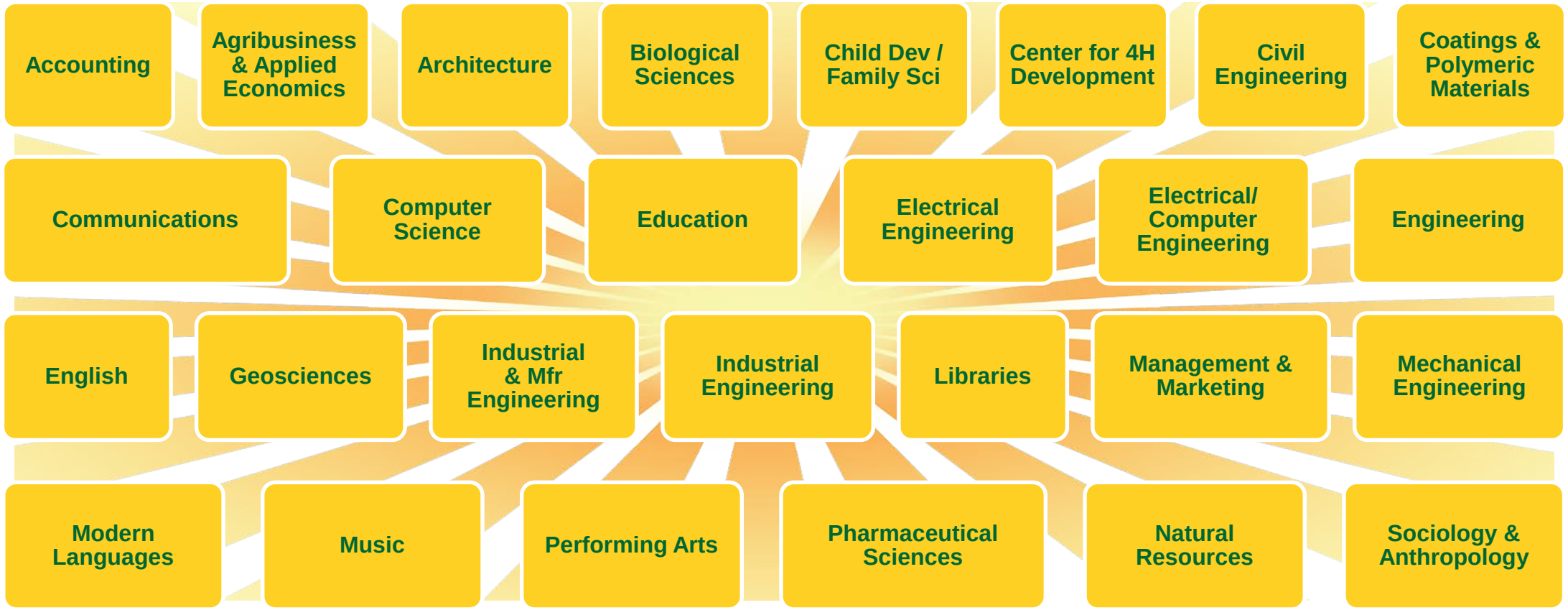
Building Critical Mass of Faculty

Tenured/tenure-track academic hires by college July 2016 - June 2018



Graduate Student Research Achievements

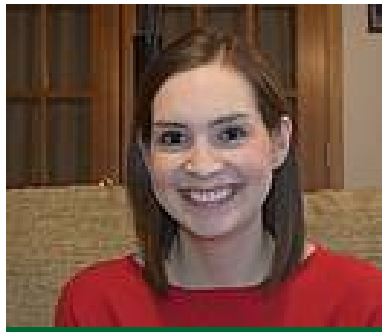
Jackie Stenehjem's research predicts mosquito breeding habitat areas

Pharmaceutical sciences graduate student Farnaz Fouladi wins Three Minute Thesis competition

Mihiri Mendis' paper is one of the most viewed on the American Association of Cereal Chemists website

2018 National Science Foundation Graduate Research Fellow Kurt Williams

Maneka Malalgoda wins the 2017 Walter Bushuk Graduate Research Award in Cereal Protein Chemistry

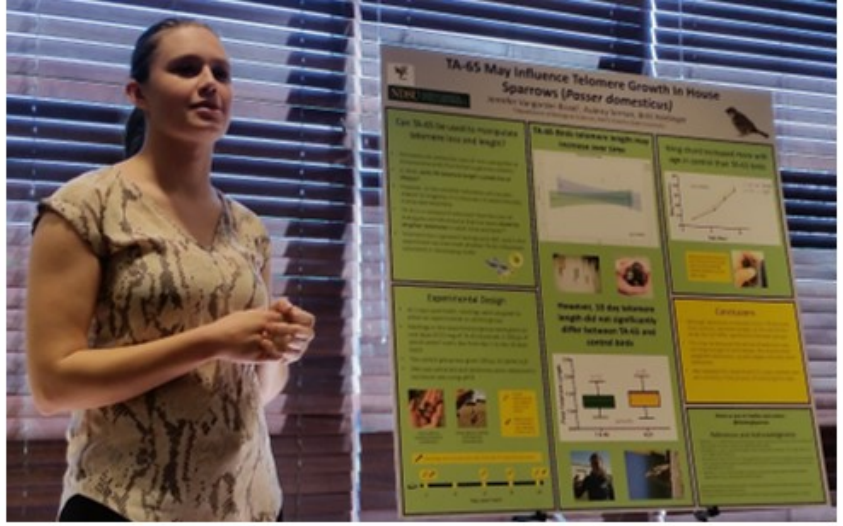


Shelly Davis awarded Northwest Native American Research Centers for Health fellowship

Why Undergraduate Research?

- Promotes the development of critical thinking and problem solving skills
- Provides opportunities for networking and public speaking
- Offers a powerful career development opportunity
- NDSU undergraduates who engage in research report significantly higher levels of satisfaction with their overall academic experience, a better connection to faculty, and an increased feeling of being valued on campus


Top 10
5. DO NOT BE AFRAID TO ASK QUESTIONS.
4. Much of research is failure, be patient.
3. There are ups and downs
2. How great the experience is! I would have started earlier!
1. It's a large time commitment


TA-65 May Influence Telomere Growth in House Sparrows (Passer domesticus)


NDSU
1:11
Monday, April 16


EXPLORE

NDSU Explore

A program dedicated to promoting undergraduate research at NDSU

- Annual showcase of undergraduate research and creative activities
- Funding for undergraduate research projects
- Undergraduate research week filled with opportunities for professional development.

