WHIN

WABASH HEARTLAND
INNOVATION NETWORK

Report to Lilly Endowment

September 2019

Submitted by: Johnny Park, CEO, WHIN

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Message from the Chairman: **Too Numerous to Count**

As Chair of the Wabash Heartland Innovation Network, it is a privilege and a pleasure to report on the progress this Lilly Endowment funded endeavor has experienced over the past year. This Annual Report will highlight many of the activities that have been unfolding during the past six months, as well as many of the partnerships that have been developed. No report, however, can fully represent the breadth and depth of the work that has been ongoing, the contacts and relationships that have been forged, and the far-reaching impact of this project to change the future of our Region and the lives of the residents that call this place home.

Under the leadership of our CEO, Johnny Park, and our growing staff of talented subject matter experts, the influence and impact of WHIN has grown over the past year in ways that could not have been envisioned at the beginning of this project. Please let me highlight some examples of progress on endeavors funded by our grant that were anticipated, as well as progress on unanticipated opportunities and that have emerged.

Progress on grant-envisioned priorities:

- Our Regional Cultivation Fund planning and impact grants have been awarded and our second round of grant activity is currently underway.
- Our Purdue and Ivy Tech educational partners are working daily to implement the various specific activities outlined in our grant.
- Testbeds in both the agricultural and manufacturing space are being set up and populated with sensor technology.
- Our digital supply chain tool is being rolled out to regional manufacturing firms this fall.
- Educational material for incumbent workers is being developed with input and guidance from those who will be using these tools.
- Research, development, and deployment of smart sensor networks are underway and yielding real-world results and insights.
- Hundreds of meetings and thousands of interactions have been facilitated over the past year in our region.
- Agricultural and manufacturing networks have been developed and nurtured.
- The WHIN Board has also evolved and matured along with the expansion and growth of WHIN.

Emerging opportunities for WHIN and the Wabash Heartland Region:

- Creation of WHIN Alliances for both agriculture and manufacturing to help drive sustainability for WHIN going forward.
- Creation of data via a regional network of hundreds of weather stations, run by Alliance members and educational partners, to be used by Purdue and other researchers.
- Development of tech partnerships that add real value to our ag and manufacturing Alliance members through digital and data-driven tools that enable real-time decision-making.
- WHIN's facilitation and convening around regional rural broadband coverage and technology.
- Sharing WHIN's model for community and economic development and innovative efforts during speaking engagements nationally and internationally.

It seems to me that the opportunities for WHIN to positively impact the Wabash Heartland Region are too numerous to count. And the really exciting thing is that new opportunities emerge weekly, if not daily. While exciting, these opportunities present a constant challenge: executing to the very best of our ability the work envisioned and funded by Lilly Endowment, while at the same time, recognizing the constantly changing landscape of technological advancements. Our CEO and his team are up to this challenge. This team is "all in" with WHIN. They are totally committed and passionate about the mission of the Wabash Heartland Innovation Network, as are our partners at Purdue and Ivy Tech.

It has been an exciting year of growth and discovery for WHIN. We all look forward with great anticipation to the months and years ahead. Thank you for this wonderful opportunity to change our Region and, ultimately, the world.

Gary D. Henriott, Chairman

WHIN Overview: **Smarter Together!**

Johnny Park, CEO of WHIN

Can you believe that only 10% of rural Indiana has electricity? Even though it's abundantly available in urban areas, most of the hardworking men and women throughout the Wabash Heartland are still forced to use horses for farm work, wash clothes by hand, and read at night by candlelight…

Of course that's not true in 2019!

But in 1919, exactly 100 years ago, that was the very situation right here in north-central Indiana. Power systems for electricity were actually developed in the 1880s, but forty years later, only 10% of rural America was electrified. We can't even fathom this today.

But despite our incredulity, the same thing has the potential to repeat itself if we're not careful. There is once again a technology emerging with the potential to forever change the way we live and work, and it's data. It's information gathered through a network of interconnected sensors on everything you can imagine all pulled together and organized to inform, drive decisions, and optimize results. This is the internet we access from the phones in our pockets, the weather stations that talk to satellites in real-time, and the equipment/tools/appliances that daily interact with one another in a mesh of information.

The opportunities for this technology are as limitless as electricity. Just as in Indiana 100 years ago, our urban centers are installing high-speed internet connections and data sensors accessible from every home and on every street corner, and the applications and services accessible through this network are exploding. But the majority of the Wabash Heartland region is being left behind. Not only are we relying on being connected to data for work, entertainment, and civic life more and more these days, but the divide is growing to affect a difference in education and job opportunities.

That's why the WHIN team (pictured below) is working to provide growers, manufacturers, and regional stakeholders with cutting-edge sensor-based technology and the know-how to use it. We don't just want every home in the Wabash Heartland to have broadband internet access, we want every stalk of corn and every conveyor belt to have broadband access, too. We are forming a network among our 10 counties, a Data Decagon, to learn from one another and share solutions.

We're off to a strong start, and we're excited to share with you on the following pages some of what we have been up to so far. Thank you for being part of this incredible success story that we will create together.

We're smarter together.

March 2019 — August 2019: **Key Highlights**

Regional Engagement

SMART Films Industry Day at Purdue:

On May 16, 2019, WHIN's key research partner Birck Nanotechnology Center showcased their latest research and advances in low-cost IoT sensors and digital technologies related to agriculture and manufacturing. WHIN guests included more than 25 interested stakeholders (pictured below), including Ag and Manufacturing Council members and several LEDOs from the region. Company participants included Bayer, United Technologies, Fluke, The Climate Corporation, Sartorius, BASF, and Evonics. This research is key to WHIN accomplishing its mission of becoming a global epicenter for IoT-based digital agriculture and next-generation manufacturing.

NanoDays:

On June 13 and 20, 2019, the Birck Nanotechnology Center participated in Greater Lafayette Commerce's Manufacturing Camp hosting third- through eighth-graders who learned about manufacturing and performed STEM-related activities. Approximately 90 students enjoyed Nano Ice Cream, participated in cleanroom tours, played with 3D-printing pens, and visited Dr. Martin Jun's robotics lab at Flexlab.

Statewide Engagement

5G Technology:

WHIN is staying on the cutting edge. On June 10, 2019, WHIN leadership participated in the Indy 5G Summit where government, industry, and academic leaders gathered to discuss how to position Indiana as a global center for 5G technology (see group photo of participants below). On July 24 and 25, 2019, WHIN CEO Johnny Park spoke at CyberTech Midwest, a national conference held in Indianapolis. Park shared how 5G can impact rural communities like those in the Wabash Heartland Region.

Indiana Agricultural Advisory Council:

WHIN CEO Johnny Park was invited to serve on the Indiana Agricultural Advisory Council by U.S. Senator Mike Braun and his team.

Hiring Hoosiers:

An initiative between Indianapolis-based RTV-6 and IN-MaC, an organization that partners with WHIN, facilitated summer manufacturing internships for Hoosier college students. IN-MaC stands for Indiana Next Generation Manufacturing Competitiveness Center which is hosted by Purdue University in partnership with Ivy Tech Community College and Vincennes University. IN-MaC strives for growth, competitiveness and sustainability of Indiana's booming manufacturing industry.

March 2019 — August 2019: **Key Highlights** *(Cont'd)*

National Engagement

NIST's Global City Team Challenge (GCTC):

CEO Johnny Park spoke about WHIN to hundreds of municipal government leaders and technology innovators from around the world at the 2019 Smart and Secure Cities and Communities Challenge Expo on July 10 in Washington DC. The event, focusing on agriculture and rural communities, was co-hosted by the National Institute of Standards and Technology (NIST), the U.S. Department of Homeland Security, and the National Telecommunications and Information Administration (NTIA). Dennis Buckmaster served as one of the session chairs and presented highlights of Purdue's digital ag technologies at the OATS and Birck Nanotechnology centers. Charilaos (Harris) Mousoulis (pictured below with his graduate student Jose Waimin) served as a panelist during the Innovation in the Smart Rural Ecosystem discussion, where he Waimin explained WHIN's efforts and how rural communities can benefit. The joint exhibition booth was frequented by interested visitors from both industry and government.

Microsoft:

Microsoft recently announced a partnership with Watch Communications, a WHIN Regional Cultivation Fund grantee, to help close the broadband gap in rural communities in Indiana. The partnership is part of the Microsoft Airband Initiative, which is focused on bringing broadband to 3 million rural Americans in the states of Indiana, Ohio, and Illinois by July 2022. Wendy Sloan, a Microsoft spokesperson, highlighted WHIN as being an influential factor in choosing a partner for Indiana. "We'd been looking for the right partner and deal, and in Watch we found it," said Sloan. "They have deep ties to Indiana, as they are closely allied with Wabash Heartland Innovation Network." WHIN is looking forward to working with Microsoft and Watch to help bring high-speed internet to rural communities throughout the WHIN region.

InfoAg Conference:

Purdue and WHIN team members John Scott (Purdue Extension), Bruce Erickson (Purdue University Agronomy), and Johnny Park (WHIN CEO) were invited to present the InfoAg Conference, known as the premier event in precision agriculture, in St. Louis on July 22 and 23, 2019. Park shared a presentation entitled, "2M Acre AgTech Testbed: Developing the Wabash Heartland as a Global Epicenter of Digital Agriculture."

Fluke Digital Systems:

Kevin Clark, the director of global service and alliances for Fluke Digital Systems and also a Purdue Polytechnic graduate, visited with the Purdue-WHIN-Ivy Tech team on April 18, 2019. He talked about vibration and sound sensors, as well as machine learning, with several faculty members and their students. He also visited labs, saw the sensor research, and toured the WHIN testbed site. Fluke is potentially interested in further collaborations/ partnership opportunities with the WHIN Manufacturing Alliance.

International Engagement

Solinftec:

Global leader Solinftec (SOL-inf-tek) is moving its North American headquarters to WHIN's neighborhood. Solinftec is a Brazil-based digital agriculture company known for creating and using IoT platforms which generate meaningful farming operation insights in real time. Daniel Padrão, Solinftec's Chief Operating Officer, said the company moved to Indiana to be close to Purdue's College of Agriculture and WHIN. Initially the company was considering a location in Illinois. However, through the collaborative efforts of AgriNovus Indiana, WHIN, and Purdue, Solinftec chose the Wabash Heartland Region. WHIN's new partnership with Solinftec is a big win for everyone involved. WHIN's Ag Alliance members will greatly benefit from Solinftec's cutting-edge technology solutions.

Data analytics from WHIN farmers combined with Purdue's research will enable Solinftec's continued creation of new ag-related IoT platforms and sensor applications. Partnerships with companies such as Solinftec strategically facilitate WHIN's goal of making the Wabash Heartland Region a global epicenter for IoT technology.

Idea Lunchbox:

Purdue College of Agriculture collaborated with Idea Lunchbox (an international accelerator) to host four companies from Brazil and Canada in a four-week time period this summer and explore start-up potential in the WHIN region. This effort also allowed Purdue faculty with startup companies to potentially expand their products and markets in Brazil—and to refine new ag technologies.

World Community Development Conference:

Community development, and how to measure it, is a topic of global interest. Melinda Grismer (pictured in the group photo below), WHIN's VP of Regional Development, recently presented "WHIN: Local Impact, Global Significance" during the Digital Development session of the World Community Development Conference in Dundee, Scotland, on June 25, 2019. Sharing the session with presenters from India, Scotland, Iran, and the west coast of the U.S., Grismer fielded questions about how to develop and track metrics for large-scale community development efforts from comparable projects underway around the world. The presentation helped jump-start an economic parity comparison (currently underway) to investigate which regions--nationally and internationally--are striving to become global epicenters of digital agriculture and next-generation manufacturing.

Digital Agriculture: **The WHIN Ag Alliance**

Figure 1: In total, 71 progressive growers attended the first WHIN Ag Alliance Summit held at The Trails in West Lafayette on Aug. 27, 2019.

A consortium of approximately 20 innovative ag producers and agribusinesses from throughout the region launched WHIN's Ag Alliance in June 2019. Founding members agreed to:

- Adopt new technologies.
- Share lessons learned with other members.
- Grant WHIN access to data, which can be shared with academic institutions in an anonymized form for research and education purposes.

In return, they received products and services from WHIN's vetted technology partners designed to support and encourage the use of internet-enabled technologies that reduce costs, increase efficiencies, and optimize operations.

Figure 2: Greg Ottinger, WHIN's VP of Strategic Partnerships speaks to one of the Ag Alliance members during the Summit.

Figure 3: WHIN Alliance installs a Davis weather station on one of the member's farm property.

On Aug. 27, 2019, WHIN held its first Ag Alliance Summit at The Trails in West Lafayette with 20 in attendance for the morning "Alliance members only" session, and 71 in attendance for the afternoon session, which was geared towards those with interest in Alliance membership. The event created excitement and synergy for the newly-formed group. "Alliance communication is great—very professional! It's great that you publish results of the initiative's efforts," said Jason Stonecipher, one of the region's growers. "I hope the Alliance continues to champion industry development in our rural counties." Another Summit attendee, Mark Furrer of Bio Town Ag in White County, commented, "I'm hearing a lot of interesting ideas. It's early to know what will ultimately pan out vs. what will fall out. The only thing we can count on is that technology will continue to transform production agriculture. So, I support the idea of WHIN investigating these concepts."

Lt. Governor Flies Drone at ACRE

On June 25, 2019, Lt. Governor Suzanne Crouch visited ACRE for an Agriculture Drone Showcase. Multiple drones used by Purdue Ag Extension were demonstrated by Purdue Extension Digital Agriculture Specialist John Scott. Showcased were the Phantom 4 (the most commonly used UAV in agriculture today), the new Quantix fixed-wing that Extension is testing this year, the Agras M1-P (a drone that is capable of spraying or spreading), and the small Tello (the one that Extension educators use for training purposes). The Lt. Governor was given the controls to fly the Tello and Phantom drones in the field. Local media groups (WLFI, Hoosier Ag Today) covered the event.

Figure 4: Digital Agriculture Specialist, John Scott, explains how to operate the controls of the Tello and Phantom drones Lt. Governor Suzanne Crouch is about to fly.

WHIN Ag Champions

Neil Mylet, Farmer and Inventor, Camden, IN
www.linkedin.com/in/mylet

I use sensors on harvesting equipment, grain dryers, sprayers, and a wide assortment of other situations to ensure consistency and efficiency in my farming operation practices.

