ROBOTICS COLLABORATIVE

A REPORT ON THE POTENTIAL FOR A RESEARCH AND DEVELOPMENT FACILITY FOR CROSSOVER TECHNOLOGIES.

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REPORT PREPARED FOR:
City of Sterling Heights and the Velocity Collaboration Center

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Executive Summary

Bonner AG / HWA Analytics (The Team) was asked by the city government of Sterling Heights, Michigan (The City) to investigate the feasibility of a plan to create a robotics collaboration center. After investigating other robotics collaborative programs nationwide, The Team began shaping the vision for the facility as a more broadly defined innovation and collaboration center, where manufacturing expertise can be combined with innovators working in robotics, automation, and other digital-based fields. The Team envisioned the facility as a place where companies—large and small—could work in a common space on solving mutual problems by bringing manufacturing and computer science technologies together.

However, after conducting focus groups and attending meetings with regional stakeholders and advisory teams, it became apparent there was little appetite from established companies to work in a collaborative environment. Many companies felt this would compromise their competitive edge by sharing information and ideas with other companies. Larger companies said they preferred to internalize their R&D and product development operations, only working with outside organizations under blanket non-disclosure agreements. Smaller companies in the post start-up phase also said the same thing—they were afraid of losing their innovation advantage to other growing companies.

The team sought to refine the vision for the facility by focusing on identifying the target market the facility should be aimed at serving. After investigating a number of collaboration models, our conclusions were drawn to the unique ecosystem of the FIRST Robotics teams active at many high schools in Michigan and nationally, career technical education centers at high school level, and perhaps a small portion dedicated to true start-ups lacking resources for robotics innovation. We found with these audiences that focusing on STEM-based initiatives, a willingness to compete and collaborate in the same environment existed.

The Team recommends The City build and develop a regional innovation center, accessible to all FIRST robotics teams, post-FIRST graduates, career technical education centers, Square One facilitators, and anyone else with a passion for combining manufacturing technology and information technology, making a product, and potentially starting a company. This center, by combining electronics, software, and coding with traditional manufacturing can spark an interest in further study, or entrepreneurial pursuits, which will lead to job creation and entice young people once again to be excited about the manufacturing sector. In order for Southeast Michigan to compete with global centers of innovation the mind set in our education system needs to focus on software first, manufacturing second. The funding for such a collaboration will need to come from a myriad of sources that also collectively value STEM based education programs. These sources will need to include corporation, education, non-profit, local units of government, State government, and Federal government.

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Background

Sterling Heights (The City) is a suburb of Detroit in Southeast Michigan's Macomb County. Sterling Heights is the fourth largest city in the state with a population of approximately 130,000 people.

The economy of The City is highly dependent on the auto manufacturing industry with Chrysler and Ford operating as largest and second largest employers for the community. Additionally, many companies have received a large number of defense contracts over the last 10-15 years, effectively shifting a large portion of The City's labor force away from auto manufacturing and into defense manufacturing. However, the recent cutbacks in defense spending have held back The City's economy from truly surging, creating urgency for diversification beyond the auto and defense industries.

In 2011, The City partnered with Macomb County and Oakland University to launch the Velocity Collaboration Center for business incubation and economic development in defense, homeland security and advanced manufacturing. The center offers research, training, and consulting for startup companies with the assistance of the OU School of Engineering and Computer Science's Center for Robotics, Unmanned and Intelligent Systems.

As the economy of The City continues to recover from the defense spending cuts, there is high need for attraction of new industries in order to bring about long-lasting economic stability. The development of the Velocity Center has generated potential for research, development, workforce training, and startups in cyber-security, robotics, and aerospace technologies. The Velocity Center still lacks a proper experimentation facility in which businesses and entrepreneurs can collaboratively work.

The City received a grant from the Defense Manufacturing Assistance Program (DMAP). DMAP is funded by the U.S. Department of Defense and Office of Economic Adjustment and is administered by the University of Michigan Institute Research, Labor, and the Economy. U-M partners with Ohio State University and Purdue University in conducting the program. The DMAP grant funding is targeted at communities that are, or may potentially be, impacted by a downturn in defense industry contracts, layoffs, and/or a decision to close defense facilities. The goal of the program is to help communities create a strategy to diversify their economies so they are not solely reliant on the defense industry. The City applied for and received grant funding to investigate the feasibility of leveraging community assets to create and staff a robotics innovation collaboration center.