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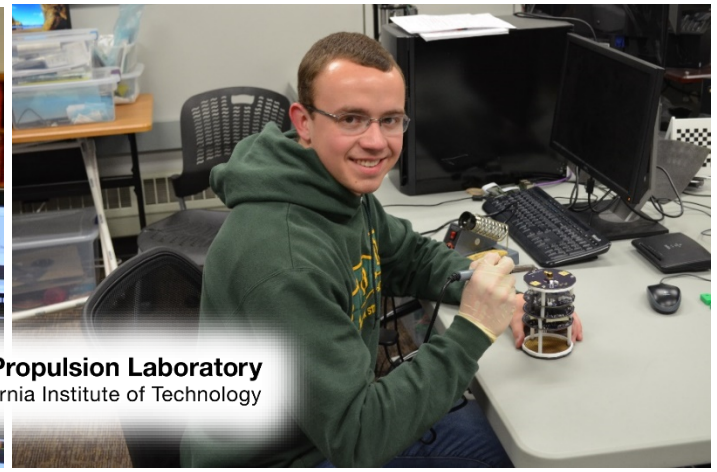
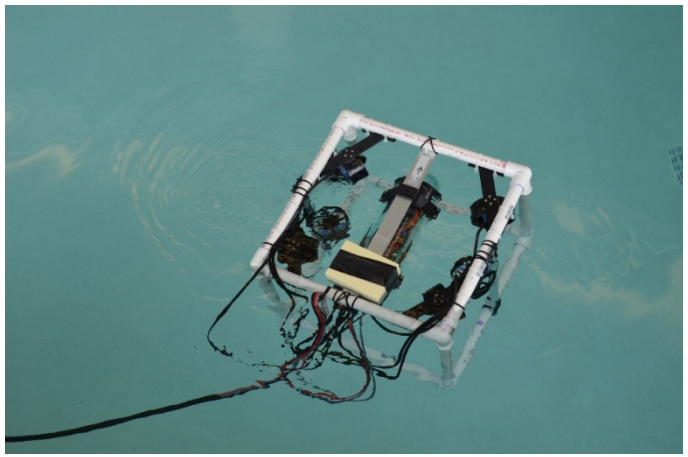
Undergraduate Research Projects





Undergraduate Research
Space – JPL Research Management

- Project in conjunction with NASA JPL research staff
- NDSU students working to develop a prototype system that will help JPL provide research opportunities for students nationwide
- Multi-phase project
  - System research / design / development
  - Testing and benefit characterization
  - Refinement and repeat assessment

Jet Propulsion Laboratory
California Institute of Technology

Engineering Grand Challenge Scholars Program

Goal: create the next generation of innovators and entrepreneurs

- Students recruited freshman year – an honors program
- Mentored by faculty though entire academic career
- Currently 15 scholars working on cutting edge research
- NDSU's program is one of only 36 in country

Institutional Core Facilities

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Institutional Core Facilities at NDSU

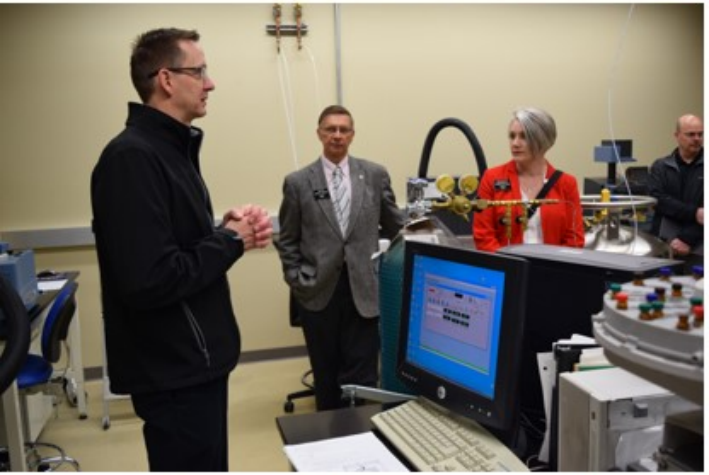
The NDSU Institutional Core Facilities provide centralized shared university resources including instruments, labs, and expertise to support research, education, and economic development.

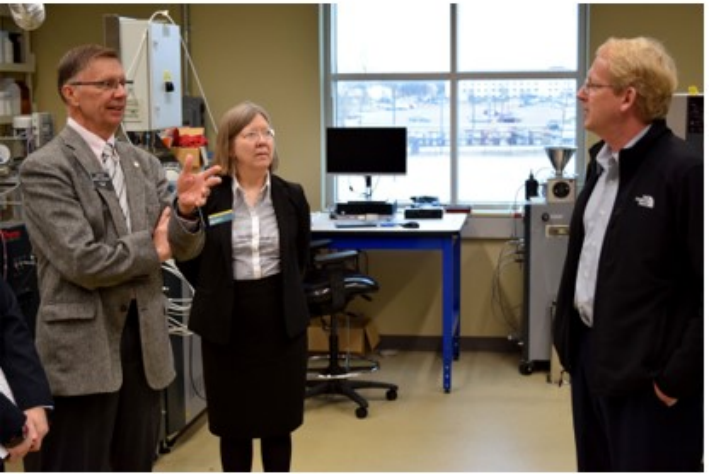
Center for Computationally Assisted Science and Technology (CCAST)