I have a team of hardware and software developers working on a wide assortment of new sensors and technologies that will fuse data from bio-metric sensors, machines, and automated industrial systems so that everyone can truly put data into greater perspective while also empowering the way people work on farms and ranches.

Nick Frey, General Manager, WCI Family Farms, Linden, IN
www.wcifamilyfarms.com

WCI Family Farms is a forward-thinking farming operation with three main missions in mind: stewardship of the land, building relationships, and making a positive difference in the local agriculture communities.

It is a goal of WCI Family Farms to proudly grow a highly successful and profitable business built with bold innovative thinking, technology, superior management, and economies of scale all on a foundation of honesty and sound business ethics. They are committed to bring solutions to landowners in the areas of land management, tax, and retirement options.

Allen Furrer, Director of Marketing and Public Relations, Bio Town Ag, Inc., Reynolds, IN
www.biotownag.com

Bio Town Ag's mission is to explore new frontiers in agricultural sustainability where they creatively deploy technologies to eliminate the environmental impacts of past agricultural production processes. Bio Town Ag is profitable converting manure and other organics into energy and other useful co-products.

Allen was an early adopter of IoT technology in the shipping logistics industry almost 30 years ago. Bio Town Ag has developed an anaerobic digester currently converting farm waste to more than 5 megawatts of power and being controlled, tracked, and reported using a proprietary SCADA system.

Allen continues to innovate, also using RFID, GPS, Wi-Fi, and cellular wireless technologies on farm and digester equipment. Bio Town Ag is beginning to use the data to make predictions on things like maintenance needs before they happen. Bio Town Ag is starting to use vibration sensors on engines to predict failure. Working with the resources provided by WHIN, Purdue University departments of Nanotechnology and Agriculture, Bio Town Ag is making significant strides from these combined efforts toward true sustainability for the future.

Go WHIN! We're Drawing Them In!

This summer marked the launch of Research and Extension Experiential Learning for Undergraduate Experience (REEU), a ten-week summer program focused on data science in agriculture. REEU was created to equip undergraduates with data skills in computer science, including spreadsheets and programming languages like Python, R, and ArcGIS, as they apply to the practice of agriculture.

This student-centered, active-learning environment began with a course-like structure and culminated in an independent research experience with eight students from six states completing the program. This successful program will continue for four more years with funding from USDA/NIFA and contributions from WHIN-supported staff members, like Dennis Buckmaster, who directed the program and served as one of the instructors.

"In the pursuit of trying to be the global epicenter for digital agriculture, all of the data sets we used were specific to agriculture," said Buckmaster. "These students from all over the U.S., including California, Texas, Hawaii, Illinois, Michigan, and Florida, came to wee little West Lafayette because this is where you get to learn this stuff!" As a result of REEU, two of those students intend to apply to Purdue University for graduate study.

Figure 5: All eight of these students successfully completed the REEU program launch in August 2019.

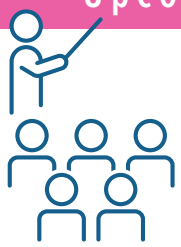
Next-Generation Manufacturing: Industry 4.0

WHIN Manufacturing Education Workshop Series

WHIN's Manufacturing Education Team (MET) launched a series of workshops designed to educate and support manufacturers throughout the region. The first workshop on Aug. 28, 2019, "Transitioning to Industry 4.0," explained the benefits, costs, and returns of implementing new technologies in manufacturing operations. "These workshops feature topics in both technical and non-technical areas," explained Steve Dunlop, MET lead and Director of DCMME (the Dauch Center for the Management of Manufacturing Enterprises). "They are designed to catapult manufacturing success in the Wabash Heartland Region."

The workshop series, which will assist more than 300 regional manufacturers, is intended to build in interest and technical complexity as regional companies take steps to the next level of business growth. Topics have been defined for 2019 events, and 2020 event topics will be finalized as the series develops. Most events will be held at IMI at the site of the IMT (Intelligent Manufacturing Testbed).

Upcoming Workshops



- SEP. 25, 2019: **Onboarding and Staff Retention**
- OCT. 16 and 17, 2019: **IMT – DEC symposium and Testbed Workshop**
- NOV. 20, 2019: **Digital Tools for Manufacturers**

WHIN Regional Collaboration Peer Groups

These Peer groups consist of six to eight non-competitive manufacturers who come together to share insights into one another's best practices and challenges. The first peer group (NE1, featured in the March 2019 report) is comprised of companies from Pulaski, Cass, and White Counties. Having met in March for the third time, this group is now self-sustaining as they are setting their own meeting schedules and agendas. WHIN's Manufacturing Education Team (MET) provides oversight to the group and continues to attend and support the group. MET formed two additional groups in April (SW1 and SE1) and another two began forming in June 2019. In addition, MET launched their problem-solving/value-stream mapping courses. To date, MET has trained 60 individuals from 25 different WHIN region manufacturers.

Figure 6: During the Aug. 28, 2019 workshop at IMI, Dr. Benjamin Dunford, Krannert (top photo) and Mark Sheets, Frito Lay (bottom photo), present transitioning models.

Digital Supply Chain Tool: Help STAT!

Following one of the WHIN Manufacturing Education Team's Regional Peer Group meetings, a company in attendance asked for emergency support. It so happens that one of this company's facilities was damaged by a tornado and was no longer able to produce castings for engine mounts. WHIN's team was able to provide a list of 11 companies that potentially could provide this service. Seven companies were extracted from the Digital Supply Chain Tool database, and four additional companies were identified from other sources outside of the 10-county area (but within the state of Indiana). The information was provided within six hours from the time of request.

Moving In!
Intelligent Manufacturing Testbed (IMT)

Site construction and build out of the Intelligent Manufacturing Testbed (IMT) in the Purdue Research Park is complete. By the end of January 2020, all of the initial equipment will be in place, connected to networks, and processes established to begin making parts. The Testbed was created through the vision of the Indiana Manufacturing Competitiveness Center (IN-MaC) and the Digital Enterprise Center (DEC), and through funding from the Lilly Endowment, Manufacturing Design Lab (MD Lab), DEC, and IN-MaC. Prior to construction, IN-MaC and WHIN personnel engaged industry leaders throughout the 10-county region. Overwhelmingly, they said their companies need help with organizational transformation, technology selection and implementation, and workforce pipeline creation. As such, the IMT is targeted at demonstrating the "art of the possible" through highly applied research and development projects, as they relate to the technologies and methods involved in helping regional manufacturing operations become digital enterprises. Manufacturers who participate in the Testbed will be able to experience new technologies, integrated techniques, and educational opportunities to which they would otherwise not have access.

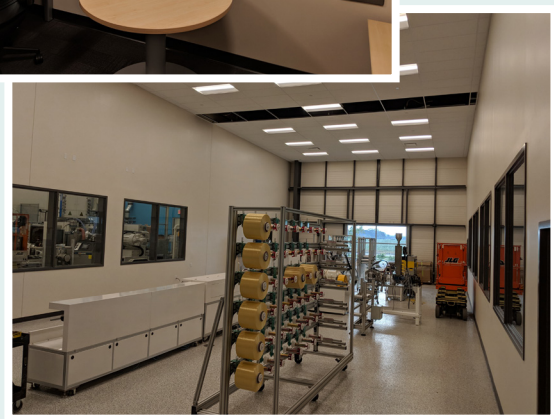


Figure 7: Views of Testbed, August 2019.

Digital Supply Chain Tool:
Ready for Launch!

Currently in the final stages of development and deployment, WHIN's Digital Supply Chain Tool has been vetted by several regional manufacturers. One of those is Todd Miller, owner of Myers-Spring in Cass County and member of WHIN's Board of Directors. Miller tested the functionality of the recently designed interfaces to provide feedback on how to optimize the tool (see Figure 8, prototype of Myers-Spring page). We're going to be adding to this tool based on manufacturers' ah-ha moments," said Jack Stucky, VP of Engineering, tasked with product deployment. "We're going to be building different kinds of services." During the Aug. 15, 2019, Manufacturing Advisory Council meeting, Bryce Brumm of Standard Industrial (Figure 9) rallied the troops, asking: "We are here to better our businesses and increase our profits. Why not do it together?"

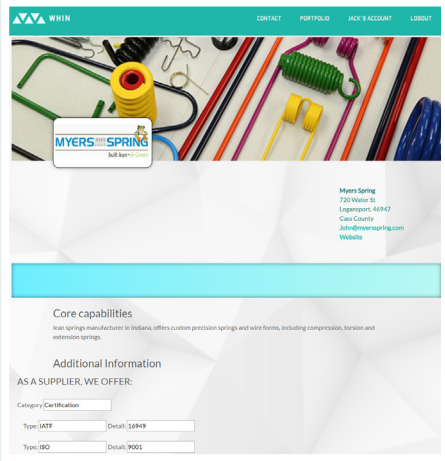


Figure 8: The idea of the Digital Supply Chain Tool (screenshot above) originated from conversations Purdue held with user groups in the region to address shortfalls in production utilization/leakage.

Figure 9: Bryce Brumm of Standard Industrial encourages fellow WHIN manufacturers to utilize WHIN's new Digital Supply Chain Tool.

IoT Infrastructure and Data Analytics: **Taking the Lab Outside**

Ivy Tech Agriculture Field Laboratory Sensor Installation

The Birck Nanotechnology Sensor Team has visited Ivy Tech several times this past summer to plan and implement the installation of sensors in the farm field plot. Originally, there were delays due to the inclement weather, but now a total of five sensor nodes are installed in the field, each collecting data on soil moisture, temperature, nitrates, and electric connectivity. Additional sensors, called Decagon sensors, are in the works to be installed in the near term.

Ivy Tech's Soma Mukhopadhyay has been working with the Birck Sensor team and Dr. Rahim Rahimi as part of her summer externship, specifically with testing of the nitrate sensor development. This connection was a result of WHIN, and some prior discussions about further connectivity among Purdue and Ivy Tech. Ivy Tech has two courses in which students measure the amount of nitrate in water using a spectrophotometer. "We thought that would help students understand better how the sensors are working if they could compare the reading from the spectrophotometer (taken by drawing a water sample from the irrigation ditch to work with in the lab) vs. the sensors installed directly into the water," explained Mukhopadhyay. "Students also try to mimic soil type (based on moisture content) in the lab in order to predict how they will perform in the field. Calibrating sensors in the field – to test accuracy of lab work – is a real breakthrough." Ivy Tech's next step is to install new computers at the Ivy Tech campus to track the LoRa Wan signal and transmit the data from Ivy Hall to Purdue."

Figure 10: Nithin Raghunathan (orange shirt) spoke to 20 students in Ivy Tech's Introduction to Crop Production class about the sensors installed at the Ivy Tech farm. He also talked to them about the data being collected, how it can be used for on-farm decision making, and what the process will be for accessing the data to use in their course work.

> *"The main reason why these sensors are going to be helpful – to identify soil types that are suitable for certain corn genetics. If you know how all these variables behave, we can predict what will work best in our farm fields. The more data and knowledge we have, the better we can be strategic in our hybrid corn and soybean selection."*
>
> – Chad Martin, WHIN-Ivy Tech Project Manager

Regional Engagements

WHIN's IoT Team is actively involved with testing sensor technology in four counties across the region. Tate and Lyle (Tippecanoe County) has deployed various vibration sensors. Standard Industrial (Pulaski County) is researching how to best connect their tube bending equipment to their network. Bio Town Ag (White County) installed sound sensors in cattle barns and on their power generators, as well as sensors in their digester exhaust system to monitor conditions. Soon, vibration sensors will be ready to deploy in their energy center. Oscar Winski (Tippecanoe County), site of a potential TAP40 project, is auto-measuring/quality-checking the parts they sell. Evonik (Tippecanoe County) is ready to deploy vibration sensors, and Nucor (Montgomery County) is also interested in vibration sensors.

Good Vibrations

Why would Ivy Tech install vibration sensors on an air compressor in its second floor Lafayette campus mechanical room? As a student demonstration, of course! In fact, Bryce Eaton, Chair of Ivy Tech's Advanced Automation and Robotics Department, plans to build desktop units where students can practice mounting vibration sensors (much like the ones installed in Figure 11) to see them in action and make adjustments more easily. Steve Musick, Assistant Chair in Ivy Tech's Mechanical Engineering Technology Program, is excited about the opportunity this "living lab" presents his ADMF 205 students. Advanced Manufacturing courses, like ADMF 205, are taken by students in Ivy Tech's Advanced Automation and Robotics and Mechanical Engineering Technology courses. These courses run in eight- or 16-week blocks covering more advanced IoT sensors like the one Eaton installed on the air compressor. "We purchased a piece of equipment called a Mechatronics trainer that simulates an assembly line," explained Musick. "On that trainer, there are various sensors that control certain operational components. That's how we're teaching the students to install, monitor, and read the resulting data from sensors to drive their decision-making in the workplace."

So, who validates sensors used in the workplace, evaluates latest technology, and incorporates state-of-the-art data analytic technics? Purdue students Wo Jae Lee and Haiyue Wu, working with professor John Sutherland in the College of Engineering, collaborate with professor Nancy Denton in Purdue Polytechnic as well as researchers at the Birck Nanotechnology Center and Bruno Ribeiro's group in Computer Science to bridge the gap. Some of the results were presented in a poster at the Vibration Institute's annual training conference, VIATC 2019, from July 23-26 (see Figure 12). At this conference, maintenance professionals and practitioners at all levels, sensor and monitoring software developers, and instrumentation specialists convene to share and learn new developments, best practices, and ongoing challenges within the machinery monitoring field. While there, these WHIN-sponsored students shared their work in the area of sensor development and machine learning for embedding wireless, ongoing predictive maintenance into the typical industrial facility. In the process, they were able to interact with maintenance practitioners, meet with suppliers, get updates on others' work, and identify potential collaborators.

Figure 11: Motor vibration sensors installed on Ivy Tech's second floor air compressor.

Figure 12: (From left) Purdue student Haiyue Wu, Professor & School of Engineering Technology Associate Head Nancy Denton, and Purdue student Wo Jae Lee.

How Sensors Work

Sensors measure some data about the operation of a machine (e.g. vibration, temperature, or pressure). Conventional sensors are expensive and data often needs to be downloaded and analyzed manually. IoT sensors make the transfer of information to the cloud seamless. The latest machine learning tools are used to process the information automatically and "close the loop," i.e. initiate an action to improve the operation or reduce the down time.