Research and Literature Review

Bonner AG / HWA Analytics (The Team) completed an analysis of The City infrastructure and regional assets, including but not limited to advanced manufacturing, technology commercialization, workforce development, and educational opportunities, as they impact potential economic and business development.

Research was comprised of a two-part approach: a literature and data search and interviews with potential users of the facility and key stakeholders in the community.

First, a literature and data search was conducted to understand both the regional economy and any potential gaps (workforce, etc.) in supporting new opportunities.

Secondly, we interviewed relevant stakeholders of such a facility including private sector, public sector and academia, in order to better understand the opportunities related to the development of crossover technologies (those technologies used by local aerospace and automotive companies that can be adapted to other industries). Appropriate stakeholder focus groups, and community and business input sessions were extremely valuable in ensuring everyone is supportive of any plan or initiative moving forward at the facility and the Velocity Collaboration Center.

Our goal with this project was to find a particular niche The City facility can fill, serving the local population, but can also contribute to the overall understanding and development of robotics and automation innovation.

Once we had determined what other facilities currently exist that may be competitive or redundant with a facility built in The City, we began honing in on the vision for this collaborative resource model.

We first had to determine the assets of the region. As a result of the incumbent automotive industry and its assembly, technical and R&D operations, and the large presence of the defense innovation and supply industry, The City has a critical mass of people experienced in the core industries of manufacturing, mass production, supply chain, logistics, and technology and product development.

The literature review pointed to many reasons The City and the larger Southeast Michigan region is an ideal location to develop a robotics innovation center. The following highlights from the literature review help sum up the key attributes of the region. Automation Alley issued a Tech Report that found the following characteristics of the Southeast Michigan region. Each year, Automation Alley publishes the Technology Industry Report to provide the technology business community with valuable insights into the future of the tech industry, both locally and nationally.

- Southeast Michigan technology and manufacturing executives were optimistic about 2016 growth.
    - 99 percent in Southeast Michigan project revenue growth in 2016
    - 83 percent in Southeast Michigan expect an increase in their company's R&D spending
    - 82 percent in Southeast Michigan plan to hire more talent in 2016
- Southeast Michigan is a better place for technology professionals to build their careers than Silicon Valley
    - Comparatively lower cost of living,
    - More networking opportunities than other metro areas
    - Leading academic institutions for self-advancement
- Southeast Michigan is a better place for technology companies to do business than Silicon Valley.
    - Easier for technology companies to retain talent

- Technology companies can have greater return on investment in the metro area
- Technology companies can benefit from the lower cost of capital in the metro area

STEM Initiatives

STEM (Science, Technology, Engineering and Math) is a priority initiative in the state of Michigan. There are major organizations that support STEM efforts to adequately prepare the pipeline of future talent. Not only are these programs popular among K-12 groups, they also rank highly on a state and national level.

- FIRST Lego League
- Robofest: Lawrence Technological University
- FIRST High School Robotics
- Oakland County Competitive Robotics Association
- Square One Educational Network
- IGVC: Intelligent Ground Vehicle Competition

Higher Education Programs

A sampling of higher education programs in the region point to an abundant and robust post- high school educational system that serves the robotics and automation fields.

University of Michigan

- Rated number two nationally in top robotics graduate programs and robotics engineering schools.
- First year graduate students to get hands-on experience right away by taking a robotics system laboratory course.

University of Detroit Mercy

- Michigan's first robotics and mechatronics engineering degree
- Received the support of the National Science Foundation and also offers a full-year of paid industrial experience (co-op) that is integrated within the four-year program

Lawrence Tech University

- Michigan's first Bachelor's in Robotics Engineering
- The curriculum includes experimental components that give students an avenue for hands-on implementation of the knowledge gained in the classroom.

Oakland University

- Oakland University has been at the forefront of research and development in the areas of controls, robotics, automation and machine vision through its Center for Robotics and Advanced Automation.

Technology Research

In a report released in early November 2016, "A Roadmap for US Robotics", the authors state that robotics, and related research has progressed significantly in recent years. The report indicates that 600,000 new manufacturing jobs have been created over the past six years, along with a corresponding growth in the deployment of automated manufacturing systems. Other fields are benefitting from robotics and automation applications, such as healthcare applications, logistics, consumer goods, autonomous cars and unmanned aerial vehicles, along with corresponding major advances in core technologies such as camera systems, communication systems, display and basic computing. Clearly, the need exists for programs and facilities that can bring together multiple disciplines to further advance an evolving technology for a variety of applications.

