Makerspaces

Supporting an Entrepreneurial System

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City of East Lansing & East Lansing Public Library

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MSU EDA University Center for Regional Economic Innovation (REI)

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Makerspaces: Supporting an Entrepreneurial System

Michigan State University

Center for Community and Economic Development

EDA University Center for Regional Economic Innovation

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TABLE OF CONTENTS

INTRODUCTION

Communities across Michigan are home to numerous thinkers, inventors, and creative people with a wide range of skills and talent. Many of these makers work by themselves in their own garage, workshop, or at a coffee shop. A strong entrepreneurial ecosystem that supports these innovators and encourages them to develop new skills, innovate, and pursue their entrepreneurial ideas is important in furthering economic growth.

The main objective of the proposed co-learning plan is to review innovative practices in building an entrepreneurial ecosystem based on talent, innovation, and creativity that fosters a vibrant local economy, in addition to provide actionable recommendations for East Lansing and interested communities. For this co-learning plan, the authors researched the makerspace concept and assessed how it functions to support innovation at the local level. A makerspace initiative thrives from the creative process and personal growth through providing a workshop space where amateurs and professionals interested in various fields such as electronics, robotics, software, wood or metal working, art, video, or photography can expand their skills, invent, and build new products in a collaborative environment. Makerspaces are places where like-minded persons gather to work on personal projects, share tools and expertise as well as learn from each other (Tweney, March 29, 2009).

The purpose of this objective is for the City of East Lansing and the Downtown Development Authority (DDA) to seek to diversify the entrepreneurial ecosystem by exploring and implementing additional programs that support creativity, risk taking, innovation and critical thinking. In 2008, the City and its Downtown Development Authority created the East Lansing Technology Innovation Center, a high-tech small business incubator located in the heart of downtown East Lansing. The Technology Innovation Center helps entrepreneurs to start and grow their business ideas by providing space, business development services and networking opportunities for the business tenants. Small entrepreneurs and Michigan State University (MSU) faculty have a place to launch their business ideas. The business incubator operates at full capacity and many of the tenant companies have grown successful businesses. The rapid success of the Technology Innovation Center led to the creation of The Hatch, a student incubator, which assists students in pursuing their business ideas.

An important part of this entrepreneurial ecosystem in East Lansing is the MSU Innovation Center created in 2012, located next to the Technology Innovation Center and The Hatch. The three components of the MSU Innovation Center are: MSU Technologies, the university's technology transfer and commercialization office established in 2007, Business-CONNECT, created in 2009 as MSU's portal for engagement with the business community and lastly, Spartan Innovations, established in 2012, which provides the educational and financial support necessary to turn MSU research technologies into successful Michigan businesses.

On the heels of the Technology Innovation Center's success, the City of East Lansing and the Downtown Development Authority are seeking to strengthen the local entrepreneurial environment and further the East Lansing innovation hub. The local officials wish to explore other approaches, programs and maybe focus on other target groups, such as teens and young adults. The City of East Lansing is exploring the makerspace program for the potential this initiative has in growing the local innovation infrastructure, as well as business development and creativity support services. These economic development efforts require a partnership network in order to integrate this new culture into the fabric of our community. The East Lansing Public Library has emerged as a leading partner for the makerspace while Michigan State University, Lansing Economic Area Partnership (LEAP), private sector businesses, the Arts Council of Greater Lansing and the East Lansing Downtown Development Authority have led other aspects of the community's innovation efforts. A public library-based makerspace program is a very effective way to introduce people, especially kids and teens, to creative and entrepreneurial concepts. Through encouraging participants to learn and develop new skills, including entrepreneurial skills, library-based makerspace initiatives are a central component of our economic gardening efforts. The design and implementation of a makerspace program at the East Lansing Public Library would benefit from the support of many regional partners, including Lansing Makers Network, MSU, the Technology Innovation Center, the private sector and other organizations involved in innovation and creativity activities.