Regional Cultivation Fund (RCF): **Round 1 Awardees**

Through the generous support of Lilly Endowment, Inc., WHIN's Regional Cultivation Fund awarded its first round of innovative grants aimed at enhancing regional quality of place. These big-impact, multi-county projects will increase vitality, education, and connectivity in the Wabash Heartland Region. Collectively, these projects represent an exciting mix of technology, learning, placemaking, and art that will benefit residents in each of the region's 10 counties, including Benton, Carroll, Cass, Clinton, Fountain, Montgomery, Pulaski, Tippecanoe, Warren, and White. More than 60 different local and regional organizations collaborated to bring these eight great projects to fruition.

Frontier School Corporation

($10,000 Planning Grant)

Digital Agriculture Testbeds at Regional High Schools

Project description: Turn FFA land plots managed by partner school districts into digital agriculture testbeds and living labs for students, area farmers, and ag businesses to experiment with data collection in practice.

Counties involved: 3 (Pulaski, Carroll, White)

Regional impact: Agricultural IoT education, workforce development

MSD of Warren County School Corporation

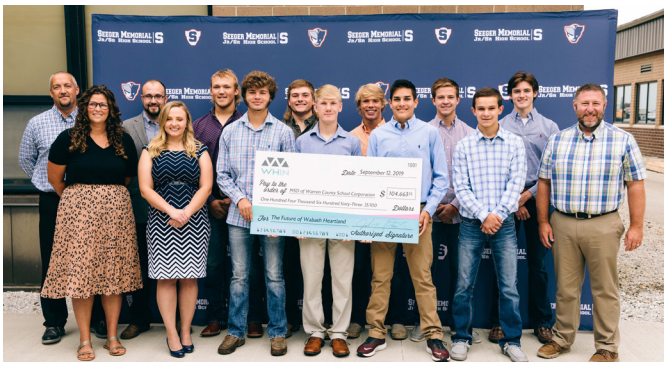
($104,663.35 Impact Grant)

Wabash River Career & Technical Education Program

Project description: Create a Department of Education-approved, dual-credit precision agriculture course and externship program offered to juniors and seniors. Share the curriculum with all Wabash Heartland schools via a train-the-trainer model.

Counties involved: 3 (Benton, Fountain, Warren)

Regional impact: Agricultural IoT education, workforce development



North Central Indiana Regional Planning Council

($242,769 Impact Grant)

Regional Mini-Ecosystems Broadband Project

Project description: Engage Watch Communications to identify infrastructure needs within the 10-county region. Design a unified regional network of fixed wireless and fiber infrastructure via collaboration with local Internet Service Providers (ISPs). Enable broadband coverage to 80% of WHIN Region, specifically in rural areas. Build at least one IoT Beta site in cooperation with LEDOs.

Counties involved: All 10

Regional impact: Civic leadership, economic and community development

Indiana Recycling Coalition

($95,110 Planning Grant)

Region-wide Recycling Collection Infrastructure: Inventory & Analysis

Project description: Analyze existing regional infrastructure for recycling collection (including processing & education) in partnership with local solid waste management districts and Purdue Environmental and Ecological Engineering. Produce an infrastructure inventory and use-case for sensors/IoT to increase system/cost efficiency.

Counties involved: All 10

Regional impact: Quality-of-life, IoT education

Indiana West Advantage and Ivy Tech Community College

($38,295 Planning Grant)

Regional Precision Agriculture Study

Project description: Conduct a regional survey of agricultural businesses and producers to analyze the skills that are necessary in the precision agriculture industry. Deploy a quantitative online survey and perform qualitative, in-depth interviews with key informants. Share the results of the survey with the region in a full report format posted online.

Counties involved: All 10

Regional impact: Digital agriculture technology, workforce and economic development

Tecumseh Area Partnership, Inc.

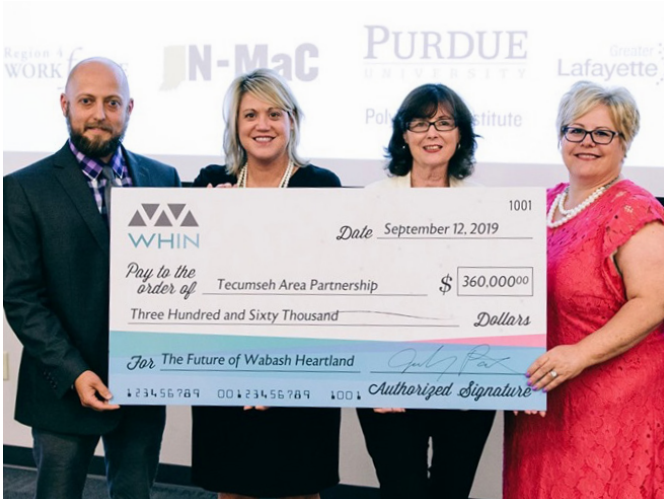
($360,000 Impact Grant)

Advancing the Next Generation for Manufacturing Competitiveness

Project description: Expand capacity of the region to offer hands-on, K-12 STEM education, teaching skills and knowledge related to additive manufacturing, prototyping, IoT technologies, programming, robotics, logistics, design, and electronics. Change the perception of manufacturing careers by exposing students to popular educational programs such as Manufacturing Week, Coder Dojos, Design & Innovation Studios, and Robotics Camp.

Counties involved: All 10

Regional impact: Education, workforce development



Regional Cultivation Fund (RCF): **Round 1 Awardees** *(Cont'd)*

Tippecanoe Arts Federation
($150,000 Impact Grant)
WHIN Walls

Project description: Develop a region-wide public art project through community collaboration. Commission community-themed pieces of art and place them in prominent locations in each of the 10 WHIN counties.

Counties involved: All 10

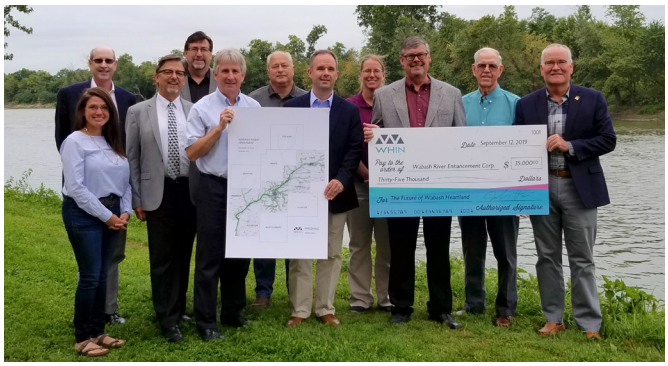
Regional impact: Regional impact – placemaking

Wabash River Enhancement Corporation
($35,000 Planning Grant)
Planning to Plan: 90-Mile River Corridor Project

Project description: Preliminary planning project for developing a five-county Wabash River Greenway Corridor master plan that would ultimately connect the entire 10-county region.

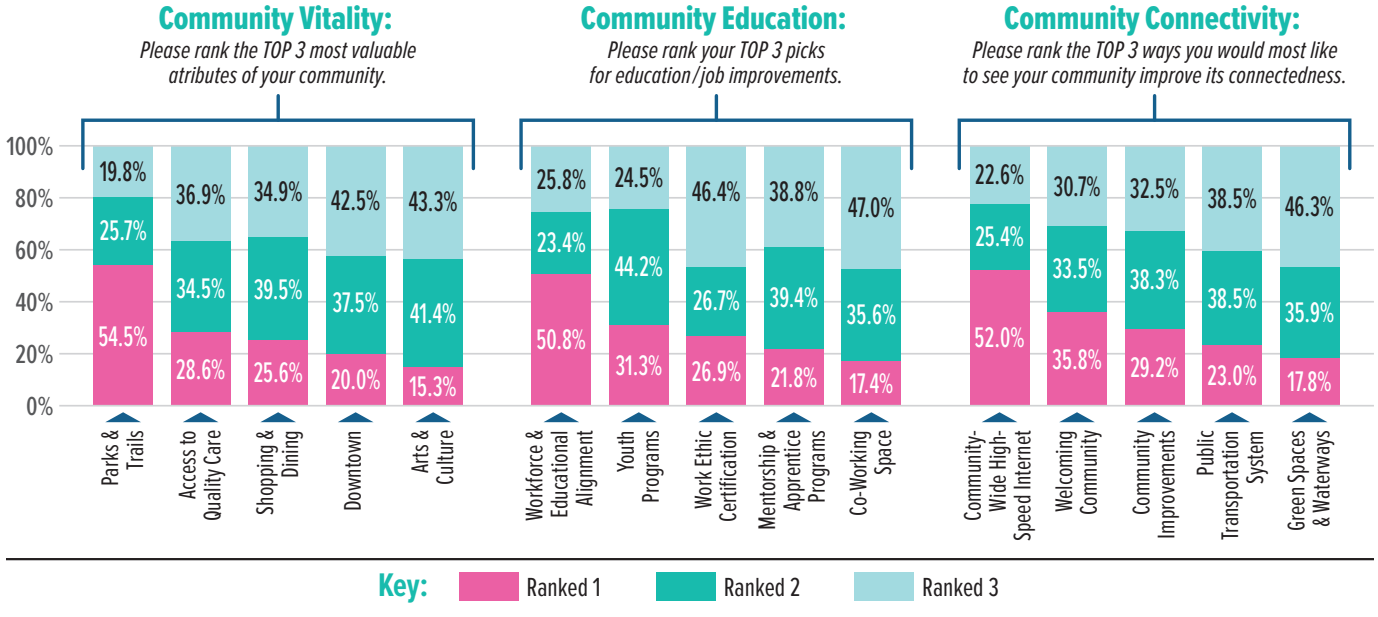
Counties involved: 5 (Carroll, Cass, Fountain, Tippecanoe, Warren)

Regional impact: Increased region connectivity, quality of life, placemaking, and IoT integration



2019 Placemaking Survey — Top Findings

WHIN staff members and interns spent three days at each of the 10 county fairs during the months of June and July, collecting 1,500 more surveys—both in person and online—bringing the total number of responses in 2018 and 2019 to 4,000, which represents approximately 1% of the region's total population. Survey respondents were asked to rank their priorities in terms of community vitality, education, and connectivity.



APPENDIX A: **Outcomes**

Please Note: Due to the connection between projects, there are outcomes listed in the Sensor Development and Implementation section that are also relevant in the Digital Agriculture section. This reflects collaboration, not duplication, of efforts or expenses.

AIM 3.1.1: Establish IoT Platform Testbeds at Purdue to Advance Digital Agriculture Demonstrations, Teaching, and Research

AIM 3.1.1.A: Implement Sensors Within the ABE High-Tech Ag Facility

Anticipated Outcomes	Outcomes to Date	%
Due to the construction timeline of Purdue's ABE Building, the ABE High-Tech Agricultural Facility is expected to be widely sensored by 2020 (Year 3, assuming a January 2018 start date). In the meantime, work will begin by investing in a planner/administrator to cultivate industry partnerships, investigate logistics, and train/recruit qualified staff.	• ABE Facility is under construction. It is expected to be widely sensored by 2020. It will include large space for equipment, high-tech labs for processing and environmental analysis, as well as instrumentation and controls for agricultural production and processing applications. There will also be a design studio to improve health-centered design for digital agriculture solutions.	50%
20 demonstrations and/or teaching initiatives per year.	• ABE Facility has begun construction. It is expected to be widely sensored by 2020.	0%
Proposals submitted for 3 community-linked research projects connected with the facility per year, post sensor installation.	• ABE Facility has begun construction. It is expected to be widely sensored by 2020.	0%
2 new technologies/intellectual property filings per year generated by the testbeds, which will result in new startups and products launched in the WHIN region.	• ABE Facility has begun construction. It is expected to be widely sensored by 2020.	0%
$3.5 million of research expenditures in the testbeds from industry and government sources, post-sensor installation.	• ABE Facility has begun construction. It is expected to be widely sensored by 2020.	0%

AIM 3.1.1.B: Implement Sensors Within the Indiana Corn and Soybean Innovation Center, Located on the Agronomy Center for Research in Education's (ACRE) Farm		
Anticipated Outcomes	**Outcomes to Date**	**%**
Purdue's ACRE Farm site is expected to be extensively instrumented by late 2018 (Year 1, assuming a January 2018 start date).	• WHIN's pilot research studies show that real-time data capabilities of the IoT testbeds work. Real-time monitoring of micrometeorology sensors, along with the automated transfer of data from ACRE to campus for processing, has proven successful in demonstrating the capability of autonomous data in our testbeds. The development of real-time parallel processing eliminates the need to rewrite code. The automation of these processes increases the speed and reduces labor for data transfer and processing. • Wireless data transfer was successfully tested at ACRE. ACRE has LoRa (LOng RAnge) capability to transmit data wirelessly, reaching remote places off the power grid. WHIN projects at ACRE are now positioned to collect/transmit/analyze low-rate sensor data from battery or solar powered devices in ground, in the air, in bins, and on machinery. • Faculty/student projects getting partial support are: - Ackerson: digital soil mapping, - Verma: biosensors for antibiotics, - Wang: iSTEM education in HS, - Stwalley: connected livestock facilities, - Chaterji: analytics development, and - Saraswat: UAVs for weed ID. • Andrew Balmos began as Data/Software Engineer on June 17, 2019. • A sensor pipeline project is underway to build a framework so that researchers can dynamically add sensors, data translation, and data analysis processes to most frequently used data flows.	90%
20 demonstrations and/or teaching initiatives each year.	• CONTxT metadata app updated to include UAV, planting, harvest, spray/spread, tillage, and anomaly operations (www.openatk.com/CONTxT) and included in UAV session of spring 2019. • 9 REEU participants learned data analytics using ACRE, SEPAC, and other Purdue data. • AgBOT competition and associated presentations. • Digital Ag Roundtable demonstrations.	75%
Proposals submitted for 3 community-linked research projects connected with the facility per year, post sensor installation.	• Chaterji, Buckmaster, and others submitted an NSF-CPS on precision application of agrochemicals (nitrates and phosphates) and microbial applications. A new collaboration with Rice ECE's Ashutosh Sabharwal, lead for the "networking" thrust, which will involve novel 5G and other technologies for networking in farm spaces. Sensors are being developed by Rahim Rahimi, the lead for the sensing thrust (nitrate, phosphate, microbial sensors). Purdue is the lead university, and Chaterji the PI on the grant. Ashu Sabharwal is the PI from Rice (still pending). • Purdue Ag/Engineering team is a part of AERPAW of NC State – a successful NSF Advanced Wireless Communication submission. • Purdue Ag/Engineering team is part of an NSF Engineering Research Center proposal (now at site visit stage) on IoT for agriculture – including Purdue farms as testbeds.	50%
2 new technologies/intellectual property filings per year generated by the testbeds, which will result in new startups and products launched in the WHIN region.	• Dr. Chaterji met with OTC for IP filing for cloud data analytics, paper accepted at Usenix ATC 2019 for more sophisticated analytics for dynamic jobs submitted to cloud-based clusters.	50%