Current trends in robotics have highlighted the growth of the industry and its potential. Five of the largest trends include:

China's Appetite for automation

China is eating up the market both as a buyer and an emerging seller. However, for Chinese companies to fully capture the robotic market within China they will have to shore up missing components that are hard to make and improve quality and precision overall.

Collaborative Robots

A viable and growing segment of the robotics industry started by Universal Robots but with competition coming from Kuka, ABB, ReThink Robotics, and others.

Robotics as a Service

Using drones to capture sensor and camera data and then developing software to analyze that data and translate it into actionable plans has crossed industry boundaries and is being offered not only to agriculture companies but to oil and gas companies, and NGOs and governments wishing to monitor hard-to-get-to areas.

Logistics and Materials Handling

During the financial crisis, capital expenditures for logistics were put off, now the crisis is behind us and consumers want their products fast. A variety of companies offer enhanced material handling methods for factories, warehouses, and distribution centers.

Investments in Robotics

Investments totaled $3.6 billion in all of 2015 and $5.0 billion for 6 months of 2016. An estimated $6 billion more announced before 2016 has even come to a close.

Broad-Based Technologies in Robotics Applications

Robotics includes mechanical engineering, electrical engineering, computer science and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. The robot itself is only the end result of creativity combined in a diverse arrangement of advance technology and engineering applications. There is no better way to influence STEM education other than the development of robotics.

- Effective human and automation collaboration and teamwork
- Collaborative robots
- Accessories and software
- Sensors
- Vision systems
- Power and force limitation
- Advanced digital instrumentation
- Training on complacency and situational awareness of operators
- Cloud based applications for monitoring equipment, managing a workspace without entering into it
- Advanced manufacturing of all types
- Fabrication
- Prototyping
- Environment simulation (e.g. operating room, fast-food restaurant, shipping docks, etc.)

Types of Robots

Robots are configured by software to carry out repetitive tasks that humans previously handled. Robotics processing and automation taps foundational technologies such as artificial intelligence, machine learning, and big data analytics to get the job done. Robotic deployments vary in sophistication. Bots employed today may execute a script to repeatedly perform a particular function. Software robots can learn about the tasks they are performing and make adjustments.

- Industrial Robots—stand alone and joint operation with humans
- Automation on the factory floor
    - Industry 4.0—Cloud Base connections with industrial machines

- Humanoid robots
- Complementary automated functions
- Full interoperability with humans—fluent integration with people
- From research on aerospace applications by Georgia Tech:
    - Integrated processes
        - Drill, Inspect & Fill
        - Seal, Inspect & Paint
        - Robotics Drill and Fill
        - Drill and inspection integrated
        - Inkjet based paint and seal
    - Automated Inspection of Every Step

Key Partnerships

Grid70, Grand Rapids

- Helps companies that work in a home office to work downtown.
- Works as a business hotel for these companies.
- Meijer has test kitchen, quality insurance, and food scientists. Space is in charge of all the food that is manufactured in any of the six facilities.
- Wolverine Worldwide is one brand that kept growing. That brand has now taken over the entire 4th floor as well.
- 3-D Printer

Benchmarks

As we began developing a comprehensive economic development plan for a Research and Development Facility for Crossover Technologies, we chose—with guidance from the administration and stakeholders in The City—to focus on robotics collaboration as a field requiring manufacturing and technological innovation, and also one that we felt would fit the collaborative framework requested by The City. The first task of the project was benchmarking a number of organizations in Michigan and across the country. From these benchmarks, we gleaned insights and data regarding their operations, how they are funded, how people and organizations access them, and developed recommendations for the future The City Collaboration Center. We grouped these benchmark organizations into a hierarchy—or more succinctly, a continuum of collaborative innovation organizations. We developed this hierarchy not as a means of ranking the organizations, but rather to understand the categories these various organizations belong in, and to also help determine a niche, or white space, that the The City center could fit into. The following are the benchmark facilities, and represent almost the entire continuum—in general terms, of robotics-, or innovation-

collaboration types of organizations. Through this process, we have determined, and will be recommending a niche that doesn't seem to be covered, and which we have received favorable feedback as we have been socializing the concept.