Online equipment database

Electron Microscopy Center

Research Operations





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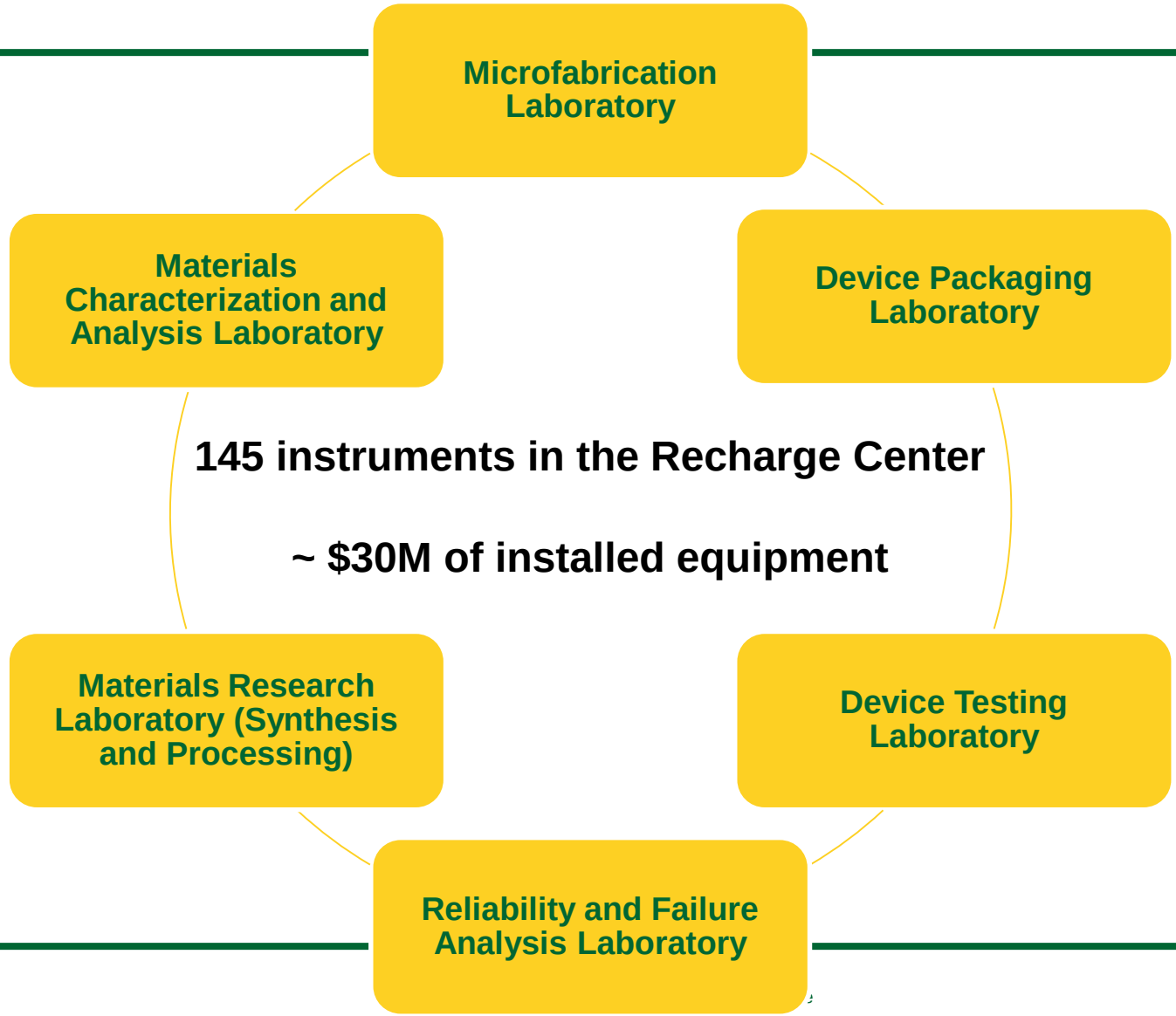
Research Operations Recharge Center



Research Operations Recharge Center Impact

9,960 Samples Processed

4,872+ Hours of Equipment Use

1200+ gallons synthesized in material scale-up reactors

75 Internal Users

3 NDSU Colleges from 10 Departments

15 External Users Entities

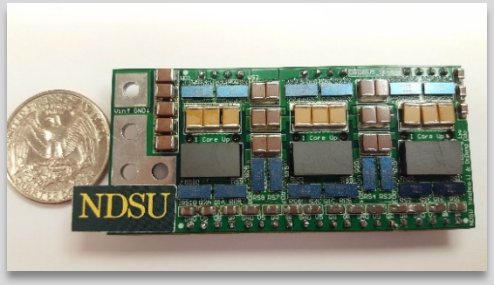
12 Private Sector, 3 Academic

Lab Sessions Provided for 3 Academic Courses

July 2016 – June 2017

Research Operations Recharge Center Projects

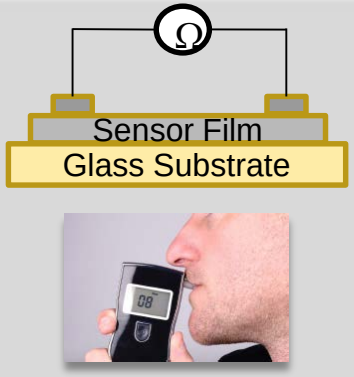
NDSU power electronics research group investigating ultra-efficient power delivery architectures for data centers and solar farms. Collaboration with Google.



High Density Power Delivery Prototype Assembled in cleanroom

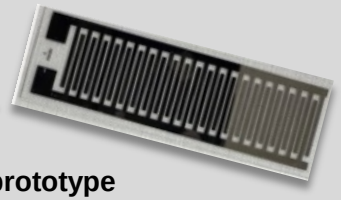
NDSU researcher developing soy-based material for road dust control applications. Applied to segment of Cass County rural road for testing.

Scale-up reactor vessels to produce pilot project volumes.



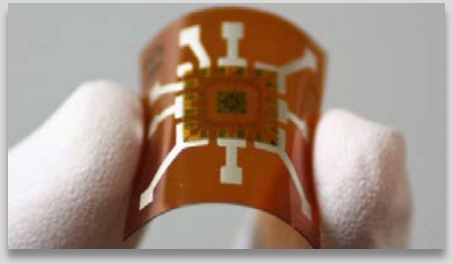
Conceptual Product

NDSU nanomaterials sensor research group developing sensor to quantify acetone in breath as an indicator of Type 1 diabetes.