AIM 3.1.1.B (Cont'd)		
$2 million of research expenditures in the testbeds from industry and government sources, post-sensor installation.	• CNH and John Deere autonomy projects underway (Buckmaster, Krogmeier, Lumkes, Evans, and others). • Those projects add to the "WHIN as global epicenter for Digital Agriculture" with global equipment leaders coming here to do what they cannot do themselves. These are leveraging dollars to propel research in instrumentation, controls, and autonomy. • USDA NIFA Sustainable Ag Systems proposal LOI submitted in June 2019 ($10M project; Bhunia lead, Foster, Iyer, Preckel, Buckmaster, Feng, and others are involved). Title: Crop-to-Consumer Sustainable Fresh Produce Production, Safety and Economics. LOI result was not encouraging of a proposal. • Those projects add to the "WHIN as world epicenter for Digital Agriculture" with institutional partners (and corporate support) coming together. Purdue is involved because there are elements best done here by expertise at Purdue. These are leveraging dollars to propel research in communication pathways, instrumentation, controls, and autonomy.	25%

AIM 3.1.2: Establish Sensors Throughout the Ivy Tech Community College – Lafayette Agriculture Teaching Laboratory		
Anticipated Outcomes	**Outcomes to Date**	**%**
Ivy Tech Community College–Lafayette Agriculture Teaching Laboratory will serve as a testbed and be widely sensored by 2019.	• The Birck Sensor Team engaged with ITCC in the Spring of 2019 to begin the deployment of the sensors in the ITCC farm. • In June 2019, the Birck Sensor Team came to Ivy Tech to test the point-to-point data collection with the use of LoRa technology from the farm field to the computer laboratory in Ivy Hall. • On Aug. 5, 2019, the first set of sensors were installed at Ivy Tech and began collecting data. The sensors installed collect nitrate levels in the soil, soil temperature, soil moisture, and electro-conductivity. • Additional sensors will be installed called "decagon" sensors in fall 2019. • Ivy Tech faculty and staff have been engaged in selecting the locations of the sensors according to soil type, and crops produced in the field. The cover crop production trials will also be integrated with sensors to measure nitrate levels.	100% for Years 1 & 2; 60% overall.
Ivy Tech will develop campus-based curriculum, and work in conjunction with the Krannert School of Management and IN-MAC, in developing online curriculum.	• PAET 107 UAV/Drone Course was offered in spring 2019. One student has passed the FAA flight licensure test and flew drones for an internship in summer 2019 with Co-Alliance. Updates to the PAET course are in process. • ITSP 235 Internet of Things Fundamentals course update was approved by the Ivy Tech Curriculum Committee. • DMBS 260 Advanced Data Analytics course is under update development. Bryce Eaton and Steve Musick will be updating an ADMF 205 course called Sensors and Manufacturing. The framework of the online course has been created and further development of the content is ongoing. • Justin Baitz will be provided with a "faculty download reassignment of one teaching class," which will include a training course on sensor connectivity and data collection.	35%
Proposals will be submitted for 4 community-linked research projects connected with the laboratory per year, following the sensor installation in conjunction with Purdue University.	• The WHIN (Ag & Manufacturing) Alliance Membership will be provided insights from the sensor deployment at the ITCC testbeds. This could involve workshops, field days, and short-course training programs. • Data collected in the WHIN testbeds will be provided to ITCC faculty and students to utilize for course projects. • WHIN is creating a data hack-a-thon event for student teams to take data from the WHIN Ag and Manufacturing Alliances to analyze the data and create problem-solving case studies. • There are several emerging opportunities for ITCC and Purdue students to engage in the Regional Cultivation Fund projects throughout the region.	100% for Years 1 & 2; 60% overall.

AIM 3.1.3: Establish IoT Testbed(s) Throughout the Wabash Heartland Region with Industry Partners		
Anticipated Outcomes	**Outcomes to Date**	**%**
3 of the community-based research projects above will be community-linked IoT platform/research projects each year, after sensor installation in the Purdue testbeds.	• Although testbeds are not yet completed, Farmers, FFAs, and other regional groups show great interest in the deployment of various current technologies and those under development. • Testbed sensor deployments are underway at TPAC, ACRE, and Ivy Tech, where such demonstrations should lead to community-based projects in the region. • Negotiations on the WHIN/Purdue data agreement is underway as it applies to WHIN Alliance Data. The use of WHIN Alliance data by Purdue researchers should lead to community-based researched projects and attract research investment dollars to the region. • Buckmaster, Scott, and Erickson continued discussions with AgIT business relationship staff on data hub for agriculture. This data hub is the first step toward autonomous data within Purdue's network, working out kinks that the WHIN Ag Data Alliance will continue to have until technical data flow issues are resolved.	25%
10 counties throughout the region will be engaged each year in community-linked IoT platform projects or training.	• Buckmaster and Erickson met with Virginia Bolshakova (Purdue Curriculum and Instruction, Science Education) to discuss Personal Food Computers for each WHIN high school as an IoT demo/education unit. As a result, a Personal Food Computer has been set up and is being tested prior to deployment. • Through the offerings of WHIN's RCF, round 1, three of the approved projects have ag-related activities affecting parts or all of the region. • All 10 WHIN county fairs were attended by the Purdue Extension teams with a strong WHIN presence. • WHIN hosted its Ag Alliance Summit on Aug. 27, 2019 with 71 in attendance.	25%
$.5 M of research expenditures in the testbeds from industry and government sources.	• WHIN CEO Johnny Park negotiated Ag Alliance partnership including 20 farmers in the region, Purdue, and Ivy Tech. The benefits include: - Solinftec is 100% funding the first year of equipment monitors. Total value approximately $450,000 per Solintfec. - Davis has also provided a significant purchase discount on their weather stations, an investment of $45,350. • RCF planning grants could potentially lead to impact grants with additional research expenditures and development of regional testbeds. • Grant awarded: An Innovative Cyber-Framework Integrating Public/Private Data for Evidence-Based Recommendations $1M, National Institute of Food and Agriculture (NIFA), Food and Agriculture Cyberinformatics and Tools (FACT). Provide proof-of-concept linking public with on-farm data to create a model ecosystem and community for continuous improvement of the evidence for practice. Focus on phosphorus (P) and potassium (K) management recommendations with more contextual relevance, on-farm value and compliance with emerging farm-to-fork sustainability metrics.	75%

AIM 3.1.4: Develop "Career Ready" Educational Programs in Applied Data Analytics in High-Tech Agriculture: Providing Middle-Skills Certifications, Undergraduate, and Graduate Education		
Anticipated Outcomes	**Outcomes to Date**	**%**
A full-time educational specialist that leverages opportunities between Purdue and AgriNovus.	• College of Agriculture Digital Agriculture website is on track, being built under the supervision of Purdue's Ag Communication. Two sites will be developed. The one that is general and public-facing will be maintained by Ag Communication. The other one, led by Dr. Erickson, will be more technical and geared to those working in digital agriculture both internally and externally. A directory for the website is being considered.	100%
25 BS graduates per year in digital agriculture.	• Ag CSRC has adopted Data Science for Agriculture outcomes. • Certificate in Data Applications approved by UEAC in March 2019. • Erickson and Buckmaster crafted a proposal for a Digital Agriculture Minor as a complement to the Data Science Certificate. • Application in Data Science Certificate has several logical paths for agriculture, which includes two courses in the foundational categories. • Erickson and College of Agriculture colleagues submitted a $99,648 grant to the provost's office to build a new course in applied digital agriculture. Departments include Agricultural and Biological Engineering, Agricultural Economics, Agronomy, Animal Sciences, Entomology, Food Science, and Forestry and Natural Resources. The grant was awarded in June 2019.	25%
50 certificates per year awarded on digital agriculture topics.	• Research and Extension Experiential Learning for Undergraduate Experience (REEU). This summer marked the launch of REEU, a ten-week summer program created to equip undergraduates with data skills in computer science, including spreadsheets and programming languages like Python, R, and ArcGIS. This student-centered, active-learning environment began with a course-like structure and culminated in an independent research experience with eight students from six states successfully completing the program. This successful program will continue for four more years with funding from USDA/NIFA. • Proposed UAV short course planned to be offered as a certificate program. • Discussions regarding using existing Agronomy e-Learning modules for Purdue's proposed winter agriculture short course. Working over contract details that define the relationship of Purdue e-Learning with the American Society of Agronomy (ASA). Decided that a code will be used to track traffic directed by ASA. • Internal discussions are ongoing regarding Credly.com about certificate offerings.	25%
8 professional MS degrees per year awarded in digital agriculture.	• Established the online graduate certificate in Geospatial Data Science. Approved for launch in January 2020, the course curriculum for this certificate will provide students with the core knowledge of data methods, geographic information systems, sensing technologies, and practical applications for use in wide-acre farming, small-holder agriculture, environmental management, and digital forestry.	25%
25 positions filled in critical needs areas (projected from baseline occupational skills needs assessment).	• Need to identify a means to quantify this metric; perhaps in conjunction with Career Fair and placement services, Interns for Indiana, and PCRD's ONA work. • Survey underway in support of a USDA-NIFA Higher Education Challenge Grant (Saraswat and Buckmaster) submission; title was "Computational Skills Development for Next Generation FANH Professionals for Sustaining Data-Driven Agriculture."	25%

AIM 3.1.5: Develop Extension Programs to Strengthen the Purdue Extension Program's Ability to Serve Agricultural Producers and Agribusinesses in the 10-County Region with Regard to "Digital Agriculture"		
Anticipated Outcomes	**Outcomes to Date**	**%**
A full-time extension specialist coordinating the outreach work of the Purdue team involved in the deployment of "digital agriculture" strategies relevant to the region.	• Purdue Extension specialist and WHIN interns conducted digital ag surveys and demonstrations at the 10 county fairs in the region, as well as the Indiana State Fair. More than 500 people were surveyed about future needs in digital agriculture, in addition to personal interactions with those attending UAV demonstrations. • Industry leaders and legislative representatives were treated to a drone demonstration at the Rural Caucus, led by a Benton County 4-H youth, who provided a glimpse of the hands-on experience students gain through the 4-H digital agriculture (STEM) programs.	100%
Investment in a marketing campaign to brand Purdue Extension as the primary and trusted source of information on science-based digital agriculture innovations.	• Prepared a list of marketing items and technologies for use by ANR Educators to engage with WHIN residents/professionals during 2019 county fair tours. • John Scott attended all 10 WHIN region county fairs with the digital ag trailer promoting digital ag practices and tools in the region. Live UAV demonstrations were conducted. Live weather station and thermal camera demonstrations were also conducted. • Investigated both Drone Deploy and Sentera technology in 2019 to expand Extension's understanding and outreach with the different features from each to give WHIN producers better information. • Received approval and purchased new technology for testing in the 2019 season. New UAV sensors for the six WHIN Extension Educators, three types of thermal cameras, and mobile and immobile weather stations with the goal of building case studies/demonstrations around these tools.	25%
Development of a suite of 15-20 extension-related products that inform, educate, and increase access through Purdue Extension channels (such as the Purdue Extension website and the Education Store).	• Train-the-trainer event for the Purdue Extension UAV Signature Program. All qualified Extension Educators can present this program in their local communities now. Plans are currently being developed to present this material across the state with 1-2 slated for the WHIN region next year. • Collaboration with CCSI; used the new FLIR E6 Thermal Camera (purchased with WHIN funds) to collect thermal imagery at a cover crop field day in Warren County looking at differences in surface temperature with different tillage and cropping systems. • Meeting with the UAV Signature Program team to discuss next steps for taking the Purdue Extension signature program nationally as an educational product. • UAV flights to collect imagery for 2019 case studies. Flew multiple fields using two different drones and three software packages. Development of uses and case studies around new UAV sensors and other digital tools underway.	25%
Adoption of digital agriculture strategies by at least 15 rural communities, agribusinesses, co-ops, and/or ag-related nonprofits by 2022.	• WHIN ANR Educators will be part of the WHIN weather station network, sponsored by Davis Instruments, to promote data collection and usage throughout the region. • Twenty-five weather stations installed across the region on farms and in coordination with Extension Educators. Working closely with Co-Alliance technicians on installations in Tippecanoe, White, Benton and Warren counties. • Met with Weaver Popcorn Bulk (Montgomery County) regarding UAV usage with their research and testing plots. • Met with three farmers in White, Cass, and Clinton Counties interested in machine data collection and a weather station as part of WHIN. • Conducting multiple flights over a side dress operation that is applying manure with a drag-line in standing corn to help determine cost-benefit to the producer.	25%

AIM 3.2.1: Establish a Testbed to Demonstrate, Teach IoT to Companies and Students

AIM 3.2.2: Establish a Testbed to Showcase Real-Time Sensor and Network Capabilities of WHIN-Area Firms for OEMs

AIM 3.2.3: Establish a Digital Supply Chain Tool to Increase the Visibility of WHIN's IoT Capabilities to Procurement Managers Discover WHIN-Area Firm Capability

Anticipated Outcomes	Outcomes to Date	%
YEAR 1		
AIM 3.2.3: Map the capabilities of companies in the WHIN region using digital tools for supply chain prototyping.	• Supply Chain Regional Mapping is partially complete to identify company locations in the region. Started confirmation of data with all targeted companies. • Completed web-scraping for 229 of 279 companies and collected equipment, product, and certification data, classifying 187 companies' products using NAPCS code. • Nvivo Software Analysis: - Worked on how it can be used to analyze a detailed list of company's comments (1,500- line items). - Reviewed/analyzed 90 company customers/employees' on-line reviews. - Performed sentimental analysis of company and employees' on-line reviews. • Validated 284 companies NIS and NAPCS codes.	100%
AIM 3.2.3: Connect with LEDOs or other economic development groups across WHIN counties to deploy supply chain prototyping tool.	• Continuation of Digital Supply Chain Tool (SCT) testing and prototyping of 35 companies; continued engagement with LEDOs through attending their monthly ITC meetings. • Met with WHIN team and agreed on attributes that will be searchable by the Digital SCT and data exchange timing. • Continued development and testing of prototyping tool for "soft launch" during August Manufacturing Council meeting. At the Aug. 27, 2019, manufacturing education workshop, local companies tested the tool and provided idea for suggested revisions.	100%
AIM 3.2.3: Work with OEMs to prioritize approaches to reduce supply chain leakage and record extent of leakage reduction.	• Presented the Supply Chain Tool Design to Manufacturing Advisory Committee receiving positive feedback and some good suggestions. • Created 15 additional company information pages for a total of 40 to be linked to main website. • Reviewed and added 5 additional attributes to database: standard products, shipping services, distribution, supplier, and warehouse.	100%
AIM 3.2.3: Work with individual companies to seek opportunities to collaborate by pursuing new business jointly.	• Establishing regional "peer" networking groups to build collaboration between companies throughout the region. Currently, the WHIN-Purdue team launched four groups, one of which are now self-sustaining.	100%

