

## Engagement in Practice: Bowman Creek Educational Ecosystem

### Dr. Jay B. Brockman, University of Notre Dame

Dr. Jay Brockman is the Associate Dean of Engineering for Experiential Learning and Community Engagement. He received his Ph.D. in Computer Engineering from Carnegie Mellon University and previously worked for Intel Corporation. He is also a founder of Emu Solutions, Inc., a startup company that is commercializing research in the area of high-performance computing.

### Maria Krug, University of Notre Dame

Maria Krug received her B.S. in Civil Engineering from the University of Notre Dame in 2014 and is now pursuing a M.S. in Environmental Engineering at the University of Notre Dame. Prior to returning to Notre Dame, Maria worked as a Civil Engineer on water and wastewater infrastructure projects at Whitman, Requardt & Associates in Baltimore, MD. Her research interests include the monitoring and modeling of green infrastructure and undergraduate experiential learning in both domestic and international contexts. She co-teaches a project-based engineering course at the University of Notre Dame that is a key component of the Bowman Creek Educational Ecosystem.

### Alicia Czarnecki, Bowman Creek Educational Ecosystem

Alicia Czarnecki is a senior Environmental Engineering major at the University of Notre Dame. Alicia served as Team Leader for the Summer 2016 Bowman Creek Educational Ecosystem intern team. Previously she was an intern for two summers at the City of South Bend Department of Public Works - Division of Engineering. Alicia was recently selected to serve on the new Ecological Advocacy Committee of the South Bend Board of Park Commissioners, and is a member of the 2017 Indiana Watershed Leadership Academy. After graduation, Alicia will be working for Abonmarche, an engineering design firm located in South Bend.

### Dr. Ryan M Nell, Bowman Creek Educational Ecosystem

My professional interests are in the areas of sustainability, geochemistry and environmental science/remediation. After finishing my bachelors in geology and continuing on to receive my doctorate in environmental geochemistry, I am looking to be actively involved with real world solutions to environmental needs.

### Mr. Gary Allen Gilot P.E., University of Notre Dame

Gary A. Gilot is the Director of Engineering Leadership and Community Engagement at the College of Engineering at the University of Notre Dame. Gary is a Fellow at the University Center for Social Concerns.

Gary earned his Bachelor of Science degree in Civil and Environmental Engineering from Clarkson University in Upstate New York (1978), and Masters in Business Administration from Indiana University at South Bend (1985). He is a licensed Professional Engineer in Indiana (since 1982).

Gary continues to serve as President of Board of Public Works in South Bend.

Gary previously served as Director of Public Works and President of Board of Public Works in South Bend and Elkhart, Indiana for 30 years.

Gary remains actively engaged in the community. Locally, Gary was recognized for distinguished public service by the South Bend Alumni Association. On a statewide level of recognition, Gary is a recipient of the Ivan H. Brinegar municipal management award through the Indiana Association of Cities and Towns. Nationally in August, 2010, Gary was selected as the nation's 2010 "Public Works Leader of the Year" by American City & County magazine for technology innovation.

### Dr. Victoria E Goodrich, University of Notre Dame

Dr. Victoria Goodrich is the Director of the First-Year Engineering Program at the University of Notre Dame. She holds a BS in Chemical Engineering from the University of Oklahoma and a MS and PhD in Chemical Engineering from Notre Dame. Her research focuses primarily on Engineering Education issues, especially focused within the first-year engineering experience.

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## **Abstract**

Bowman Creek Educational Ecosystem (BCe2) is a partnership that pilots community-engaged, sustainable projects to address real world challenges in the Southeast neighborhood of South Bend, Indiana, a mid-size city in the Midwest. BCe2 is made up of a diverse group of students and faculty from area high schools and colleges, community groups, local businesses, and the City of South Bend through the Metro Lab Network (MLN) partnership. The Southeast Neighborhood is used as a sandbox of innovation to develop feasibility studies, designs, and prototypes for urban natural resource management, sustainable placemaking projects, and data-driven community development solutions. BCe2 operates under two driving goals: 1) to advance the theory and knowledge of educational environments that contribute to building and strengthening all levels of the high school to graduate school pipeline in science, technology, engineering and math (STEM) fields, and 2) to develop a collaborative, sustainable community/institutional infrastructure to support transdisciplinary, authentic STEM learning opportunities for community impact. The team employs human-centered participatory design to address City pain points by following the design thinking process: 1. Empathize, 2. Define, 3. Ideate, 4. Prototype, and 5. Test. On every project, the team iterates with community and partner stakeholder input and adjusts project scope when necessary to be responsive to stakeholder needs. The BCe2 Summer 2016 Internship Program consisted of 22 interns from six of the area educational institutions addressing nine projects in the Southeast Neighborhood. The success from the summer is an accomplishment springboard to carry talent engaged in purpose of advancing “smart city where everyone can thrive” momentum forward. In 2017, BCe2 will build on its strong networked relationships and strategically advance its projects and programs done with the community for meaningful outcomes and transformational long term impact.