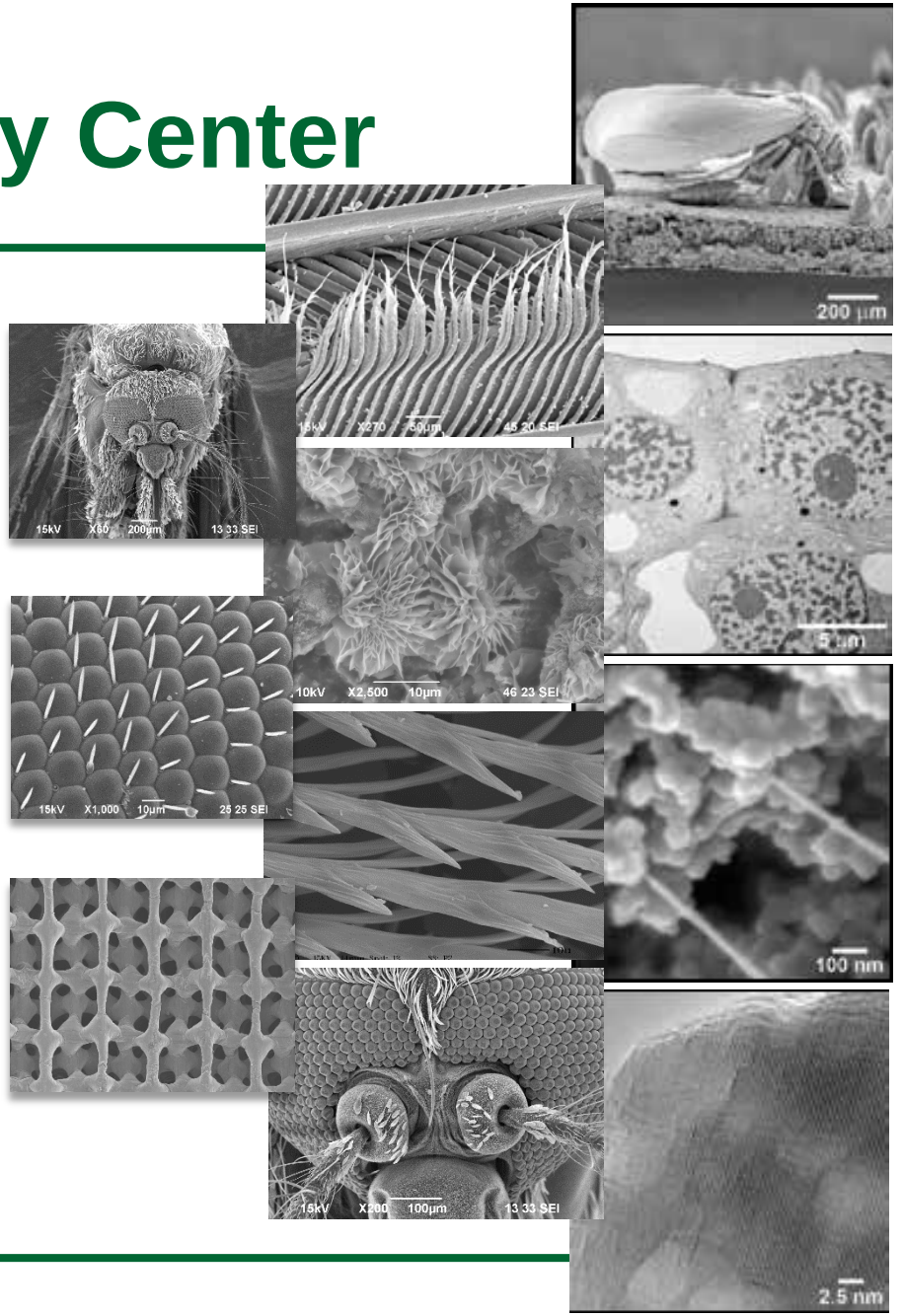
Sensor prototype fabricated in cleanroom

Uniqarta Inc., a start-up company is developing innovative new electronic manufacturing technology for microLED display and other electronic markets. Licensed NDSU technology and utilize NDSU cleanroom on fee basis.

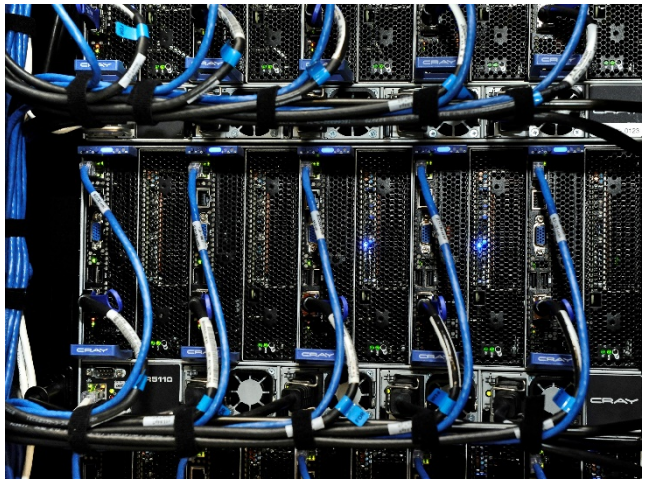


Electron Microscopy Center

- Facility provides researchers electron microscopy services from project design to publishable data
- Imaging and analysis of a wide variety of samples types from biological to materials
- Only electron microscopes and x-ray MicroCT available to all institutions in the NDUS with expert Electron Microscopy support
- Most effective and efficient model for high-cost electron microscopy instrumentation



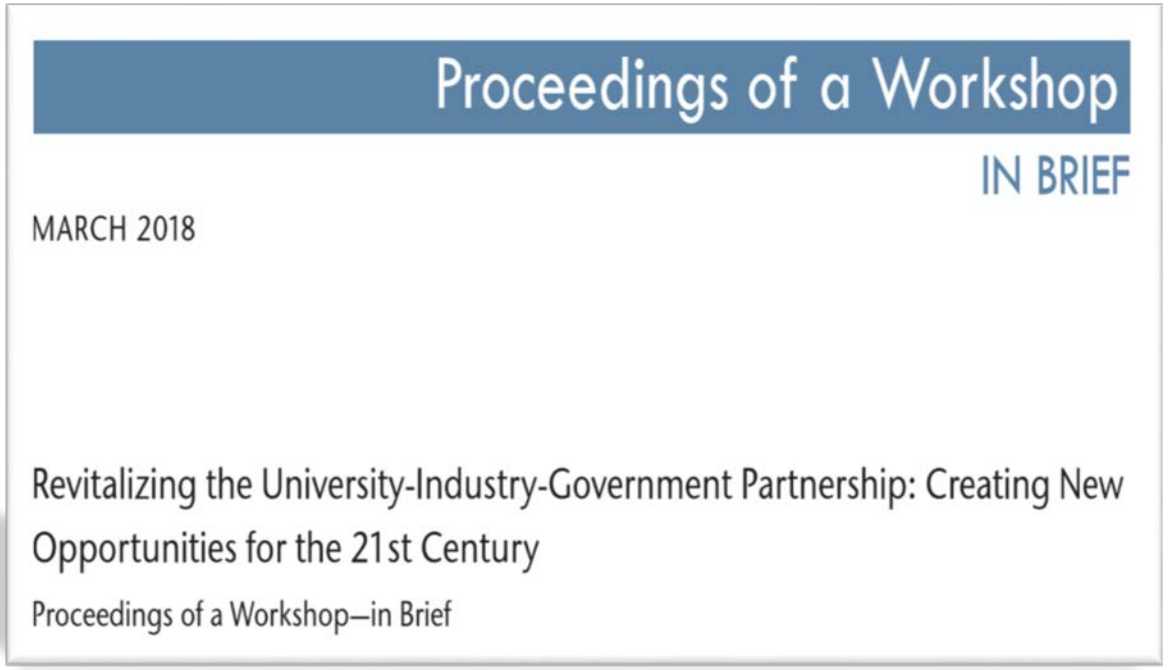
NDSU Center for Computational Assisted Science and Technology (CCAST)