This co-learning plan starts with a discussion about the need to foster innovation and entrepreneurial activities in Michigan's communities, followed by an overview of the makerspace movement, its characteristics and several examples from around the U.S. and Michigan. The next section identifies several makerspace programs developed by public libraries in the U.S. and describes an innovative program at the Detroit Public Library in Michigan. Finally, the authors of the co-learning plan provide recommendations for the feasibility of a makerspace program at a public library, with regard to the design and implementation of the program. These recommendations provide communities, along with their economic development organizations, with the relevant knowledge they need to replicate this strategy, which fosters a local entrepreneurial system, elsewhere.

THE PROBLEM

Overview

Economic growth requires continued entrepreneurial innovation and expansion (Kauffman Foundation, 2013; Schwab, 2012). Knowledge, research, innovation, learning and entrepreneurial spirit are crucial to long-term economic growth (Eaton and Kortum, 1996; Romer 1986). Places that foster innovation and creativity can adapt faster to the new economy and sustain economic growth. In order for communities to remain competitive in the global economy, technological improvements require an increased knowledge base for industrial innovation. In this regard, nurturing innovation and entrepreneurship is a central component of the strategy of any community, regardless of the existing growth patterns. Communities need to invest and foster a talented workforce in order to stay competitive in the global economy.

The ability to create new ideas is an important source of economic growth and resilience (CEO for Cities, 2008). Studies have shown that in order to develop entrepreneurs and entrepreneurial communities, a strong support network as well as a community that is ready for change and seeks innovation is critical (Litchenstein, Lyons and Kutzhanova, 2004). Innovation needs to be enabled and supported at all age groups. What is critical in furthering an entrepreneurial community is a supportive infrastructure that develops human capital and supports innovation, risk-taking and creativity (Blakeley and Leigh, 2010; Glaeser, 2005; Mathur, 1999; McGranahan and Wojan, 2007). Talent is becoming increasingly relevant in determining the allocation of economic opportunities and to foster economic productivity and growth (Blakeley and Leigh, 2010: 63, Glaeser and Saiz, 2004). Blakely (1994) suggested that high-tech companies are attracted to places where a technology, research, invention and innovation base already exists. Innovation is positively correlated to job growth in the mid- to long-term (Atkinson, Andes, Ezell, Castro, Hackler and Bennett, 2010).

The U.S. Profile

The Boston Consulting Group was recently ranked in the United States as just eighth in global innovation-based competitiveness. This assessment is based on factors such as corporate and government research and development investments, venture capital, scientists and engineers (Juan, Du, Lee, Nandgaonkar and Waddell, 2010). In a 2009 study, the Information Technology and Innovation Foundation (ITIF) ranked the United States sixth for innovation-based competitiveness out of forty countries. ITIF used sixteen indicators to assess the global innovation-based competitiveness of thirty-six countries. This report found that the U.S. ranks last in progress toward the new knowledge-based innovation economy over the last decade (Atkinson and Andes, 2009). Moreover, the latest World Economic Forum's Global Competitiveness 2012-2013 ranking dropped the United States to seventh place (Schwab, 2012).

It has been argued that the U.S. education system is in crisis due to the relative decline in science, technology, engineering and math (STEM) proficiency, fewer young people are interested in STEM fields, and decline in measured creativity (Cognizant, n.d., Institute of Museums and Library Services (IMLS), 2012). The future competitiveness and innovative capacity of the U.S. depends on the quality of the workforce. Today's globalizing economy requires countries, including the United States, to foster well-educated workers who are able to adapt rapidly to the changing economic and technological environment (Schwab, 2012). The U.S. must continue to design and develop cutting-edge products to maintain a competitive edge and move toward higher value-added activities. This requires an environment that is conducive to innovative and entrepreneurial activities (Kauffman Foundation, November 18, 2010; Schwab, 2012).