Benchmark Overview

The Robotics Institute at Carnegie Mellon

- Pay to play—commissioned work
- University-based program
- Private school—contract research, grants, and tuition programs help fund

Wilson Student Team Project Center at University of Michigan

- Access for students at University of Michigan
- Public school—contract research, grants, state support, and tuition programs

SRI International

- Spin-off from Stanford University
- Contract research
- Venture start-ups

Bolt

- Venture capital-based. Must go through their gateway
- $25 million expansion cost for San Francisco facility

Automation Alley Innovation Lab

- Automation demonstration facility
- $10 million in technology
- Companies get demonstrations of machines on-site

TechShop Detroit

- Membership-based program. Open to public for a fee.
- Hands-on
- Over $1 million in advanced machines and computer programs at each facility

FIRST Robotics

- High school level competition
- Very broad range of sophistication (depending upon access to tools, workspace, and funds)
- Relies heavily on volunteers, mentors, and corporate donations

Square One Education Network

- For high school teachers and students
- No main facility
- Traveling exhibits and hands-on learning at sponsored events and locations

A more detailed description of these organizations follows:

The Robotics Institute at Carnegie Mellon – Pittsburgh, PA

- The Robotics Institute at Carnegie Mellon University was established in 1979 to conduct basic and applied research in robotics technologies relevant to industrial and societal tasks.
- The Robotics Institute is a technology transfer organization that designs, develops and tests robotic systems and vehicles for industrial and government clients.
- Innovative research and academic programs
- PhD, masters programs and an undergraduate minor for Carnegie Mellon students down to the K-12 level
- The facility includes approximately 100,000 square feet at the main Pittsburgh campus, another 100,000 square feet at the National Robotics Engineering Center in Lawrenceville and 7,000 square feet and 40 acres of testing fields at Robot City, the Field Robotics test site in Hazelwood
- The institute regularly partners with government, industry, and non-profit organizations in the areas of sponsored research and education.

Wilson Student Team Project Center at University of Michigan – Ann Arbor, MI

- 20,000 sq. ft. facility located on the campus of University of Michigan
- $10-million facility for design, assembly, machining, electronics, and painting
- Access to the facility empowers student teams by providing a space in which they can experience hands-on development and fabrication, enhance engineering theories, and allow members to use practical application of knowledge
- Student team projects provide practical design fabrication experience that complements classroom instruction in addition to real-life lessons in cooperation

SRI International – Menlo Park, CA

- Nonprofit, independent research center serving government and industry through government and industry cross collaboration non-profit organization
- Total of $4 billion in sponsored research
- Provides assistance with patents, licensing, company spin-offs
- Examples include: SIRI (Acquired by Apple), Redwood Robotics (Acquired by Google) DaVinci Robot, HDTV
- Two Michigan Facilities – Ann Arbor and Plymouth

- Ann Arbor focused on radar, imaging and Plymouth facility on Pharma-related projects
- Sponsored R&D is at the center of SRI's integrated business models. Focus is always on meeting client and market needs to create and deliver new value, whether the outcome is an R&D solution, technology license, new product or spin-off venture
- The revenue generated by R&D projects, commercialization activities, and marketplace solutions is reinvested in SRI capabilities, facilities, and staff to advance our mission and to continue to meet client and partner needs
- Clients and projects include government agencies, commercial businesses, foundations and associations, along with client-sponsored R&D
- Ventures and Licensees: SRI licensees range from large corporations to mid-size firms and small start-ups that are spearheading new technologies and products. SRI has created and launched more than 40 ventures with a total market capitalization that exceeds $20 billion

Bolt – Boston, MA and San Francisco, CA

- Bolt is a venture capital fund that invests in start-ups and provides the tools, facilities and expertise to help these small companies combine software and hardware and create a prototype, or small run of the product
- Invests $100k to $500k in early stage startup portfolio companies at the intersection of hardware and software
- Boston facility was opened with $4 million fund
- Second facility opened in San Francisco with $25 million commitment
    - Opened in the Autodesk Workshop on San Francisco waterfornt
    - Design/Engineering team will utilize Autodesk's "worldclass prototyping shop", in Boston and San Francisco
- Hands-on investment model
- Includes full engineering/design team
    - Leverage their experience of designing, manufacturing and shipping tens of millions of units (previous jobs)
- "High-end prototyping facilities"
    - CNC Machining, Metalworking, Electronics, Firmware, Rapid Prototyping, office space
- Make manufacturing cool

TechShop Detroit – Detroit, MI

- TechShop is a community-based workshop and prototyping studio on a mission to democratize access to the tools of innovation.
- For-profit; community-based workshop and prototyping studio
    - Facilities in Arizona, California (multiple), Michigan, Missouri, Pennsylvania, Texas, and Virginia/DC, along with Paris, Abu Dhabi, and Tokyo
- Cutting-edge tools, equipment, and computers loaded with design software featuring the Autodesk Design Suite
- Variety of classes and workshops are offered at the facility
- Welcomes all innovators, from backyard tinkerers to software engineers, to use our resources and bring an idea to life or invent the next big thing in automotive technology
    - TechShop offers space to make, and the support and camaraderie of a community of makers."
- Facility attracts more weekend hobbyists than serious entrepreneurs