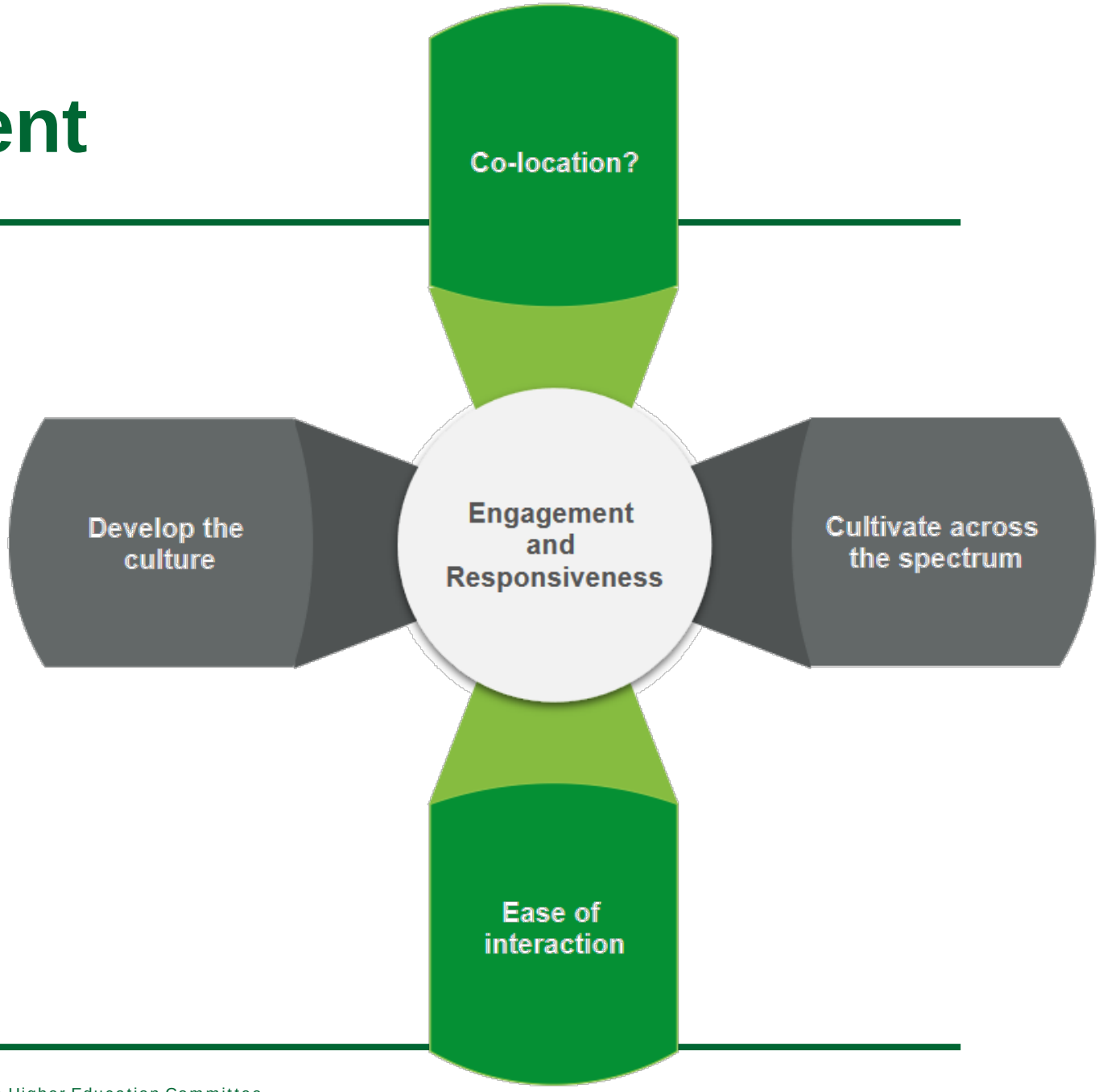


Economic Development

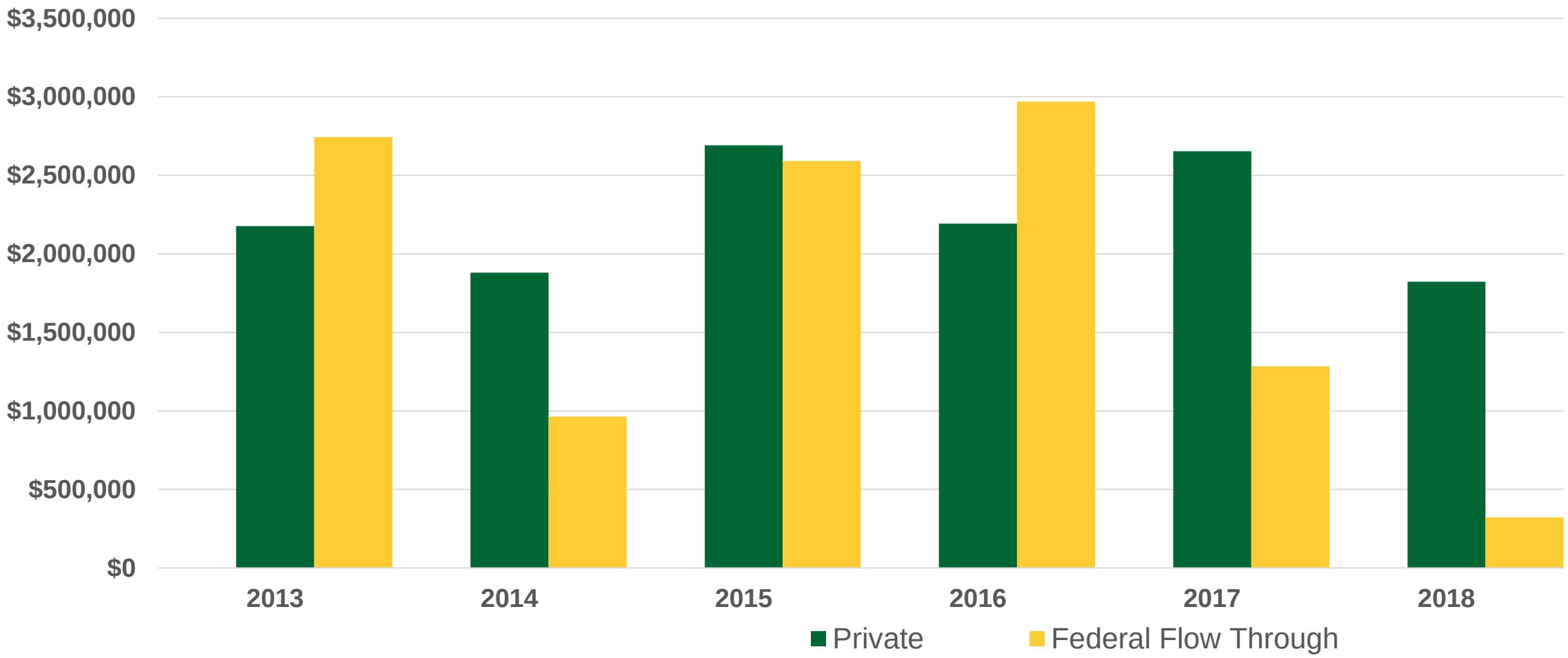
Economic Development

Engage with authenticity

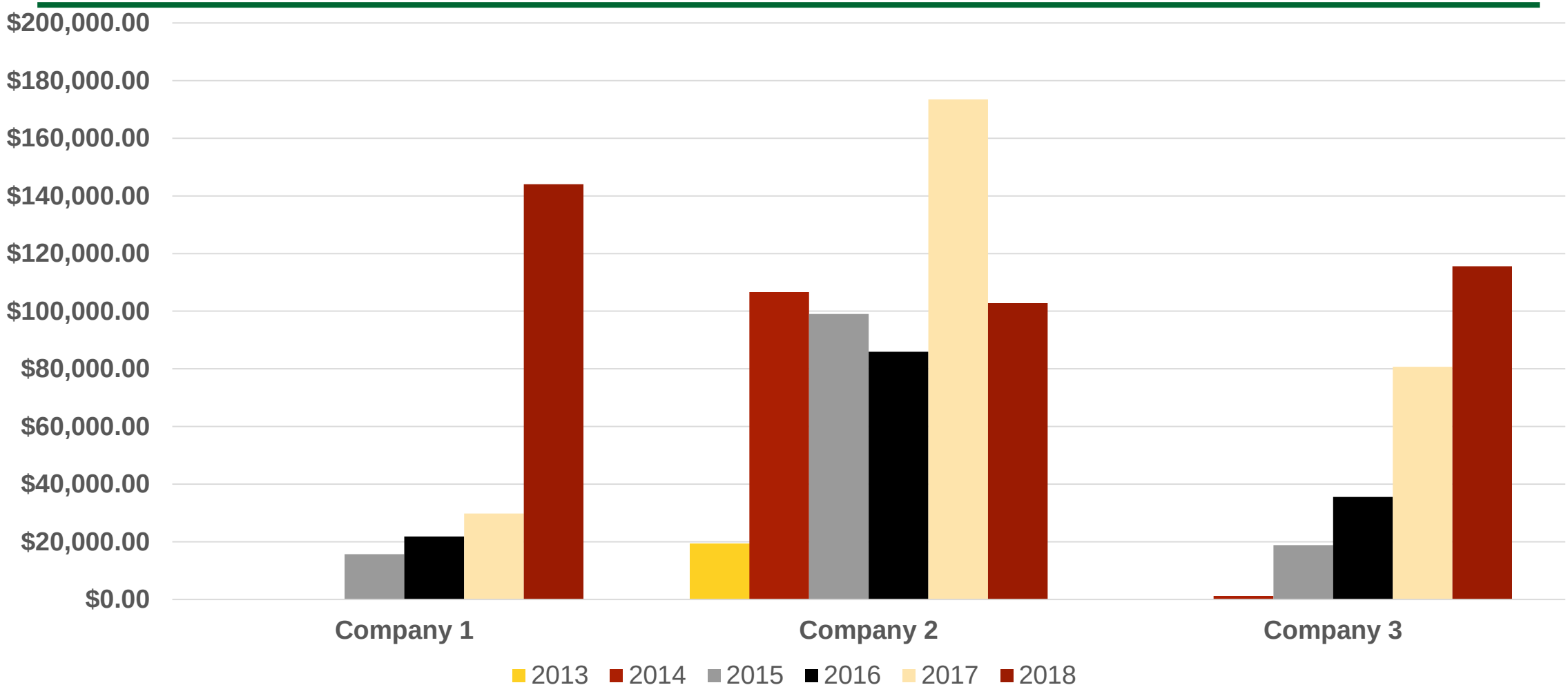




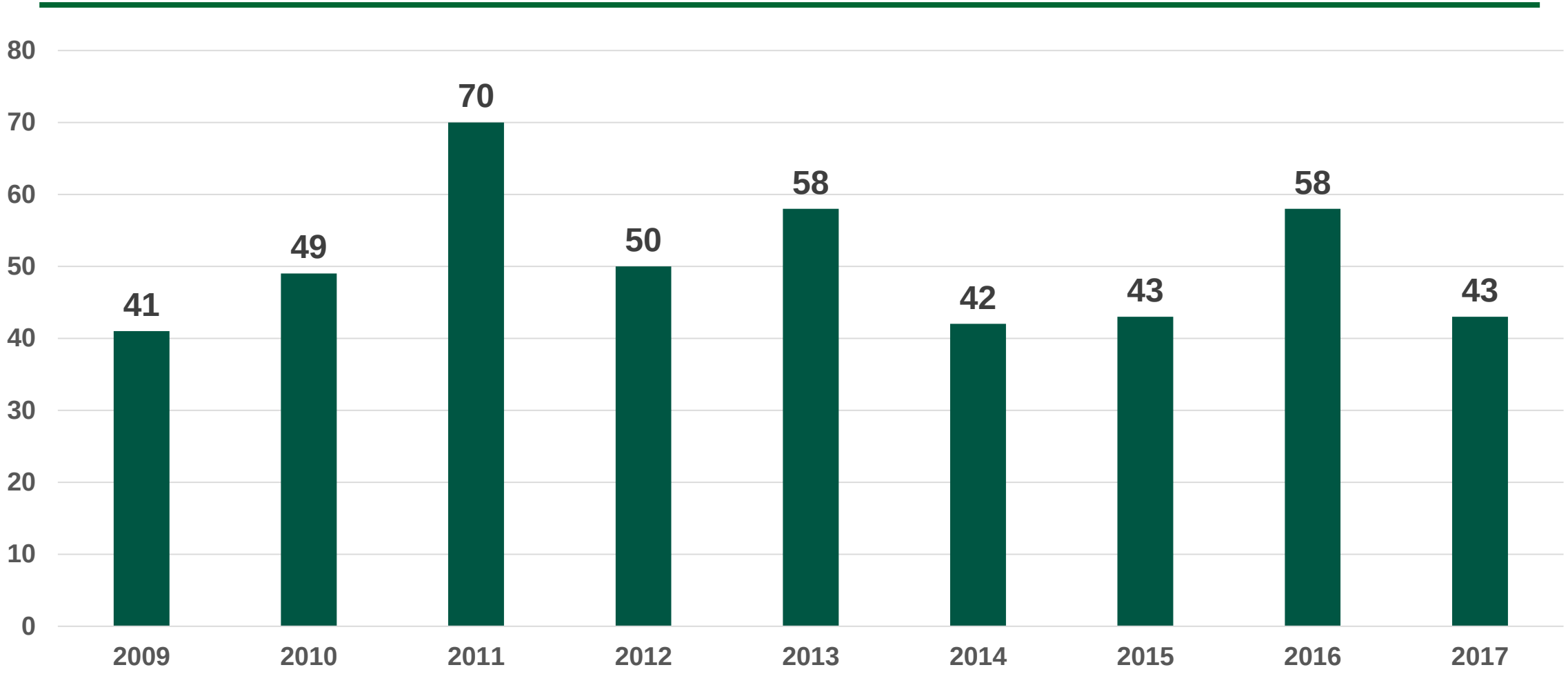
Sponsored Research - Private



Growth of research funding over time with individual companies



Invention Disclosures by Year



Contracting Models

Traditional Model	• Sponsor receives an option for an exclusive license that grants rights to commercialize any technology that is developed in the performance of the research • Payment of patenting costs and royalties are negotiated after IP is developed
Assessment NERF (Non-Exclusive Royalty-Free)	• Sponsor receives a limited term (max 5 year) commercial, non-exclusive, royalty-free license in a defined field of use and also receives an option to extend the license at a commercially reasonable rate after the initial term. No sublicensing rights are granted to sponsor.