## **1.0 Background**

The Southeast Neighborhood of South Bend, IN faces an array of environmental and economic challenges. Environmentally, Bowman Creek is the most impaired tributary of the St. Joseph River as measured by the joint voluntary Aquatic Community Biology Monitoring Program by the Cities of South Bend and Elkhart. A 2011 Supplementary Environmental Program (SEP) revealed that Bowman Creek showed unhealthy levels of E. coli, ammonia, and phosphorous (McCormick 2013). Additionally, the Southeast Neighborhood exhibits high concentrations of poverty, crime, and vacant lots left by the demolition of abandoned and blighted structures. The area is a food desert with high unemployment rates and limitations of walkability, transportation and transit services.

BCe2 pilots community-engaged, sustainable projects to combat these area stresses by partnering with the city government, community organizations, and several educational institutions. BCe2 tackles projects which require multidisciplinary approaches and capitalize on the strengths of each of these strategic partnerships. The long term goal is to help the city government provide more efficient and effective services, build capacity amongst community organizations to strengthen citizen engagement, increase positive perceptions of South Bend, and promote student

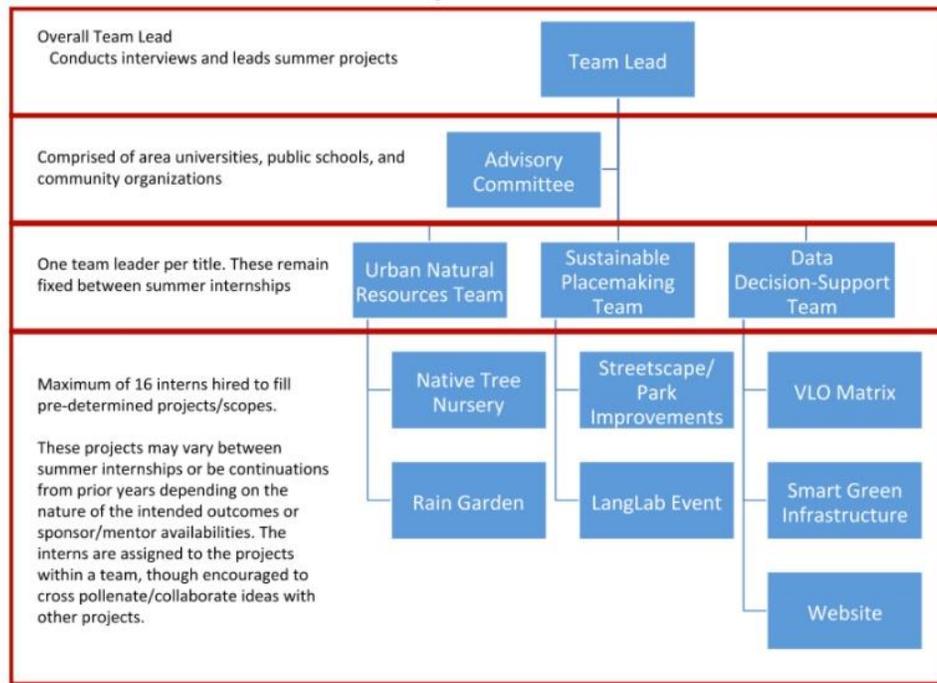
talent development through meaningful experiential learning. BCe2 believes that creating engaging internship experiences helps young talent realize opportunities to make a difference by pursuing post-graduate positions in South Bend. With this philosophy, BCe2 is emerging as a potent partner in strategic brain gain for the region.

Through this framework, BCe2 improves undergraduate STEM education by providing opportunities to apply curriculum to real challenges in South Bend. Its flagship summer internship program brings together students from diverse educational institutions and ages, thus creating opportunities to belong to a multidimensionally diverse team. Students benefit from project-based learning and supplement traditional STEM curriculum with exposure to community based research, participatory design, and design thinking methodologies. Through this collaborative environment, students gain real world experience and engage in meaningful work on issues around Bowman Creek and the quality of life in the surrounding neighborhood.