Automation Alley Innovation Lab – Troy, MI

- Previously housed inside the Technology Center on the campus of Oakland University
- The 1,500-square-foot space featured emerging technologies including 3D printing and scanning, robotics, modeling and simulation.
- $10 million in technology value
- Serves as a demonstration facility for advanced manufacturing
- The lab allowed small and medium-sized manufacturing firms to test those technologies for possible implementation in their operations
- Automation Alley is migrating the training and demonstration capabilities currently at the Oakland University location to its headquarters in Troy

Square One Education Network – Waterford, MI

- Square One's mission is to identify, fund and enable STEM (science, technology, engineering, and math) projects for K-12 teachers and students
- The Square One Education Network provides grant funding to schools and other K-12 learning environments, enabling them to provide innovative, meaningful STEM (science, technology, engineering, and mathematics) programs.

- The Board of Directors are industry leaders and educators with a common vision that students should have the opportunity to pursue technology oriented careers through authentic, hands-on science, mathematics and engineering opportunities.
- Grants typically range from $2,500 to $5,000

FIRST Robotics – Farmington Hills, MI

- FIRST (For Inspiration and Recognition of Science and Technology) was founded in 1989 to inspire young people's interest and participation in science and technology.
- "The mission of FIRST is to inspire young people to be science and technology leaders, by engaging them in mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership."
- FIRST, at its core, is a robotics competition for high school students
- Out of approximately 900 teams nationally, the state of Michigan has more than 400 teams—more FIRST high school robotics teams than any other state
- FIRST in Michigan has expanded its tournament schedule with 21 district competitions being held this year compared to 18 competitions in 2015.
- Michigan teams have won 14 winning trophies at the world competition, more than any other state
- "Engage kids in kindergarten through high school in exciting, mentor-based, research and robotics programs that help them become science and technology leaders, as well as well-rounded contributors to society."

Recommendations

When looking at the robotics and automation sectors, we found that the common overlaps were in manufacturing technology and information technology. Once we understood the primary requirements of the knowledge base within automation/robotics sector, we became excited that The City and the surrounding region seemed to be endowed with the very people needed to grow and innovate the sector within this region. And, this was confirmed as we benchmarked the existing organizations (discussed above) and found many of these organizations promoted their abilities to bring "hardware and software", or "manufacturing technology and information technology" together.

We soon began shaping the vision for the facility as an innovation and collaboration center, where the manufacturing expertise can serve as a draw for innovators working in robotics and automation. We envisioned it as a place where companies—large and small—could work in a common space on solving mutual problems.

However, after conducting meetings with regional stakeholders and advisory teams, we found little appetite from established companies to work in a collaborative environment. Many companies felt this would endanger their competitive edge by sharing information and ideas with other companies. Larger companies told us they preferred to internalize their R&D and product development operations, only working with outside organizations under blanket non-disclosure agreements. Smaller companies in the post start-up phase also told us the same—they were afraid of losing their innovation advantage to other growing companies.

We then sought to refine the vision for the facility by asking our advisory teams and other stakeholders to help us determine the population this facility should be aimed at serving.

We knew we had to bring manufacturing technology—CNC machines, laser cutting tools, 3D printers, and other tools into the facility so people could fabricate their vision and build a working prototype. We also knew the facility would have to have an electronics and software component to enable the automation of the prototype. As we looked at articulating the population that would be interested in using such a facility, we realized there are already many communities of people working in this space—albeit scattered in many workshops throughout the city, county and state. These communities are the high school teams competing in FIRST robotics. Each of these teams is based in a high school, and each team must raise funds, write code, and fabricate a robot capable of performing the tasks in the FIRST competitions held in the state and nationally. There is a wide breadth of knowledge and access to tools for each of these teams. Some are able to raise funds and gain access to workshops within some of the largest automotive companies in the region, while others are using spare space in their school's wood shop. Also, we found that after finishing high school, there is no place for people who have caught the robotics/automation bug to continue to work on actual projects.

As a result of this process, we are recommending our vision for the City facility is to build and develop a regional innovation center, accessible to all FIRST Robotics teams, post-FIRST graduates, Square One facilitators, and anyone else with a passion for combining manufacturing technology and information technology, making a product, and potentially starting a company. This center, by combining electronics, software, and coding with traditional manufacturing can spark someone's interest in further study, or entrepreneurial pursuits, which will lead to job creation and young people once again excited about the manufacturing sector and skilled trades.