AIMS 3.2.1, 3.2.2, and 3.2.3 (Cont'd)		
YEAR 2		
AIM 3.2.1 & 3.2.2: Design and plan IMT physical location at Indiana Manufacturing Institute (IMI) in Purdue's Research Park.	• Jan. 30th saw the public launch of the MD Lab, which occupies the 20% of the IMI Testbed (IMT). • June 30th saw the conclusion of the Testbed site construction - Construction concluded below the authorized budget of $2.0M; no WHIN-funds used for construction. • The 3rd phase of Testbed launch is on-plan for deployment in Q1 2020.	80%
AIM 3.2.1: Establish IMI Testbed to showcase IoT sensor/network capabilities to companies and students.	• Industry partnerships are in development to launch and sustain the Testbed: - Negotiations continue with industry hardware, software and service providers (Hexagon, Forcam, True Analytics, Fanuc, Fluke, Sage Clarity, Epicor, Infor, and Google). • GoogleX donated 6 autonomous vehicles to be utilized in the Testbed.	40%
AIM 3.2.2: Conduct research and development valuable to and in harmony with Industry needs.	• Predictive Maintenance based on machine learning at WHIN-company locations: - Commercial vibration sensors (Fluke) were deployed at Bio Town Ag (White County) and are scheduled for deployment at Evonik (Tippecanoe County). - A sound acquisition system was installed on the 5-axis CNC machine spindle at Standard Industrial (Pulaski County); Work continues with the machine learning group to develop a robust deep-learning model. • Development of part dimension measurement system using 2-D vision: - A program to detect the edges of part images and estimate dimensions was developed at Oscar Winski (Tippecanoe County). • Exercise MT-Connect (middleware) technology: - A web-based dashboard showing machine information has been developed to enhance MT connect applications. The MTConnect system has been deployed to Standard Industrial (Puaski County). - A Raspberry PI was attached to a pipe bending machine to collect the signals from manual buttons. - A geometric virtual twin is constructed using (Unity) game engine. • Real-time cost modeling research within MD Lab portion of testbed is on-plan: - Cyber cost model demonstrator of MD Lab equipment implemented. - Transitioning to web-based application. • Machine learning based predictive maintenance and its testbed: - Work with the machine learning group is ongoing to develop a robust deep learning model. • Exploration of sensor needs: - Project completed to explore sensor needs for a digester at Bio Town Ag (White County).	40%
AIM 3.2.2: Translate IoT and advanced manufacturing knowledge into Testbed workshop modules for Industry.	• The workshops will be held on Oct. 17th 2019 following the Digital Enterprise Center fall symposium (open to all WHIN companies) on Oct. 16th 2019. • A 12+ month launch sequence of IMI Testbed workshops is in development, informed by company-participant interests, manufacturing research, and capability deployment plans in the testbed site. Workshop content and participant takeaways are being coordinated across all Purdue-WHIN efforts.	30%
AIM 3.2.2: Identify a relevant use case for demonstrating connectivity between OEM and supplier for design, production (including supply chain), and sustainment.	• Demonstration of the new MBWI (model-based work instructions) use case to Digital Enterprise Center (DEC) partners. MBWI modules will be adapted for WHIN. Obtained feedback from companies that use augmented reality (AR) for work instruction to gather information on integrating AR with MBWI.	60%

AIMS 3.2.1, 3.2.2, and 3.2.3 (Cont'd)		
YEAR 2 (Cont'd)		
AIM 3.2.1 & 3.2.2: Deploy commercial software, hardware, and middleware, establishing the IMT digital sensor and networking architecture, between laboratories on West Lafayette campus for prototype workflow/infrastructure.	• Predictive Maintenance based on machine learning and testbed interaction: - Mini-motor testbed on Purdue campus (POTR). Testbed allows for various faults to be introduced. Faults have been successfully detected using machine learning methods. - Experiments conducted at KNOY motor lab using an industrial scale motor to collect acceleration signals under different motor conditions. Data is being shared with IoT group machine learning team. - An RPM invariant deep learning model developed through collaboration with machine learning group. Model has been validated with experiments. • Sensor/Communication (collaboration with the IoT group): - Two tri-axial sensors (piezoelectric and Mems) were deployed in Birck facility room. The pump is monitored by the sensors, and historical data are used to develop data-driven model. A web-based user interface is being developed to visualize sensor data. - A vibration sensor based on TI technology is designed. A first version has been tested on a motor; some new features and modifications are under development. A flexible vibration sensor, which was developed by the IoT group will be tested in a motor testbed. • Exercise open-source middleware technology (MT Connect) to validate machine data: - A user interface to navigate and check the machine data in the VR-based digital twin was developed. • Machine learning based predictive maintenance and its testbed: - A collaborative robot was installed in the lab testbed. Since it uses ROS, an open-source framework for robotics, a new MTConnect adapter combined to ROS was developed so the robot could be added to the digital twin using Unity game engine.	40%
AIM 3.2.2: Identification of the minimum product and systems information model to communicate between OEMs and suppliers.	• The physical design and network architecture for the IMI Testbed at launch are complete with initial commissioning planned for Q4 2019. The information models for the flow of product and systems data across the enterprise and extended supply change are in development for testing and deployment in grant year 3.	70%
AIM 3.2.3: Connect with LEDOs or other economic development groups across WHIN counties to deploy supply chain prototyping tool.	• Met with WHIN team and agreed on attributes that will be searchable by the Digital SCT and data exchange timing. • Continued development and testing of prototyping tool for "soft launch" during August Manufacturing Council meeting. At the Aug. 27, 2019, manufacturing education workshop, local companies tested the tool and provided idea for suggested revisions.	100%
AIM 3.2.3: Map the capabilities of companies in the WHIN region using digital tools for supply chain prototyping.	• Current Supply Chain Tool Results - Total Number of Manufacturing Companies = 279 - Companies with equipment Data = 85 - Companies with certification data = 122 - Companies with NAPCS codes = 279 • Completed web-scraping for 229 of 279 companies and collected equipment, product, and certification data, classifying 187 companies' products using NAPCS code.	100%
AIM 3.2.3: Work with individual companies to seek opportunities to collaborate by pursuing new business jointly.	• Established regional "peer" networking groups to build collaboration between companies throughout the region. The WHIN-Purdue team launched four groups, one of which is now self-sustaining.	100%

AIMS 3.2.1, 3.2.2, and 3.2.3 (Cont'd)		
YEAR 3		
AIM 3.2.2: Deploy and assess the digital product and process information model with partner companies and their supply chains.	• Planned for Year 3.	
AIM 3.2.1 & 3.2.2: Have deployed full digital enterprise sensor and networking architecture and infrastructure within the IMT location.	• Complete by 30-June 2020.	
AIM 3.2.1 & 3.2.2: Develop prototype predictive analytics architecture and tools.	• Prototype tools by 30-September 2020.	
AIM 3.2.2: Finalize satellite locations for IMT architecture at companies throughout the WHIN region.	• Identify [3] satellite locations in the region by March 30, 2020.	
AIM 3.2.1: Establish additional technology adoption opportunities through mobile demonstrations.	• Planned for Year 3.	
AIM 3.2.1: Deploy the next version of the supply chain prototyping tools that includes targeted certification and skill development at firms.	• Planned for Year 3.	
AIM 3.2.1 & 3.2.2: Develop mechanisms to enable ROI for smart tool investments across the supply chain.	• Planned for Year 3.	
AIM 3.2.3: Map the capabilities of companies in the WHIN Region using digital tools for supply chain prototyping.	• Planned for Year 3.	
AIM 3.2.3: Expand the Digital Supply Chain Tool to include specialized suppliers.	• Planned for Year 3.	
YEAR 4		
AIM 3.2.3: Map the capabilities of companies in the WHIN Region using digital tools for supply chain prototyping.	• Planned for Year 4.	
AIM 3.2.3: Deploy supply chain prototyping tools as web based resources to attract new manufacturing investments to the WHIN region.	• Planned for Year 4.	
AIM 3.2.3: Develop a link between the supply chain prototyping tool and IMT to enable digital exploration of supply chain capabilities.	• Planned for Years 3-4.	

AIMS 3.2.1, 3.2.2, and 3.2.3 (Cont'd)

YEAR 5

AIM 3.2.3: Deploy supply chain prototyping tools as web based resources to attract new manufacturing investments to the WHIN region.	• Planned for Year 5.	
AIM 3.2.3: Expand the development of the link between the supply chain prototyping tool and IMT to enable digital exploration of supply chain capabilities.	• Planned for Year 5.	
AIM 3.2.3: Map the capabilities of companies in the WHIN region using digital tools for supply chain prototyping.	• Planned for Year 5.	
AIM 3.2.3: Evolve the digital supply chains in the WHIN region to incorporate emerging technologies for smart manufacturing.	• Planned for Year 5.	

AIM 3.2.4: Establish the Ivy Tech Next-Generation Center Pilot Program

Anticipated Outcomes	Outcomes to Date	%
The first year of the grant will be focused on fostering greater collaboration between Ivy Tech and Purdue in terms of IoT expertise and student need assessment.	• In fall 2018, Purdue Polytechnic integrated a pilot run of installing sensors that collect data from the field (at the ITCC Agriculture Teaching Laboratory) and deliver the data back to Purdue's campus. We are in discussions with them to continue this effort for an ongoing basis for this fall 2019.	100% for Years 1 & 2; 60% overall.
Year 2 will be focused on recruiting students and setting up the sensored lab in preparation for the pilot.	• Integration of the sensors into the lab took place Aug. 5, 2019. Fall 2019 course work will use sensors and evaluate data sets collected within the AGRI courses, as well as in the computer science department. • Vibration and flow sensors were installed on the compressed air system in Griffin Hall to collect data for student interpretation. Future work with include duplicating this practical application in a lab-based trainer format. • In early September, 2019 at the beginning of the fall semester, 20 students in the Introduction to Crop Science course where given an in-the-field demonstration of the sensors and the data being collected for use in their course work. • One student, Ivy Tech's WHIN Intern, Kelsey Miller, was involved with the pre-installation testing, as well as the installation of the sensors in July and August 2019.	70% for Year 2; 40% overall.
Years 3 and 4 will be implementation-focused, working with 80 Ivy Tech students per year, spanning several disciplines in agriculture and manufacturing (for a total of 240 students in years 3-5).	• We have already begun engaging students into the farm field (Introduction to Crop Sciences course), by introducing them to the field sensors installed at Ivy Tech, and how data is collected and analyzed for real-world and practical experiences. As curriculum is deployed and integrated into the course work, more students will become engaged with the WHIN objectives across several schools and programs, including School of Advanced Manufacturing, Engineering, and Applied Sciences, as well as the School of Information Technology.	Planned activity for 3-5 years.

AIMS 3.2.4 (Cont'd)		
A minimum of 20 students will participate in summer internships during years 3-5 (located at both the Ivy Tech and Purdue University campuses), stemming from the pilot program.	• In the Summer of 2019, we hired a student to assist with the deployment of the sensors in the Ivy Tech testbed. She was also given the opportunity to proctor the Regional Placemaking Survey at all 10 county fairs, to gather data from residents about how best to focus the Regional Cultivation Fund. • We are in the process of hiring another student intern during the Fall, 2019 semester and beyond in the School of Information Technology at Ivy Tech to assist with data collection from the field sensors, and data management. • More work needed in this area. Additional planning in terms of recruitment, development of opportunities and implementation will be occurring shortly in order to provide those opportunities/place those students in the upcoming spring and summer semesters.	Planned activity for 3-5 years.