## **2.0 Project design and execution**

BCe2's Summer 2016 Internship Program consisted of twenty two interns from six South Bend institutions: Indiana University South Bend, Ivy Tech Community College, University of Notre Dame, Riley High School, St. Joseph High School and Washington High School. To identify project focus areas within the Southeast neighborhood, design thinking methodology was used to identify issues with key stakeholders and users, including neighborhood associations, representatives from the City of South Bend, and local business partners. Prior to the summer internship, BCe2 leadership engaged in user interviews and brainstorming sessions with those stakeholders and collectively identified three focus areas: management of urban natural resources, support of community-based sustainable placemaking processes, and development of city wide initiatives for data based decision making. Interns then worked with BCe2 leadership and stakeholders to identify specific projects within these focus areas, as shown in Figure 1. Interns worked on a variety of projects at different stages of implementation, allowing them to experience and contribute to all stages of project development.

To support the management of urban natural resources, a team of interns researched and implemented low impact development solutions to address a significant issue of combined sewer overflow in South Bend. South Bend's combined sewer system collects surface water runoff and untreated wastewater in the same pipes and can become overwhelmed in heavy precipitation events. This causes overflows into the St. Joseph River and sewage backups in residential areas across the city, leading to infrastructure and property damages and serious environmental and public health concerns. In this project, BCe2 interns piloted eight rain gardens to absorb precipitation runoff from impervious surfaces, thus limiting the amount of surface runoff that enters the combined sewer system. The eight rain gardens were installed at residences within the Southeast neighborhood and have the capacity to divert 600-1000 gallons of water per 2 inches of rainfall from the sewer system. Interns focused on the design and implementation of the rain gardens including size, shape, types of plants, soil engineering, project management and process documentation. Additionally, interns investigated novel technologies to reduce the cost of acquiring real time data of storage and infiltration from green infrastructure solutions.



**Figure 1. BCe2 Project Organization**

Another team of interns contributed to a variety of sustainable placemaking projects. As the Southeast Neighborhood Master Plan identified streetscape enhancements as a neighborhood priority, interns were initially going to support a City project to implement new lighting, street trees, and aesthetic enhancements near a neighborhood high school. Due to delays in the project, the team pivoted from its original scope to instead make improvements to a neighborhood park including a little free lending library, a drinking fountain, playground equipment refurbishing and over 500 feet of new road and sidewalk. In collaboration with a University of Notre Dame student chapter of the American Society of Civil Engineers, BCe2 interns also worked on the design of a pedestrian bridge to replace a ruin in the park over Bowman Creek. By working in partnership with several City departments, interns' work was a catalyst for more improvements for this area in the future. Additionally, BCe2 interns focused on making South Bend a more sustainable and resilient city through the addition of attractive urban forest, specifically on vacant lots as community native tree nurseries. BCe2 interns conducted a feasibility study of growing trees on vacant lots and tested the economics of growing trees from seedlings and bare root whips to then transplant mature plants to public projects. The first distributed tree nurseries will be piloted this spring in partnership with the City of South Bend forestry team to prove it a viable solution to scale to vacant lots across South Bend.

To help city government provide more efficient and effective services, interns also investigated ways to use data to make more informed decisions throughout the city. The primary project focused on the Vacant Lot Optimization Matrix, which built upon previous work from a University of Notre Dame Society of Women Engineers chapter. A participatory design process identified that a large pain point in the neighborhood was high numbers of vacant lots which once held abandoned houses, created after an initiative to demolish 1000 vacant and abandoned homes throughout the city in 1000 days. The project aimed to help stakeholders determine a

rational basis for deciding how to cost-effectively reuse vacant lots and make them an asset to the City and the neighborhood. The prototype of the tool was an Arc-GIS based platform which filtered data through logic models to identify feasible solutions for reuse. BCe2 interns further iterated this prototype by conducting field checks of the GIS matrix outputs, modeling sensitivity analysis, weighting enhancements, and planning potential demonstrations of positive adaptive reuses.

These primary projects were supplemented with Arduino workshops and individual job enrichment projects to further develop STEM skills. Teachers from a partner high school led a series of workshops for interns from BCe2 and other local organizations to introduce Arduino technology. The final project tasked interns to develop their own innovative technology solutions centered around the theme of environmental monitoring. The resulting prototypes piloted ideas that could provide significant cost savings for city entities and added value to restoring healthy aquatic life and quality of life in the neighborhood around Bowman Creek. Interns presented their projects to a wide audience and judges of practicing professionals in a maker competition, providing professional networking opportunities and exposure for interns. In addition to the workshops, interns were encouraged to find where their skills and passion intersected with the broader Bowman Creek neighborhood revitalization mission to develop job enrichment projects. For example, two interns collaborated to write, illustrate, and publish a children's book explaining the water cycle and benefits of rain gardens. As long as it related to the overall mission, ingenuity and creativity were encouraged as key aspects of healthy self-expression, participatory design process and job satisfaction—all of which enhance STEM retention.