The next phase of the project should include evaluating support for the facility, fundraising and build out. The following is a list of what should be considered and included in the facility.

Assets

- Manufacturing tools

- Fabrication machinery and tools—lathes, 3D printers, laser cutters, metal bending equipment, etc.

- Software
- Electronic tools and equipment
  - Soldering, printed circuit board design and manufacturing, software tools, computer aided design equipment, etc.
  - Laptops and desktop machines
  - Data storage/cloud
  - IoT capabilities
  - Software packages
  - Engineering program packages
  - VR simulation
  - Modeling capability
    - Purchase 3-4 Rethink robots—Baxter, Sawyer

Resources

- What is the secret sauce
  - Devoted leader/visionary—Facility needs a strong dynamic leader who can create the vision and work closely with industry and users to enable center to reach its highest, most beneficial use
  - Small grants
  - Innovation fund
  - Culture is important
  - Solicit volunteers from companies—current employees, or retirees, who can lend their expertise to help people develop their product
  - Recruit entrepreneurial mentors to help with formation of a business, scale to volume, etc.
- Benefits
  - FIRST schools could use the lab and expertise to develop their robot
  - Companies would see first-hand the type of people working on the FIRST teams, and on individual projects—possibly
- Users
  - HS FIRST teams,
  - Any person, HS and beyond with a project to build

- Does the facility need a gateway—or can anyone walk in?
  - FIRST teams
  - Make a pitch
  - Bring in a business plan
  - Proof of concept—funding would be made available based on submission of a business plan or technology development plan.
  - Offer grants in the range of $5K to help someone explore and develop their idea

Sample Funding Strategy

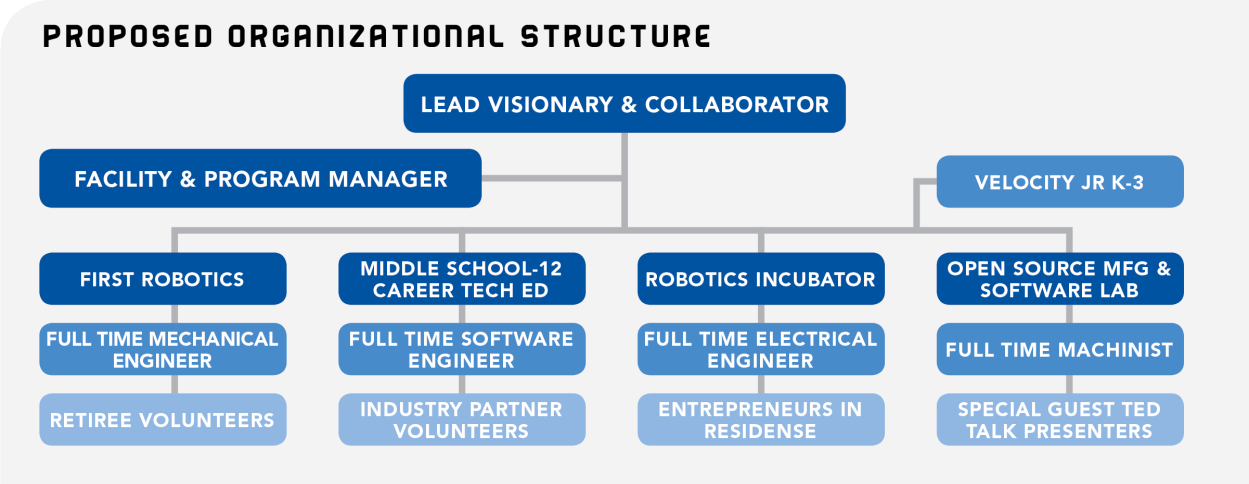
- Raise money
  - Solicit funding from companies—rather than just funding one school's program, fund a center where many school programs could have access
  - Solicit funding from public sector entities—local, county and state funding sources.
- Government can donate space
- Seed Funding – Government and Corporate Partners
  - Department of Defense
  - National Science Foundation
  - Department of Education
  - The New Economy Initiative
  - The Ralph Wilson Foundation

Proposed Business Model

- Sustainability
  - Membership Dues
  - Corporate Partners
  - Grants
  - Sponsored Research
  - Licensing
  - Spin Offs and Sales
- Private Membership model (pay to play)