AIM 3.2.5: Establish Workforce Engagement and Training for Smart Manufacturing and IoT

YEAR 1

Anticipated Outcomes	Outcomes to Date	%
Reach out to all 77 manufacturing companies identified in the region (during Year 1), targeting 5-6 consultations per month in order to visit all of them within the first year, if possible.	• Attempts to contact all 302 companies previously helped students determine that 23 of these companies are either no longer in business or not manufacturing. This leaves 279 companies that will be the target group for WHIN Education programs. • Next step will be to compare each company's business description as listed on their website to verify that these companies perform manufacturing. According to the SCT team, categorization identifies some of these companies as non-manufacturing companies. • WHIN Education Team logged a total of 348 contacts to date with WHIN region manufacturers—either by meeting personally with clients, relaying information back and forth via email, or engaging in phone discussions.	100%
Develop relationships with all adult education programs in the region to find ways to collaborate with them in effectively appealing to the underemployed (during Years 1 & 2).	• WHIN-Manufacturing Education, Seminar and Workshop coordinating team (S. Dunlop, M. Ursem, T. Fiock) met weekly to coordinate plans for the "Wabash Heartland Manufacturing Group" seminars and workshops; save the dates were sent to WHIN manufacturing shareholders for first 4 workshop. More than 50 people showed up to the first workshop on Aug. 28, 2019. • Reached out to potential partners to establish working relationships to enhance the course portfolio and to avoid re-inventing the wheel. Potential partners are: Skillful Indiana, ToolingU, Workforce One, LARA, MEP. • Published 11 technology information posters for distribution to all engaged companies. Received initial feedback and will incorporate suggested changes. • Inaugural WHIN Manufacturing workshop series (1/2 day) hosted at Purdue IMI on Aug 28, 2019, with ~45 participants. The workshop theme was "Transitioning to Industry 4.0;" discussion and feedback from industry participants was positive. • A 12+ month launch sequence of workshops is in development, informed by company-participant interests, manufacturing research, and capability deployment plans in the testbed site. Workshop content and participant takeaways are being coordinated across all Purdue-WHIN efforts.	100%

AIM 3.2.5 (Cont'd)		
YEAR 1 (Cont'd)		
Use the gap analysis process to develop customized courses (aggregated as company needs align) to help build the capacity of their employees to increase their "value creation ability" by using IoT and related smart tools (during Years 1 and 2).	• WHIN-Manufacturing Education, Seminar and Workshop coordinating team (S. Dunlop, M. Ursem, T. Fiock) met weekly to coordinate plans for the "Wabash Heartland Manufacturing Group" seminars and workshops; save the dates were sent to WHIN manufacturing shareholders for first 4 workshop. More than 50 people showed up to the first workshop on Aug. 28, 2019. • Reached out to potential partners to establish working relationships to enhance the course portfolio and to avoid re-inventing the wheel. Potential partners are: Skillful Indiana, ToolingU, Workforce One, LARA, MEP. • Published 11 technology information posters for distribution to all engaged companies. Received initial feedback and will incorporate suggested changes. • Inaugural WHIN Manufacturing workshop series (1/2 day) hosted at Purdue IMI on Aug 28, 2019, with ~45 participants. The workshop theme was "Transitioning to Industry 4.0;" discussion and feedback from industry participants was positive. • A 12+ month launch sequence of workshops is in development, informed by company-participant interests, manufacturing research, and capability deployment plans in the testbed site. Workshop content and participant takeaways are being coordinated across all Purdue-WHIN efforts.	100%
Implement communication plan that includes WHIN web-site and periodic newsletter (Year 2).	• Continued development and testing of Purdue-WHIN website, rolled out on a beta basis to the Manufacturing Advisory Committee company members in June and the general public in August. • The latest edition of the Education and Supply Chain Newsletter was sent out in July 2019.	100%
Engage with LEDO's and individual companies on a regional basis to promote education programs and encourage small project co-learning (Year 2).	• There are now FOUR regional groups, one of which, after five meetings, is running autonomously with our support; 14 of our high-engagement companies attending ten meetings (eight regional and two special-interest meetings). • Facilitation of the regional groups with emphasis on local non-competitive, closed groupings that produce a unique setting in which to share knowledge and best-practices and co-develop for improved manufacturing excellence across the three dimensions, 'Smart Business' (business & systemization), 'Smart People' (human development) and 'Smart Technology.' • Managing three of the four closed, non-competitive peer-groups {one now being self-managing (sustainable)}. All other groups will also become self-sustainable. - Supporting all four groups and launch a prospective fifth group embracing seven, or more, of the ten counties. - Three regional meetings (held in July) requested our input on a range of issues important to their manufacturing needs for excellence, (Laf-SE1., SW1 and NE1). • Look to initiate and support three or four new special interest groups depending upon shared needs and demand.	100%

AIM 3.2.5 (Cont'd)		
YEAR 2		
Design curriculum around the content most needed by employees (as exposed in the gap analysis) to increase their "value creation ability" and productivity (Years 2-5).	• Finalized first roll-out of Education courses for web-launch across 18 distinct areas of need. • The WHIN education team is getting ready to roll out a series of workshops to assist manufacturers with current and future issues impacting your operations, topics in technical and non-technical areas.	100%
Determine the best delivery system suited for the audience(s), adapt how the course is delivered (in-person, online or hybrid) during grant period based on the feedback received (starting in Year 1, continuing through Year 5).	• Offering a range of delivery options including web-based, digital apps, face-to-face workshops.	100%
Arrange a training schedule based on company/employee needs (assessing opportunities for training at shift change, worker needs like transportation and childcare, and availability) (Years 2-5).	• Offering a range of delivery options including web-based, digital apps, face-to-face workshops that will enable employees at all levels to participate in classes at their own pace and own time.	100%
Deliver courses, on an as-needed basis, on-site at the manufacturing plant to current employees (Years 2-5).	• Offering a range of delivery options including web-based, digital apps, face-to-face workshops that will enable employees at all levels to participate in classes at their own pace and own time.	100%
Engage at least 30% of the 77 companies (for a total of at least 25 companies implementing/operating courses designed and deployed by DCMME) (by the end of Year 5).	• Conducted combo Problem Solving/VSM/Project Reporting. To-date, 60 participants from 25 companies have attended 115 classes. • Engaging with over 30 companies that participate in Peer Group meetings and workshops.	200%
YEAR 3		
Design curriculum around the content most needed by employees (as exposed in the gap analysis) to increase their "value creation ability" and productivity (Years 2-5).	Planned for Year 3.	
Determine the best delivery system suited for the audience(s), adapt how the course is delivered (in- person, online or hybrid) during grant period based on the feedback received (starting in Year 1, continuing through Year 5).	Planned for Year 3.	
Engage with LEDO's and individual companies on a regional basis to promote education programs and encourage small project co-learning.	Planned for Year 3.	
Arrange a training schedule based on company/employee needs (assessing opportunities for training at shift change, worker needs like transportation and childcare, and availability) (Years 2-5).	Planned for Year 3.	
Deliver courses, on an as-needed basis, on-site at the manufacturing plant to current employees (Years 2-5).	Planned for Year 3.	
Engage at least 30% of the 77 companies (for a total of at least 25 companies implementing/operating courses designed and deployed by DCMME) (by the end of Year 5).	Planned for Year 3.	

AIM 3.2.5 (Cont'd)		
YEAR 4		
Design curriculum around the content most needed by employees (as exposed in the gap analysis) to increase their "value creation ability" and productivity (Years 2-5).	Planned for Year 4.	
Determine the best delivery system suited for the audience(s), adapt how the course is delivered (in- person, online or hybrid) during grant period based on the feedback received (starting in Year 1, continuing through Year 5).	Planned for Year 4.	
Engage with LEDO's and individual companies on a regional basis to promote education programs and encourage small project co-learning.	Planned for Year 4.	
Arrange a training schedule based on company/employee needs (assessing opportunities for training at shift change, worker needs like transportation and childcare, and availability) (Years 2-5).	Planned for Year 4.	
Deliver courses, on an as-needed basis, on-site at the manufacturing plant to current employees (Years 2-5).	Planned for Year 4.	
Engage at least 30% of the 77 companies (for a total of at least 25 companies implementing/operating courses designed and deployed by DCMME) (by the end of Year 5).	Planned for Year 4.	
YEAR 5		
Design curriculum around the content most needed by employees (as exposed in the gap analysis) to increase their "value creation ability" and productivity (Years 2-5).	Planned for Year 5.	
Determine the best delivery system suited for the audience(s), adapt how the course is delivered (in- person, online or hybrid) during grant period based on the feedback received (starting in Year 1, continuing through Year 5).	Planned for Year 5.	
Engage with LEDO's and individual companies on a regional basis to promote education programs and encourage small project co-learning.	Planned for Year 5.	
Arrange a training schedule based on company/employee needs (assessing opportunities for training at shift change, worker needs like transportation and childcare, and availability) (Years 2-5).	Planned for Year 5.	
Deliver courses, on an as-needed basis, on-site at the manufacturing plant to current employees (Years 2-5).	Planned for Year 5.	
Engage at least 30% of the 77 companies (for a total of at least 25 companies implementing/operating courses designed and deployed by DCMME) (by the end of Year 5).	Planned for Year 5.	

AIM 3.3: IoT Infrastructure and Data Analytics		
Anticipated Outcomes	**Outcomes to Date**	**%**
YEAR 1		
Finalize the design of soil sensor (nutrients, moisture, temperature) and fabricate hundreds of sensors that will be placed at Birck's IoT testbed, College of Ag's ACRE as well as at Ivy Tech farm.	• Sensor installation at the field: Prototype boards were installed at the TPAC site collecting temperature and humidity conditions. The installation exhibited the functionality of the designed network, with concurrent real-time visualization of the conditions via online portal. • Sensor deployment: Prototype boards uploading real-time nitrate, temperature, and moisture measurements to the cloud were installed at Birck for long-term testing in a controlled environment. A total of 14 boards are up at three sites (4 at Birck, 3 at the School of Electrical and Computer Engineering, and 7 at TPAC) continuously uploading data to the cloud. • Flexibility demonstration of the sensing platform: The expansion capability of the sensing platform was demonstrated in the field, with the coupling of commercial soil-moisture and temperate sensing elements by Decagon. The online portal updated in order to relay real-time measurements from the Decagon sensing modules at the TPAC site. • The final design iteration of the soil sensor began in November 2018. The design will couple the custom sensing modules that have been extensively tested at various locations with the robust design of the communication platform that was provided by an external company (Huwomobility) and has been already verified by Purdue. The final sensor will optimized for packaging by an outside company.	100% on design of ag sensor. 50% on installations.
Finalize the design of distributed temperature and humidity sensors and fabricate hundreds of sensors for Purdue's ACRE facility and IN-MaC's testbed.	• On-sensor analytics: The capability of performing data-related functions independently on sensors was developed. These functions include anomaly detection (i.e. transmit only when a measurement exceeds a certain range) and data compression (i.e. transmit condensed information less frequently saving power and bandwidth). These capabilities are now being transferred to the prototype boards. • The final iteration of the sensing platform will provide robust, modular functionality with temperature, humidity, and other measurement capabilities, along with long communication range and low power consumption for extended battery life, especially for outdoor applications.	100% on design of T and humidity sensors. 100's of sensors tested in the lab.
Install sensors at main manufacturing partners: Caterpillar, Oerlikon, Wabash National; as well as Frito-Lay and Tate & Lyle (monitoring of moisture during processing – synergy with post-harvest initiative at Purdue).	• Worked with Tate and Lyle on vibration analysis and condition-based maintenance. Initial commercial sensors installed at five of their motors. • The vibration sensors were evaluated for compliance to the applicable ranges and resolution performance. A second generation of vibration sensor deployment planned for Tate and Lyle. Other testing sites at Evonik and Bio Town Ag energy center were also identified. • Manufacturing advisory committee meeting focused on condition-based maintenance was well attended by two-dozen companies. Our tests at Tate & Lyle were shared. We learned about broad spectrum of needs for companies in the region. Some have dedicated staff with regular maintenance schedules and some others are more reactive.	100%
Develop a communication network and hub design (with initial installation at 5 locations throughout the community).	• Improvement of network configurations: Dynamic mesh configuration was successfully tested at TPAC using the LoRa protocol. Also implementing a short-range mesh-network capability. This functionality will reduce power consumption where this type of network is applicable (e.g. on the factory floor). • Evaluation of commercial sensing platform solutions: Group is collaborating with HuwoMobility for a communication and sensing platform to create a strong streamlined product which meets the diverse requirements that can read commercial sensors as well as Purdue's low-cost nitrate sensor. IoT group has developed the necessary firmware for the embedded electronics and tested the communication range of the platform at the TPAC farm. Based on these results we acquired 100 units for testing and deployment. • Improvement of network configurations: The added functionality allows the network to automatically reconfigure when a sensor is added or removed.	100% on design. 40% on installations.

AIM 3.3 (Cont'd)		
YEAR 1 (Cont'd)		
Implement data storage in the cloud and user access through a cell phone app and computer network.	• Cloud data Web site with Mapbox initially populated with sensors at BRK and EE. • Work continues adding live sensor data to Mapbox Web site as a demonstration tool for WHIN stakeholders. Enhancements planned. • An interactive display for Birck Center Atrium is up and running. Visitors to Birck can view "live sensor data" and historical data through this display as we continue to deploy sensors throughout the region.	100%
Conduct guest lectures at community outreach workshops about IoT sensors and data analytics and their impact in improving the supply chain, condition-based maintenance and business operation, and by enabling new business models focused on quality of service and consumer experience.	• Starting in September 2018, both Ag and Manufacturing Council meetings focused on "themed" discussions each month, bring more focus on topic areas of most interest to council members and regional stakeholders. Ag Council meeting theme in September was "asset tracking and management" best practices, Manufacturing Council theme was "Supply Chain Leakage" bringing sellers and buyer together in the WHIN region. • Purdue WHIN wide poster session was held in October 2018 at Birck Center with more than 50 participants from WHIN region. • In depth meetings with Bio Town Ag (White County) and Belstra Milling (Fair Oaks in Jasper County outside of WHIN region), and Benton County Soil & Water Conservation District that have great interest in IoT related projects. • Plans discussed for various workshops in 2019 for WHIN region stakeholders on various IoT topic areas. The IoT group will collaborate with Ag and Manufacturing to create impactful and informative workshops informing stakeholders regarding emerging technologies.	100%
YEAR 2		
Obtain field data from 5-6 IoT nodes throughout the region.	• To date sensors have been deployed at TPAC, Birck, ECE, Tate & Lyle, Standard Industrial (Pulaski County), and Bio Town Ag (White County). A visit with Nucor (Montgomery County) is pending to discuss deployment opportunities there. • The ACRE farm was added in Spring 2019. Currently, four nitrate sensors are reporting measurements from LoRa modules mounted at two different water collection centers. • Five sensor modules were deployed at the Ivy Tech farm to measure nitrate in the soil. Coordinating with Ivy Tech instructors to incorporate field measurements in courses. • Real-time sensor data from Purdue Ag testbeds (ACRE and TPAC) used to optimize communication /networking protocols and sensor devices. For example, optimized wireless mesh network communication to overcome increased crop height; study different water-collection practices to minimize periodic drying of the nitrate sensors due to dry weather conditions.	100%
Study the field data from soil sensor (nutrients, moisture, temperature) and study sensor aging, drift, biofueling.	• Finalized the firmware of the latest ag sensor module to work with 4 Decagon sensors and 2 nitrate sensors (maximum capacity of sensors, with the temperature and humidity). Four additional ag sensors were installed at TPAC. • Monitoring of field data (since 3/13/19 for nitrate data) and frequent on-site maintenance/ inspections are being conducted to evaluate and optimize connection to electronics, passivation, and packaging. • Sensor conditioning for different soil moisture levels was performed in the lab using a variety of soil standards. • Development of a new ag IoT sensor package to ensure consistent moisture levels, unobstructed water flow, and sensor durability. This was initially tested at the Ivy Tech location.	100%