All project areas were monitored by weekly individual intern reports at team meetings giving updates on project deliverables and interactions with stakeholders. At the end of the 10-week internship, interns presented their work to over 100 people from the neighborhood, the City of South Bend government and other partner organizations. Interns reported on project outcomes and told a story of engagement, implementation and future goals for each of the three focus areas.

### **3.0 Lessons learned**

Overall, the program had great success in generating momentum to encourage partner organizations to carry projects forward in beneficial partnerships to maximize resources. The final presentation at the end of the internship program was an indicator of success with high attendance by stakeholders, including prominent figures from South Bend and partner educational institutions. By successfully completing projects and deliverables, the BCe2 team showed accountability and responsiveness to the wants and needs of the area, thus increasing the trust of neighborhood residents and encouraging buy-in from both neighbors and the city government. Rain garden implementation was the most successful project with significant progress in experimental design, documentation, and measurement of implementation compared to the previous year. Another highly successful project was the Arduino workshops, which showed a quick increase in technical skills by the participants, as only 3 out of 30 participants had prior knowledge of the technology. Building and testing their own Arduino projects also gave interns experience with hands on maker skills.

By collecting written reflections from interns throughout the summer, BCe2 identified progress in key goals of increased positive perceptions of South Bend through shifts in student perception, especially from students who are native South Bend residents. A significant example was an increased sense of ownership and personal connection to the people that were impacted by their work, with a notable shift from referring to “those people” in “the neighborhood” to “our neighborhood” and “our neighbors”. BCe2 is also making progress in talent retention, as seen through students continuing internships and pursuing post-graduate careers in South Bend. As the academic year progresses, there has been an increase in outreach about BCe2’s work due to past intern testimony and advocacy. The leadership of BCe2 also presented their work at the US Conference of Mayors at the mayor of South Bend’s invitation to broadcast this model of city and university collaboration, thus increasing partnerships on a larger scale.

Lessons learned at both the organizational and project level can inform the progress of the organization moving forward as well as implementation of similar programs in other areas. Lessons learned at the project level included timing of planning and industry partner acquisition, monitoring of project development, and further development of initial training modules. Moving forward, project planning and partner acquisition will begin earlier so that interns have sufficient background information available to complete more project deliverables. Methods for project and progress monitoring will be adjusted, as weekly updates on an individual basis were time consuming and did not effectively communicate progress on deliverables. This method will shift to weekly reports by project teams, with public speaking skill development emphasized by having rotating presenters. Finally, future orientations will further emphasize existing team building and leadership training sessions and will add a diversity training to better inform the structuring of project teams and maximize the combinations of creativity on teams.

At the organizational level, the BCe2 leadership team structured work during the academic year to continue progress on current projects while beginning to plan projects for the next summer internship program. After piloting an academic year program in Fall 2016 with both paid interns and students receiving academic credit working on the same deliverables, BCe2 adopted a model to differentiate work between academic courses and paid interns. In the Spring 2017 semester, students will receive academic credit to develop project scopes and plans for the summer internship program, while paid interns will be responsible for completing ongoing project deliverables. Students in partnering academic courses will conduct background research, facilitate deeper thought and discussion about project planning, and begin working on prototypes that can be implemented by future interns. This will help ensure summer interns have more background information and will maximize efficiency during the full-time internship program.

#### **4.0 Conclusions**

Moving forward, the organization will focus on the same three focus areas of Urban Natural Resources Management, Sustainable Placemaking, and Data Decision-Support, with rotating projects that align with the yearly goals and project partners. These focus areas strategically align with BCe2’s position as one of the three pillars of the South Bend - University of Notre Dame partnership in the national MetroLab Network program. In 2017, BCe2 will develop the structure for the 10-week summer internship and implement effective strategies during the academic year for part time internships and academic coursework. A major organizational focus will be on

expanding partnerships and industry advisors that align with the Summer 2017 projects. Moving forward, BCe2 will focus on the transferability of pilot projects to other organizations, businesses or departments in South Bend for continuation. Examples of this in motion are the transfer of the Tree Nursery to the South Bend Department of Venues, Parks, and Arts and programs to transfer knowledge of rain garden construction across other neighborhoods in South Bend. In the future, BCe2 will study how this model can be transferred to implement projects in other cities across the nation facing similar challenges.

## **References**

McCormick, D. L. (2013). Bowman Creek Supplemental Environmental Project.

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