        - Hourly
        - Weekly
        - Monthly
        - Full-year partnership (corporate partners)
        - Corporate or individual
    - Public memberships
        - Subsidy support from Corporate partners (sponsors)
            - TARDEC
            - MEDC
            - University
            - Community College (hold classes onsite)
            - K-12 (First Robotics, STEM)

Proposed Organizational Structure



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Appendix A: Proposed Operation Budget

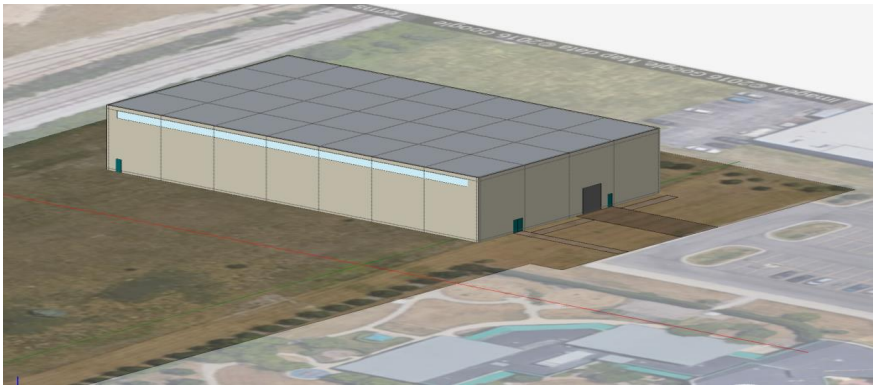
Robotics Collaboration Center		Proposed Operation Budget									
	Months of Operation	12	12	12	12	12	12	12	12	12	12
	Year	1	2	3	4	5	6	7	8	9	10
DEVELOPMENT INCOME:											
City/LDFA Contribution		$ 100,000.00	$ 100,000.00	$ 100,000.00	$ 100,000.00	$ 100,000.00	$ 100,000.00	$ 100,000.00	$ 103,758.00	$ 112,277.00	$ 120,837.00
Annual Gross Rental Income		$ 162,500.00	$ 167,375.00	$ 172,396.25	$ 177,568.14	$ 182,895.18	$ 188,382.04	$ 194,033.50	$ 199,854.50	$ 205,850.14	$ 212,025.64
Annual Other Income		$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00	$ 678,000.00
Gross Income		$ 940,500.00	$ 945,375.00	$ 950,396.25	$ 955,568.14	$ 960,895.18	$ 966,382.04	$ 972,033.50	$ 977,854.50	$ 983,850.14	$ 990,025.64
Vacancy Loss Commercial		$ (16,250.00)	$ (16,737.50)	$ (8,619.81)	$ (8,878.41)	$ (9,144.76)	$ (9,419.10)	$ (9,701.67)	$ (9,992.73)	$ (10,292.51)	$ (10,601.28)
Effective Income		$ 924,250.00	$ 928,637.50	$ 941,776.44	$ 946,689.73	$ 951,750.42	$ 956,962.94	$ 962,331.82	$ 967,861.78	$ 973,557.63	$ 979,424.36
Administrative Expenses		$ 680,142.80	$ 730,953.47	$ 783,135.42	$ 836,718.37	$ 849,269.15	$ 862,008.19	$ 874,938.31	$ 888,062.38	$ 901,383.32	$ 914,904.07
	Office Payroll	$ 552,500.00	$ 585,000.00	$ 617,500.00	$ 650,000.00	$ 650,000.00	$ 650,000.00	$ 650,000.00	$ 650,000.00	$ 650,000.00	$ 650,000.00
	Advertising/Marketing	$ 13,005.00	$ 13,770.00	$ 14,535.00	$ 15,300.00	$ 15,300.00	$ 15,300.00	$ 15,300.00	$ 15,300.00	$ 15,300.00	$ 15,300.00
	Legal /Accounting	$ 1,105.00	$ 1,170.00	$ 1,235.00	$ 1,300.00	$ 1,300.00	$ 1,300.00	$ 1,300.00	$ 1,300.00	$ 1,300.00	$ 1,300.00
	General Office	$ 7,282.80	$ 7,711.20	$ 8,139.60	$ 8,568.00	$ 8,568.00	$ 8,568.00	$ 8,568.00	$ 8,568.00	$ 8,568.00	$ 8,568.00
	Technology	$ 106,250.00	$ 112,500.00	$ 118,750.00	$ 125,000.00	$ 125,000.00	$ 125,000.00	$ 125,000.00	$ 125,000.00	$ 125,000.00	$ 125,000.00
Utilities		$ 17,000.00	$ 18,091.80	$ 19,194.29	$ 20,307.56	$ 20,411.13	$ 20,515.23	$ 20,619.86	$ 20,725.02	$ 20,830.72	$ 20,936.95
	Electricity	$ 12,750.00	$ 13,500.00	$ 14,250.00	$ 15,000.00	$ 15,000.00	$ 15,000.00	$ 15,000.00	$ 15,000.00	$ 15,000.00	$ 15,000.00
	Water & Sewer	$ 4,250.00	$ 4,500.00	$ 4,750.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00
Maintenance/Non-Capitalized Repairs		$ 27,824.75	$ 29,903.42	$ 32,038.19	$ 34,230.28	$ 34,743.74	$ 35,264.89	$ 35,793.87	$ 36,330.77	$ 36,875.73	$ 37,428.87
	Contracted Maintainence	$ 6,574.75	$ 6,961.50	$ 7,348.25	$ 7,735.00	$ 7,735.00	$ 7,735.00	$ 7,735.00	$ 7,735.00	$ 7,735.00	$ 7,735.00
	Repairs	$ 21,250.00	$ 22,500.00	$ 23,750.00	$ 25,000.00	$ 25,000.00	$ 25,000.00	$ 25,000.00	$ 25,000.00	$ 25,000.00	$ 25,000.00
Property & Liability Insurance		$ 8,500.00	$ 9,135.00	$ 9,787.14	$ 10,456.78	$ 10,613.64	$ 10,772.84	$ 10,934.43	$ 11,098.45	$ 11,264.93	$ 11,433.90
Reserve Requirements		$ 12,643.75	$ 13,454.44	$ 14,272.92	$ 15,099.24	$ 15,174.74	$ 15,250.61	$ 15,326.87	$ 15,403.50	$ 15,480.52	$ 15,557.92
Total Expenses		$ 746,111.30	$ 801,538.13	$ 858,427.97	$ 916,812.25	$ 930,212.39	$ 943,811.76	$ 957,613.33	$ 971,620.12	$ 985,835.21	$ 1,000,261.71
Revenue after Expenses		$ 178,138.70	$ 127,099.37	$ 83,348.47	$ 29,877.49	$ 21,538.03	$ 13,151.18	$ 4,718.49	$ -	$ -	$ -