AIM 3.3 (Cont'd)		
YEAR 2 (Cont'd)		
Study the field data from distributed temperature, humidity and moisture sensors. Study sensor aging and drifts.	• Commercial, wireless vibration sensors were installed on the process water pumps at Birck, (2 Fluke 3561 FC) and at Tate & Lyle (4 Fluke 3561). These are in additional to the Bluvision sensors previously installed at Tate & Lyle. • The manufacturing team is doing initial testing and analyzing data from three TI (Texas Instruments) vibration sensors (2 piezoelectric and 1 MEMS sensor) that were installed, with the help of the IoT team, at Birck Nanotechnology Center. • Achieved on-demand data extraction from Bluetooth-enabled vibration sensors. This will allow us to obtain spectral vibration data to better depict motor conditions. Existing wireless commercial modules only give the average vibration amplitude with coarse time resolution. • Working on the online visualization of the real-time data and analytics from the deployed vibration sensors located at the Birck Center as well as Tate & Lyle.	100%
Use machine learning to identify key factors impacting the design of reliable and robust sensors.	• The Machine Learning (ML) team continues to improve the algorithms and methods for prediction. • The ML team is working with the manufacturing team on an rpm-invariant model of the classification and prediction of failures based on raw vibration data: the model successfully works at a 300 rpm and the team is optimizing it for cross-rpm prediction. • The ML team developed a new model to successfully predict nitrate sensor readings when the physics model might not be able to capture underlying non-ideal factors; the benefits of this new model is expected to become apparent when nitrate sensors are deployed in the soil (instead of a solution). • Continue the development of physics-reinforced deep-learning for IoT sensor nodes. This is particularly helpful for ag sensors that require long stabilization after dry out. Able to make better predictions using initial data both within domain and out-of-domain.	100% on physics-based, machine-learning for nitrate sensors in water. 50% for vibration sensors.
Evaluate communication fidelity and cloud storage data security (data from private companies will be anonymized).	• The development of a mesh network for communication fidelity and adaptability has been completed and validated through simulations and temporary deployment, using 6 nodes across campus. • The mesh-network firmware was improved to eliminate synchronization issues that appeared and were due to drifting of the timing components; the stability of the new firmware was validated in the lab and will be implemented during the upcoming deployments • Successfully deployed a large (12-node, upgraded from original 6 nodes) LoRa mesh network across the whole main Purdue campus and tested for two weeks. Mesh configuration extends the range in an obstructed environment, without the need for multiple receivers with internet access. The optimized network configuration will be deployed at the various agricultural sites (i.e. Ivy Tech and TPAC).	100%
Expand sensor network to 15 locations throughout the community (commercial farms, small manufacturers, public building/ services (in consultation with county's public work offices).	• The teams deployed sensors at ACRE in June. During July, we demonstrated a short-term deployment at the Purdue main campus, expanded the sensor network at TPAC, and deployed sensors at Ivy Tech. • The Ivy Tech network will be fully online by September. Deployments of manufacturing sensors also planned at Evonik in collaboration with the manufacturing group for September 2019.	50%

AIM 3.3 (Cont'd)		
YEAR 2 (Cont'd)		
Help community testbeds with IoT sensors, data network and data analytics.	• Many activities ongoing with various companies in both Ag and Manufacturing sectors in the region, (Tippecanoe, Pulaski and White Counties). • Began collaboration with Krannert Business Analytics re: monetization strategies for IoT sensor data. • Data from current and future deployments are available to the community through our web portal (http://purduewhin.ecn.purdue.edu) providing access to both custom sensors (nitrate) and commercial sensors (temperature, humidity, soil information, and vibration). The data visualization pages was recently redesigned with automatic scaling for different window sizes. Also focus to better illustrate the regional collaboration.	100%
Guest lectures (K-12, community colleges, local businesses).	• SMART Films Industry Day on May 16, 2019, at the Birck Nanotechnology Center with very positive feedback from the member companies and a strong presence from local businesses as well as community collaborators (~70 participants). (See Key Highlights, page 3.) • On May 15, 2019, workshops were offered covering a variety of topics, including introduction to machine learning, big data basics and securing, edge-analytics, printed and roll-to-roll sensors, as well as bio- and electrochemical sensors. • On June 13 and 20, 2019, the Birck Nanotechnology Center participated in the Greater Lafayette Commerce Manufacturing Camp hosting 3rd to 8th graders who learned about manufacturing and performed STEM activities. (See Key Highlights, page 3.) • On July 10-12, 2019, the Purdue IoT Team led by Dr. Mousoulis attended the Global City Teams Challenge Smart and Secure city Expo (GCTC) in Washington D.C. The team highlighted the need for sensors in agricultural and participated in industrial panels. (See Key Highlights, page 4.) • IoT team is preparing IoT and data analytics demonstrations for the Purdue 2050 Conference of the Future in September 2019. Examples include Ag IoT devices, wearables sensors and real-time video analytics of audience's facial expressions. These demos will be used in subsequent community engagements. • Dr. Shakouri gave a presentation at Corteva in Indianapolis on Aug. 29, 2019, to highlight unique IoT devices and digital ag testbed in the WHIN region.	100%
YEAR 3		
Obtain field data from a dozen IoT nodes throughout the region.	• Planned for Year 3.	
Purdue will help the local community testbeds to install and maintain their IoT sensors, data network, and to analyze the data.	• Planned for Year 3.	
Help train company employees who should start to maintain the sensor network.	• Planned for Year 3.	
Give guest lectures on sensors and IoT platforms in collaboration with education partners (K-12, community colleges, local businesses).	• Planned for Year 3.	
Test pressure sensors at 3-5 local manufacturers.	• Planned for Year 3.	

AIM 3.3 (Cont'd)		
YEAR 3 (Cont'd)		
Based on Year 2 field data and analysis, optimize the design of soil sensors (nutrients, moisture, temperature) and fabricate several hundred that will be placed at Birck's IoT testbed, College of Ag's ACRE and Ivy Tech and in dozen of commercial farms throughout the Wabash Heartland.	• Planned for Year 3.	
Based on Year 2 field data and analysis, optimize the design of distributed temperature and humidity sensors and fabricate several hundred for Purdue poultry facility, IN-MaC testbed, main manufacturing partners as well as a dozen of local small businesses.	• Planned for Year 3.	
Finalize the design of water sensors for Purdue's Water Quality Field Station.	• Planned for Year 3.	
Fabricate two dozen sensors for lab characterization and field test.	• Planned for Year 3.	
YEAR 4		
Continue to obtain field data from several hundreds of sensors in several dozen IoT nodes throughout the region.	• Planned for Year 4.	
Purdue will help the local community testbeds to maintain their IoT sensors and to analyze the data.	• Planned for Year 4.	
Oversee as local businesses take the responsibility to operate and maintain the sensor network.	• Planned for Year 4.	
Give guest lectures on sensors and IoT platforms in collaboration with education partners (K-12, community colleges, local businesses).	• Planned for Year 4.	
Test water sensors in a dozen of locations in the Wabash Heartland region.	• Planned for Year 4.	

AIM 3.3 (Cont'd)		
YEAR 5		
Birck Nanotechnology Center will continue to obtain field data from several hundreds of sensors in several dozen IoT nodes throughout the region.	• Planned for Year 5.	
Once the impact of IoT sensor data in different businesses is demonstrated, local companies will be responsible for the maintenance and operation of IoT devices through their IT department or by outsourcing (similar to what they do for their computer network and Internet).	• Planned for Year 5.	

AIM 3.4.1: Build Capacity and Connections Through RFPs		
Anticipated Outcomes	**Outcomes to Date**	**%**
There is better collaboration between public and private entities in the region--and a net increase in financial and social capital.	• WHIN staff members and partners attend the monthly ITC (Indiana Technology Corridor) meetings with 9 of the 10 county LEDOs. All 10 LEDOs helped identify the region's "mini-ecosystems," 15 areas of need for rural broadband access. More than 60 private, nonprofit, and public organizations were involved in Round 1 of WHIN's RCF. • Currently investigating the development of MOUs (Memorandums of Understanding) with the two overlapping EDA-recognized regions, KIRPC (Kankakee Iroquois Regional Planning Council) and NCIRPC (North Central Indiana Regional Planning Council). NCIRPC was a recipient of one of WHIN's Round 1 RCF (Regional Cultivation Fund) impact grants. • A GIFT VII grant conferred by the Community Foundation of Greater Lafayette (CFGL) is funding a baseline assessment of current public-private investments in all 10 counties. This assessment is intended as an analysis of grants capacity in the Wabash Heartland, revealing where the potential lies and how that potential can be maximized by public-private collaboration.	40%
There is better alignment between regional education and workforce efforts, yielding more youth and adults prepared for employment.	• WHIN staff members and partners attend the monthly Workforce 2030 meetings with regional stakeholders to stay connected with the discussion about education and workforce alignment. • Several of WHIN's Round 1 RCF grantees specifically address better alignment between education and workforce, such as: the Advancing the Next Generation for Manufacturing Competitiveness grant (fiscal agent: Tecumseh Area Partnership, Inc.).	30%

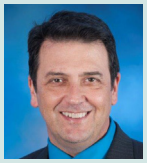
AIM 3.4.2 : Educate the Region's Future Workers		
Anticipated Outcomes	**Outcomes to Date**	**%**
Implementation of I-STEM curriculum into the 26 elementary schools in the region without comprehensive, research-based science, technology, engineering and math curriculum.	• Several of WHIN's Round 1 RCF grantees specifically address research-based science, technology, engineering, and math curriculum, such as: the Region-wide Recycling Coalition Infrastructure: Inventory & Analysis grant (fiscal agent: Indiana Recycling Coalition), the Advancing the Next Generation for Manufacturing Competitiveness grant (fiscal agent: Tecumseh Area Partnership, Inc.).	20%
Implementation of Project Lead the Way (PLTW) into the 22 middle and high schools without research-based science, technology, engineering and math curriculum.	• Several of WHIN's Round 1 RCF grantees specifically address research-based science, technology, engineering, and math curriculum, such as: the Advancing the Next Generation for Manufacturing Competitiveness grant (fiscal agent: Tecumseh Area Partnership, Inc.).	20%
3,000 high school enrollments in STEM career education courses region-wide (from the baseline of 1,558 current high school enrollments).	• Several of WHIN's Round 1 RCF grantees specifically address research-based science, technology, engineering, and math curriculum, such as: the Regional Mini-Ecosystems Broadband Project grant (fiscal agent: North Central Indiana Regional Planning Council) and the Advancing the Next Generation for Manufacturing Competitiveness grant (fiscal agent: Tecumseh Area Partnership, Inc.).	20%
750 "STEM-Ready" high school graduates (who have taken at least 1 STEM-related course).	• This approach is being examined to ensure it integrates thoroughly within the newly launched Regional Cultivation Fund process.	20%
800 manufacturing and agriculture industry-recognized credentials awarded in high school (from the baseline of 420 current credentials awarded).	• Several of WHIN's Round 1 RCF grantees specifically address research-based science, technology, engineering, and math curriculum, such as: the Digital Agriculture Testbeds at Regional High Schools grant (fiscal agent: Frontier School Corporation), the Regional Precision Agriculture Study grant (fiscal agent: Indiana West Advantage) and the Wabash River Career & Technical Education Program grant (fiscal agent: MSD of Warren County).	20%

AIM 3.5: Cultivation Fund		
Anticipated Outcomes	**Outcomes to Date**	**%**
The population grows and the tax base is strengthened. This will be measured by a baseline assessment of population and current tax base in all 10 counties, tracked annually.	• Population and gross assessed property value on a county level are tracked by PCRD via their Indiana Rural Stats portal (http://pcrd.purdue.edu/ruralindianastats) and updated annually. The property value data is on a two-year data lag (based on a report provided annually by Dr. Larry DeBoer), According to his 2016 report, the aggregated gross assessed property value for the Wabash Heartland Region was $93,704.40. American Community Survey (ACS) has a five-year rolling sample that provides the updates for our remaining CVIs. According to the 2017 data, the aggregated county population increase for the Wabash Heartland Region was 863 people.	100% of target, 20% of goal over 5 years.
Within less than 1 year, an RFP process will be established to evaluate proposals submitted by regional entities to address WHIN's Cultivation Fund goal: To create an incentive for two or more counties in the Wabash Heartland to work together to boost the education, vitality and connectivity of the region.	• WHIN's RCF process was established in October 2018 and approved by LEI in November 2018. WHIN hosted Road Shows in December 2018 and Idea Forums in January 2019 to encourage RCF proposal submission. Round 1 of the RCF kicked off in February 2019 with Proposer's Day and was concluded in June 2019 with the orientation of newly awarded grantees. In September 2019, Round 2 kicked off with the second Proposer's Day, drawing 140 regional stakeholders as attendees. Letters of Intent (LOIs) for Round 2 are due Oct. 11, 2019. Successful LOI submissions will be invited to apply in Q4 2019, and awards will be made in Q1 2020. Rounds 3, 4 & 5 are on track for deployment as anticipated according to the RCF Guidelines posted on WHIN.org/RCF/Overview.	100%
Within 2-4 years, WHIN will fund $10 million in projects in the WHIN counties designed to increase the region's vitality, education and connectivity.	• WHIN's RCF made eight grant awards (four planning and four impact) in June 2019, totaling just over $1 million ($1,035,837.35). • The anticipated amount of grant funds available for Round 2 is between $2 and $3 million.	10% (Just over $1 million granted.)
In 5 years, WHIN will have a positive impact upon educational opportunities, vitality, and connectivity of the Wabash Heartland Region as a result of the funded projects.	• Prior to the end of Year 5.	
Pre-survey delivered by Purdue Center for Regional Development to all 10 counties in the region. Surveys completed by regional residents at county fairs, via social media, and with the local deployment/promotion assistance of LEDOs, Community Foundations, Extension, Chambers of Commerce and other community partners.	• Results of the second round of the WHIN Placemaking Survey were reported at the end of August 2019. Currently, 4,000 residents (representing 1% of the total region's population) has participated in the survey. When asked: "How would you rate the Wabash Heartland Region as a place to live?," 57% of respondents said "good," 21% said "fair," 18% said "excellent," and 4% said "poor."	100% of target, 20% of goal over 5 years.