Option NERF (Non-Exclusive Royalty-Free)	• Sponsor receives a commercial, NERF license in a defined field of use for the life of the patent and has the option to an exclusive, royalty bearing license. Option must be exercised within six months of the initial disclosure of the invention. No sublicensing rights are granted to sponsor. • Issue fee: 5% of total project costs ($7,500 minimum)
Advance License	• Sponsor will be entitled to an exclusive, sublicense-able, commercial license within a defined field of use. • License is royalty-free until annual sales reach $20M, at which time a royalty rate of 1% on annual net sales will commence. • Issue fee: 10% of total project costs ($15,000 minimum)

NDSU NORTH DAKOTA STATE UNIVERSITY

Research and Technology Park

Park Tenants

- Appareo
- John Deere Electronic Solutions
- Candlewood Suites
- NDSU R1, R1A, R2 Buildings

Support Companies

- Bank of ND
- Small Business Development Center
- MinnDak Computers

Anchor Tenant
- Bobcat

Software
- Omnibyte
- Harvest Profit
- MCP Networks
- Genesis Feed
- FarmQA

Materials/Coatings
- Red Diamond Coatings
- Renuvix LLC
- Elinor Specialty Coatings

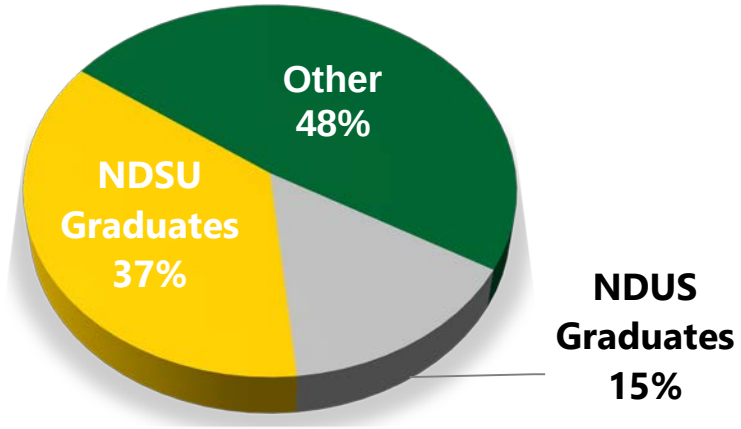
Drone Technology
- Field of View LLC
- Project Phoenix
- Flight Pros

Marketing
- OpGo
- Go/Do
- Probitas Promotions

Technology
- Be More Colorful
- Intelligent Malt
- Summers Manufacturing

Research and Tech Park Economic Impact

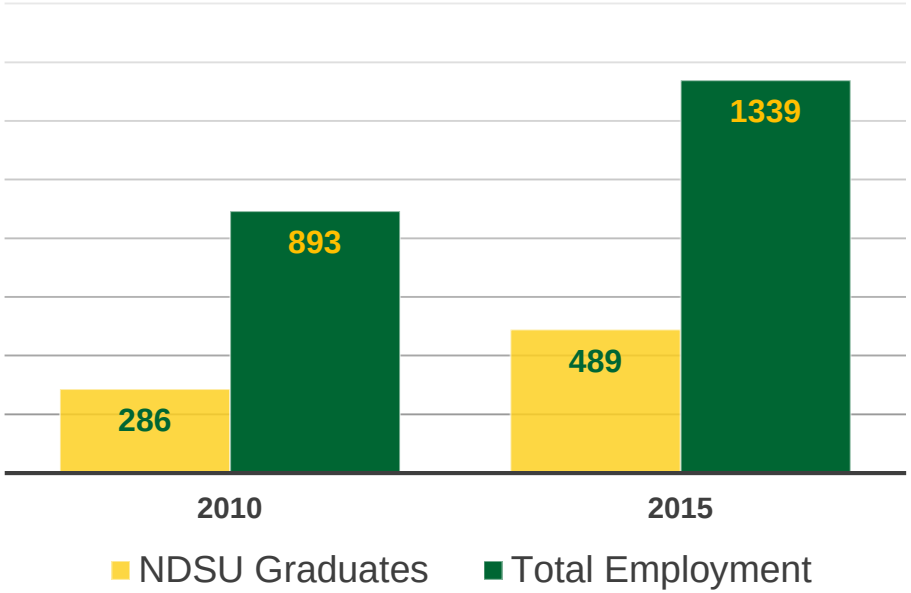
Research Park Employees



Total Salaries: $85,158,744
Average Salary: $ 63,614

Student Interns: 107
60% NDSU Students

Research Park Employment



Value-Added Services

- Coaching/Mentoring
- Student Employee Program
- Educational Events/Forums
- Access to Capital
- Relationships/Networking
- Innovation Challenge
- Innovate ND Entrepreneur Grants