OTHER INCOME AND ASSUMPTIONS		
Description	Monthly Income	Annual Income
Facility Rental - Single User*	$7,500	$90,000
Program Fees	$7,500	$90,000
Naming Rights	$25,000	$300,000
Corporate Partnerships	$15,000	$180,000
Annual Event	$1,500	$18,000
TOTALS:	**$56,500**	**$678,000**

***MEDC:** This column of cells should be used to input other forms of income such as tenant contributions, parking, fees, etc., and any other forms of income that do not fit in the sections above.

Appendix B: Proposed Facility Plan

Robotics Center	
Robotic R&D Center - New Facility	
Sterling Heights, MI	**New Facility Area: 25,000 SF**
Conceptual/ Program Estimate - Rough Order of Magnitude	**Estimate Date: 11-17-16**



Item Numer	Description	GSF	Cost/ GSF	Aggregate Cost
A	Substructure	25,000	$13.34	$333,557
B	Shell	25,000	$60.16	$1,503,965
C	Interiors	25,000	$29.96	$748,975
D	Services	25,000	$53.72	$1,343,000
E	Equipment & Furnishings	25,000	$0.48	$12,000
G	Building Sitework	25,000	$18.13	$453,163
Total Construction Costs - Direct		**25,000**	**$175.79**	**$4,394,660**

Construction Costs - Indirect		
Design, Estimating, and Construction Contingency	10.00%	$439,466
Market Escalation	2.00%	$87,893
GC's, Bond & Fees, CM OH&Profit	1 LPSM	$875,000
Design and Engineering Fees	1 LPSM	$500,000
Total Construction Costs - Indirect	**$76.09**	**$1,902,359**
Total Construction Cost	**$251.88**	**$6,297,019**

Owner Controlled Costs		
Geotech, Commissioning, Surveys & Testing	ALLOWANCE	$50,000
Furniture, Fixtures & Equipment	1 LPSM	BY OWNER
Technology Equipment	1 LPSM	BY OWNER
Total Owner Controlled Costs	**$2.00**	**$50,000**
Total Project Cost	**$253.88**	**$6,347,019**

NOTE: Estimate breakdown is for accounting purpose ONLY