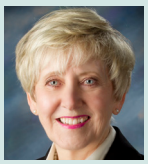
WHIN Global Metrics **Note:** It is not appropriate to assign a "percent complete" to WHIN's Global Metrics since they are intended to track WHIN's economic progress over the five-year period and beyond.	
An annual growth rate of 3.13% in GRP over 5 years. • For every $1 of Lilly Endowment, Inc. investment, the Wabash Heartland region would generate approximately $3.24. (e.g. $126M).	• PCRD has estimated annual growth rate of GRP from 2016 to 2018. The average of annual (year-by-year) growth rate of real GRP from 2016 to 2018 is 2.93%. The annual compound growth rate of real GRP from 2016 to 2018 is 3.04%.[1] Note that during 2017 to 2018 WHIN's economy has grown by nearly 5.4%. The real GRP in 2016 (based on $2018) was $15.97 billion, which became $16.08 billion in 2017, and grew further to $16.95 billion in 2018.[2]
2% job growth in next-generation manufacturing over 5 years and 3% job growth in digital agriculture over 5 years, resulting in 652 new jobs in the region over the same time span of the grant period.	• We use the most conservative category of workers covered under Unemployment Insurance (UI) Program available from the Bureau of Labor Statistics (BLS) data and compare 2018 jobs against the 2016 BLS baseline. We have determined that a 7% (7.1% precisely) job growth has occurred in the Wabash Heartland's next-generation manufacturing industry (defined as the 58 industry sectors of the metal processing supercluster). Similarly, a 7% (6.9% precisely) job growth has also occurred in the digital agriculture industry (defined as the 93 industry sectors of the ag-biosciences supercluster). • PCRD has analyzed jobs change by considering various classes of workers including the most conservative "covered workers" from BLS to the covered workers, self-employed and proprietors estimates available from the EMSI. PCRD compared 2016 baseline data to the current 2018 employment data to find that at least 750 jobs have been added in the ag-biosciences supercluster in that timeframe, and almost 1,400 jobs had been added in the metal processing supercluster in that timeframe for a total of 2,150 jobs gained in these industries since 2016.[3,4,5,6]
125 positions will be filled in critical-need areas over 5 years (such as data analytics, precision agriculture, and IoT-related manufacturing).	• Further analysis needs to be done to conclude what percentage of these 2,150 jobs were "critical needs" positions and what percentage of these occurred in companies directly affiliated with/impacted by WHIN. • The career pathways project timeline and deliverables are underway in collaboration with regional stakeholders, ConxusNEO and EWIN.

1. Annual compound growth rate of real GRP (Gross Regional Product) should be used.
2. Cross-checked this substantial growth in GRP in 2018 by using JobsEQ, another economic model subscribed by PCRD. The numbers in the report are based on EMSI model.
3. The jobs change within the metal processing super cluster is being led by a few specific industry sectors, which include automobile manufacturing, travel trailer and camper manufacturing, and other motor vehicle parts manufacturing.
4. The jobs change within the ag-biosciences supercluster is being led by a few specific industry sectors, which include meat processed from carcasses, pesticides and other agricultural chemical manufacturing, animal slaughtering, wet corn milling, R&D in the physical engineering and life sciences, etc.
5. The cluster definitions include a variety of industry sectors and emanate from the original BATTELLE's study, PCRD's research during grant application, and feedback from the WHIN team.
6. More jobs have been added from 2017 to 2018 than 2016 to 2017. This could be because of new businesses opening or locating in the WHIN Region and a booming national economy. PCRD's shift-share analysis of 2016 to 2018 by using the conservative covered-workers (BLS) data reveal a value of +429 for Ag-biosciences and +281 for the metal processing super cluster. The positive values show that the region has grown jobs over and above the national boom and the industry trend.

APPENDIX B: **Biographies**

WHIN Board (MEETS BIMONTHLY)		
	**Gary Henriott**	Chair of Henriott Group (insurance and risk management services) and past Chair of Greater Lafayette Commerce Economic and Community Development Council; City of Lafayette Housing Authority; President of Board of Works and Safety – City of Lafayette, IN; Lafayette Community Bank Board; The Community Foundation of Greater Lafayette Board, and Chair of Community Commitment to Education Committee.
	**David Bathe, PhD**	Chancellor of Ivy Tech overseeing Lafayette, Logansport, Crawfordsville, Frankfort, and Monticello campuses. Leadership roles include Greater Lafayette Commerce, the Greater Lafayette Convention and Visitors Bureau, and the City of Lafayette Economic Development Commission.
	**JoAnn Brouillette**	Purdue Board of Trustees and managing partner and president of Demeter LP – privately owned grain and commercial warehouse business – Benton County, IN. Community leadership roles include the Executive Committee of the Indiana Chamber of Commerce, Lafayette Bank and Trust Advisory Board, and the National Grain and Feed Association Board.
	**Ron Dickerson**	Retired Vice President / General Manager – Nucor Steel Indiana and has most recently served as President of the Montgomery Economic Development organization; Community Foundation of Montgomery County.
	**Dick Giromini**	Executive Advisor, former CEO at Wabash National Corporation. Leadership roles include Central Indiana Corporate Partnership (CICP) Executive Committee and CICP's Ascend Indiana; Indiana Manufacturers Association (IMA); Board of Greater Lafayette Commerce (GLC) and GLC Economic & Community Development Council.
	**Gary Lehman**	Purdue University Board of Trustees, retired Chairman of the Board of Oerlikon Fairfield and President of Oerlikon AG-Americas, and the founder of Cannelton Group. Gary's leadership roles include Board of the Indiana Chamber of Commerce, Indiana Manufacturers Association, North Central Health Services, Ivy Tech Corporate College, and Greater Lafayette Commerce, Chair.
	**Stephanie Long**	President/CEO of North Central Health Services (NCHS), River Bend Hospital – a private inpatient psychiatric hospital, and capital grantmaker to eight of the 10 counties in the WHIN region. Previously served as CEO at IU Health White Memorial Hospital. Community leadership roles include White County Economic Development Board of Directors; Greater Lafayette Commerce Board of Directors; and Community Foundation of Greater Lafayette.
	**David Luhman**	Of Counsel to the law firm of Hoffman, Luhman & Masson, PC in Lafayette, Indiana. Leadership roles include Tippecanoe County Attorney (1997-2014) and counsel for Wabash River Enhancement Corporation, Tippecanoe County Parks and Recreation Foundation, and The Community of Greater Lafayette Board of Directors, Chair (2013-2016).

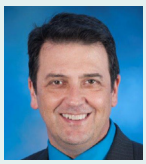
WHIN Board (Cont'd)

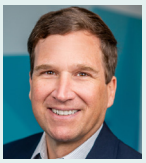
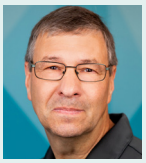
	**Todd Miller**	President/CEO Myers Spring, Logansport, Indiana. Community leadership includes Indiana Chamber of Commerce, Cass County Logansport Economic Development Organization, Logansport Municipal Utilities.
	**Marianne Rose**	President and CEO of the Community Foundation of Greater Lafayette, Indiana; 14 years with The Foundation.
	**Steve Schultz**	Chief Legal Officer for Purdue University. Previously with Barnes & Thornburg, Indianapolis; Fried, Frank, Harris, Shriver & Jacobsen, London, England; General Counsel with Irwin Financial, Columbus, Indiana; and Chief Counsel to former Indiana Governor Mitch Daniels.

Purdue Leadership (MEETS QUARTERLY)

	**Jay T. Akridge, PhD**	Provost and Executive Vice President for Academic Affairs and Diversity. He also served as Principal Investigator for the WHIN-Purdue.
	**Theresa S. Mayer, PhD**	Executive Vice President for Research and Partnerships. She is also a Professor of Electrical and Computer Engineering.

Ivy Tech Leadership (MEETS QUARTERLY)

	**David Bathe, PhD**	Chancellor of Ivy Tech overseeing Lafayette, Logansport, Crawfordsville, Frankfort, and Monticello campuses. Leadership roles include Greater Lafayette Commerce, the Greater Lafayette Convention & Visitors Bureau, and the City of Lafayette Economic Development Commission.
	**Todd Roswarski, PhD**	Ivy Tech-Lafayette Vice Chancellor for Academic Affairs & Professor of Psychological Sciences. Roswarski oversees all academic programs, grants, secondary initiatives, library services, and testing and assessment. He also serves on the Campus Academic Officers' Committee that sets all academic policy for the Statewide Community College System. Dr. Roswarski serves as Principal Investigator for WHIN-Ivy Tech.
	**Andrea Schwartz**	Dean, School of Advanced Manufacturing, Engineering & Applied Science, Ivy Tech.

WHIN Staff (MEETS WEEKLY)		
	**Johnny Park, PhD**	Chief Executive Officer (CEO).
	**Melinda Grismer**	Vice President of Regional Development.
	**Jack Stucky**	Vice President of Engineering.
	**Jason Tennenhouse**	Vice President of Strategy & Design.
	**Ted Fiock**	WHIN-Purdue Managing Director.
	**Chad Martin**	WHIN-Ivy Tech Project Manager.
	**Lynette Bleed**	Regional Cultivation Fund Program Coordinator.
	**Audette Taylor**	Director of Finance.
	**Greg Ottinger**	Vice President of Strategic Partnerships.

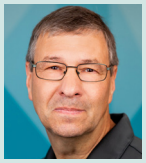
WHIN Staff (Cont'd)

	**Jessica Strasburger**	Communications Coordinator.
	**Pat Corey**	Community Development and Grants Consultant.

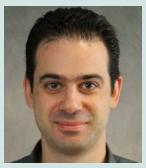
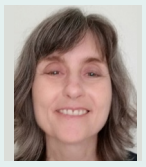
WHIN-Purdue Operations Team (MEETS MONTHLY)

	**Ali Shakouri, PhD** WHIN-Purdue & WHIN Operations Committees	Mary Jo and Robert L. Kirk Director of Birck Nanotechnology Center; Professor of Electrical and Computer Engineering.
	**Jan-Anders Mansson, PhD**	Distinguished Professor of Materials & Chemical Engineering; Director of Purdue's Composite Manufacturing Simulation Center (CMSC) and Co-Director of IN-Mac. Dr. Mansson is also the founder of the composites companies EELCEE Ltd. and QEESTAR Co. Ltd., which are active in the field of high-volume composites and additive manufacturing.
	**Dennis Buckmaster**	Professor of Agricultural & Biological Engineering, Dean's Fellow for Digital Agriculture.
	**Lionel J. "Bo" Beaulieu, PhD**	Director of the Purdue Center for Regional Development and Director of the Extension Community Development Program.
	**Steven Dunlop**	Managing Director of Dauch Center for the Management of Manufacturing Enterprises (DCMME) and Global Supply Chain Management Initiative (GSCMI).
	**Melinda Grismer**	Community and Regional Development Specialist, Purdue Center for Regional Development and Vice President of Regional Development for WHIN.
	**Nathan W. Hartman, EdD**	Head of Computer Graphics Technology, Dauch Family Endowed Professor, and Co-executive Director of IN-MaC.

WHIN-Purdue Operations Team (Cont'd)

	**Ted Fiock**	WHIN-Purdue Managing Director.
	**Jason R. Henderson**	College of Agriculture Administration, Associate Dean and Director of Purdue Extension.
	**Ananth Iyer, PhD**	Senior Associate Dean, Krannert School of Management; Susan Bulkeley Butler Chair in Operations Management.
	**Mary Nauman**	Director of Strategic Initiatives, Corporate and Foundation Relations, University Development Office, Purdue Research Foundation.
	**Michael Ursem**	Managing Director, IN-MaC.
	**David Snow**	Center Director, Manufacturing Extension Partnership.
	**John Sutherland, PhD**	Professor and Fehsenfeld Family Head of Environmental and Ecological Engineering.
	**Nithin Raghunathan**	Research Scientist, Birck Nanotechnology Center.
	**Martin Jun**	Associate Professor of Mechanical Engineering.

WHIN-Purdue Operations Team (Cont'd)

	**John Scott**	Digital Agriculture Extension Coordinator.
	**Bruce Erickson**	Digital Agriculture Education & Outreach Director.
	**Maria Wiltse**	Metrics Manager, Purdue Center for Regional Development (PCRD).
	**Charilaos Mousoulis**	Project Manager of IoT Infrastructure and Data Analytics, Senior Research Scientist, School of Electrical and Computer Engineering.
	**Somali Chaterji**	Assistant Professor of Agricultural and Biological Engineering.
	**Andrew Balmos**	Data/Software Engineer in Agricultural Research and Graduate Education.
	**Nancy Denton**	Professor & School of Engineering Technology Associate Head.

WHIN-Ivy Tech Operations Team (MEETS MONTHLY)

	**Andrea Schwartz**	Dean, School of Advanced Manufacturing, Engineering & Applied Science, Ivy Tech.
	**Chad Martin**	WHIN-Ivy Tech Project Manager.
	**Bryce Eaton**	Program Chair, Advanced Automation & Robotics Technology.
	**Kraig Bowers**	Program Chair, Agriculture.
	**Andrew Gibbs**	Department Chair, School of Computing & Informatics.
	**Bruce Sillery**	Farm Manager and Crop Production Faculty.
	**Todd Roswarski, PhD**	Vice Chancellor of Academic Affairs.

Frequently Used Acronyms

ABE.....Purdue School of Agricultural and Biological Engineering
ACRE.....Purdue College of Agriculture's Agronomy Center for Research and Education (a testbed site)
ANR.....Purdue Extension's Agriculture and Natural Resources
AR.....Augmented Reality
DCMME.....Dauch Center for the Management of Manufacturing Enterprises
DSCT.....Digital Supply Chain Tool
EDA.....Economic Development Administration
GCTC.....Global Cities Team Challenge
IMI.....Indiana Manufacturing Institute (located at Purdue Research Park)
IMT.....Intelligent Manufacturing Testbed
IN-MaC.....Indiana Manufacturing Competitiveness Center (located at Indiana Manufacturing Institute)
IoT.....Internet of Things
ISP.....Internet Service Provider
LEDO.....Local Economic Development Organization
MEP.....Manufacturing Extension Partnership
MET.....Manufacturing Education Team
NIST.....National Institute of Standards and Technology (a federal government organization)
NSF.....National Science Foundation
OATS.....Open-Agriculture Technology and Systems Group (a Purdue Ag and Engineering research team)
OEM.....Original Equipment Manufacturer
ONA.....Occupational Skills Needs Assessment (a survey to be conducted to assist with metrics)
OTC.....Office of Technology & Commercialization
PCRD.....Purdue Center for Regional Development
RFP.....Request for Proposal
RWIN.....Rural Workforce Innovation Network (a USDA public-private partnership)
TPAC.....Throckmorton-Purdue Agricultural Center
UAV.....Unmanned Aerial Vehicle
VR.....Virtual Reality
WHIN.....Wabash Heartland Innovation Network

Wabash Heartland Innovation Network
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WHIN.org