The Innovation Challenge

- Annual contest for NDSU Students
- Three competitive tracks with three rounds of competition
  - $5,000/track, $20,500 total
- 5 student startup companies
- Current year
  - 2 definite company startups
  - 9 potential startups
  - Increase supported by new NDSU curriculum in entrepreneurship

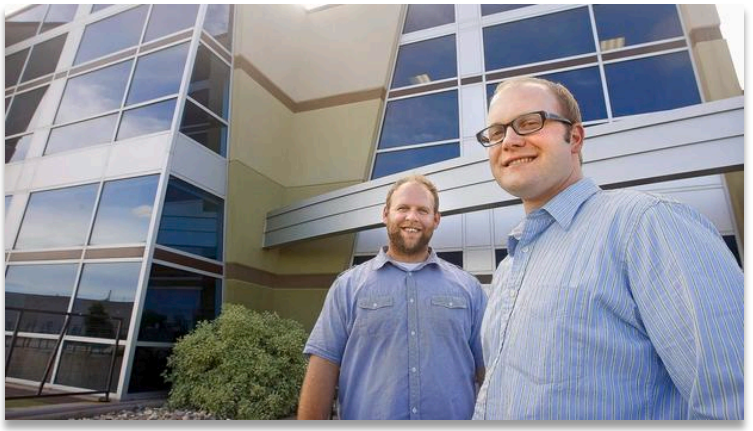
Innovate ND Program

- Dept. of Commerce Program
- Administrated by local Entrepreneur Centers
- Three phases of up to $24,000 for each startup company
- Dr. Jeff Stamp entrepreneurial training – online and in person boot camp
- Of 60 companies in Fargo in first biennium, roughly 2.3 jobs created per company.
- 182 companies, roughly 40% in Fargo region
- Statewide Funding
  - Total Entrepreneur Grants - $2.25 M (down from $3.25M)

June 2018 Incubator Graduates

c2renew

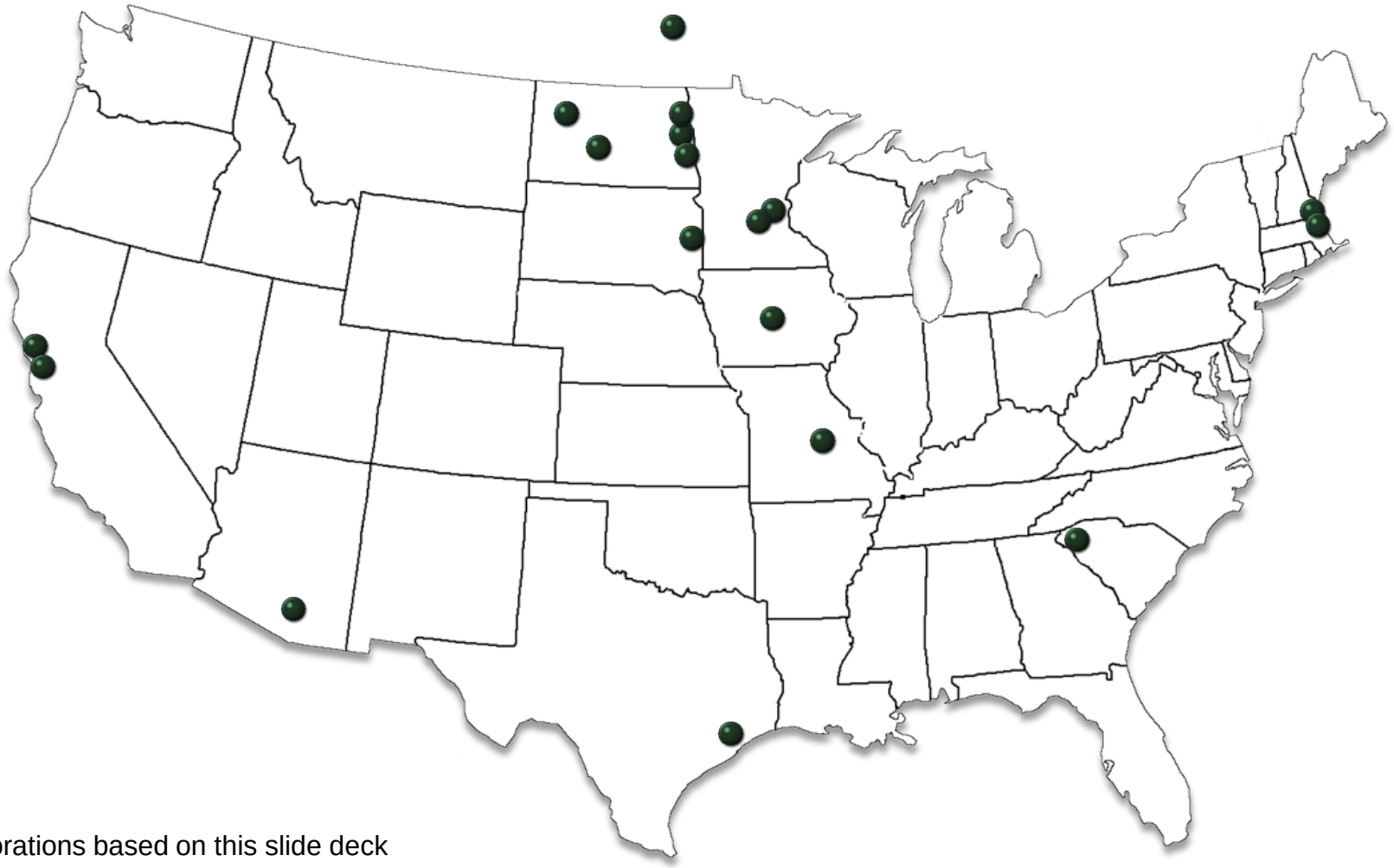
NDSU Faculty startup in renewable materials



Discovery Express

Innovation Challenge student winner instilling passion for STEM in elementary age children

Collaborations across the Country



Collaborations based on this slide deck

Thank you