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

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Vice President - Office of Research and Creative Activity
Executive Director - North Dakota EPSCoR
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

Vibrant Community
- Social Assets
- People Magnet
- Financial Assets
- Centers of Innovation
- Cultural Assets

Research University
- Vital Partnerships/collaborations
- Research University
- Diversity
- Human Assets
- Knowledge Creation
- Regional and Global Good
- Technology Assets
- Innovation/Creativity/Art

ND Interim Higher Education Committee
The Landscape has Changed

Higher Education Research and Development Expenditures
(in billions; not adjusted for inflation)

Federal funds account for only ≈ 54% of all funding (2016) versus 61% in 2010

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 research offices support basic to commercialization
• How we create interdisciplinary/transdisciplinary teams
• How we think about faulty hires
• How we train our students
• How we develop partnerships external to campus
• How we move products to the private sector

Actions
• Support and training for collaborative teams
• Create integrated campus efforts
• Engage external constituents in long-term partnerships
• Function as innovation and entrepreneurial hub

NAE Grand Challenges for Engineering

14 Grand Challenges for Engineering in the 21st Century
Basic research is a bedrock of the research enterprise
How do we catalyze and develop collaborations to create sustainable and impactful efforts?

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

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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.
The New ABCs of Research

Creating Solutions to Complex Problems
Creating Solutions to Complex Problems

1. Food systems and security
2. Healthy populations and vital communities
3. Sustainable energy, environment, and societal infrastructure
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.
Center for Engineered Cancer Test Beds
Center for Engineered Cancer Test Bed
In vitro Creation of Prostate Cancer Metastasis

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

Single Cancer Cell on Scaffold

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
UAS Supply Chain

**Airframe**
- Maintenance Training
- Remote Pilot Training
  - Large UAS and BVLOS
- Remote Pilot Training
  - Small UAS – Part 107

**Research**
- Detect and Avoid
- Control and Communication Links
- Airframe Materials, Power & Avionics

**Sensor Payloads**
- Remote Sensing Specialists
- Sensor Operators
- Sensor Hardware
- In-Situ Data Processing
- Sensor Miniaturization
- Application Specific Sensors

**Other Data Sources**
- Ground-Based Sensors
- Satellite Imagery
- Climate Data

**Data Processing and Management**
- System Architecture
- System Management
- Data Storage
- Data Processing
- Data Analytics
- Decision Support Algorithms

**End Use Applications**
- Precision Agriculture
- Energy
- Transportation
- Insurance
- Construction
- Surveying
- Natural Resource Management
- Law Enforcement
- Emergency Response

**Research Education Training**

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**Airframe Education & Training**

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**Sensor Payloads Education & Training**

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**Other Data Sources Education & Training**

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Nontraditional Funding Sources
Nontraditional Funding Sources

- 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
Faculty and Students
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

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

2018 National Science Foundation Graduate Research Fellow Kurt Williams

Come Join Us! All are Welcome!
• 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
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.
Undergraduate Research Projects
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
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.
Research Operations Recharge Center

- Microfabrication Laboratory
- Device Packaging Laboratory
- Materials Characterization and Analysis Laboratory
- Device Testing Laboratory
- Materials Research Laboratory (Synthesis and Processing)
- Reliability and Failure Analysis Laboratory

145 instruments in the Recharge Center

~ $30M of installed equipment
## Research Operations Recharge Center Impact

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samples Processed</td>
<td>9,960 Samples Processed</td>
</tr>
<tr>
<td>Equipment Use</td>
<td>4,872+ Hours of Equipment Use</td>
</tr>
<tr>
<td>Material Scale-up Synthesis</td>
<td>1200+ gallons synthesized in material scale-up reactors</td>
</tr>
<tr>
<td>Internal Users</td>
<td>75 Internal Users</td>
</tr>
<tr>
<td>College Representation</td>
<td>3 NDSU Colleges from 10 Departments</td>
</tr>
<tr>
<td>External Users</td>
<td>15 External Users</td>
</tr>
<tr>
<td>Entities</td>
<td>12 Private Sector, 3 Academic</td>
</tr>
<tr>
<td>Lab Sessions Provided</td>
<td>Lab Sessions Provided for 3 Academic Courses</td>
</tr>
</tbody>
</table>

**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.

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

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

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
Economic Development
Economic Development

Engage with authenticity

Proceedings of a Workshop
IN BRIEF

MARCH 2018

Revitalizing the University-Industry-Government Partnership: Creating New Opportunities for the 21st Century
Proceedings of a Workshop—in Brief

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Sponsored Research - Private

- 2013: $2,500,000
- 2014: $1,500,000
- 2015: $2,000,000
- 2016: $2,500,000
- 2017: $1,500,000
- 2018: $0

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Growth of research funding over time with individual companies
Invention Disclosures by Year

- 2009: 41
- 2010: 49
- 2011: 70
- 2012: 50
- 2013: 58
- 2014: 42
- 2015: 43
- 2016: 58
- 2017: 43
## Contracting Models

<table>
<thead>
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</thead>
</table>
| **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)                                                                 |
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
- 60% NDSU Students
- Other 48%
- NDSU Graduates 37%
- NDUS Graduates 15%

Research Park Employment

- NDSU Graduates
  - 2010: 286
  - 2015: 893
- Total Employment
  - 2010: 489
  - 2015: 1339

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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
- Administered 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