Problems Facing Michigan

The problems facing Michigan are well known and reviewed elsewhere (Ballard, 2010). Michigan is lagging the nation in developing a knowledge-based economy and adapting to a rapidly changing global economy (Glazer and Grimes, May 2012:6). Michigan ranked 17th in the Kauffman Foundation's 2010 State New Economy Index report, which measures to the extent of which state economies are knowledge-based, globalized, entrepreneurial, IT-driven, and innovation-based (Atkinson and Andes, November, 2010).

Michigan's communities need to place technology, innovation, and entrepreneurship at the center of economic policymaking. Communities need to develop programs that support learning, innovation and entrepreneurial spirit. Economic gardening initiatives that seek to harness the inherent knowledge-base of the community and foster creativity, as well as the desire to learn and innovate in the community's youth are critical for Michigan communities. Preparing the children for the 21st century economy through innovation, learning and creativity skills are important in placing Michigan in a competitive position.

The State of Michigan and its communities have already developed and implemented many programs and initiatives designed to foster innovation and entrepreneurship. However, unemployment, lack of investment and job mismatch are still major challenges faced by many of Michigan's communities. Creating effective strategies to develop entrepreneurs through local entrepreneurial support ecosystems is critical in cultivating an entrepreneurial culture in Michigan. This is especially true in those places struggling with unemployment, poverty and lack of private investment. Creating, not just retaining and attracting talent, through economic gardening is a cost effective option in developing vibrant economies in distressed communities. Within this ecosystem it is important for communities to foster creativity and innovation at all ages and beyond formal institutional environments.

MAKERSPACE PROGRAMS

Definition

Numerous makers groups can be found across the nation and the world. Makerspaces are places where like-minded persons gather to work on personal projects, share tools and expertise as well as learn from each other (Tweney, March 29, 2009). The driving principle of makerspaces is that users enjoy sharing tools, equipment, expertise and ideas rather than working by themselves in the garage or basement (Roush, May, 22, 2009). Maker Media defines makerspaces as:

> Learning environments rich with possibilities, Makerspaces serve as gathering points where communities of new and experienced makers connect to work on real and personally meaningful projects, informed by helpful mentors and expertise, using new technologies and traditional tools. (Spring 2013:1)

Makerspaces display different legal structures, different projects and tools, and different mentorship programs. The scope of a makerspace is driven by its members and their creative needs. The interests of makerspace users vary and include electronics, knitting, machining, crafts, scrapbooking, woodworking, ceramics, sewing, design, and much more. Makerspaces allow members to pursue their creative needs in a collaborative environment. Many of the makerspaces provide numerous learning opportunities through classes and demonstrations (Kalish, November 21, 2010). In many cases, members have day jobs but prefer to join makerspaces for their creativity needs. Many members represent independent, local small businesses. The founder of Willoughby & Baltic, a hackerspace in Somerville, MA, notes:

> A lot of the people who come here at night or on the weekend went to work at high-tech companies thinking they were going to have a certain level of creativity, and they've come to feel over time that their creativity is being squashed. But they still need a creative, collaborative environment - so they come here." (Quoted in Roush, May, 22, 2009).

History and Variations of Makerspace

Similar initiatives to Makerspaces include hackerspaces, tech workshops, Fab Labs and techshops, defined below. Sometimes makerspace and hackerspace are used interchangeably. With regards to the hackerspace movement in the U.S., it has been argued that the movement was inspired by the growing open-source hardware movement and hacker collectives in Europe, especially in Germany and Austria (i.e. Metalab in Vienna, c-base in Berlin, Chaos Computer Club in Hannover, Germany) (Roush, May 22,

2009; Tweney, March 29, 2009). Among the first hackerspace in the U.S., the NYC Resistor, New York and HacDC, Washington, D.C. opened in the late 2007 while Noisebridge, San Francisco, CA opened in the fall 2008. Website links for the makerspaces and similar groups mentioned in this co-learning plan are provided in the Appendix.

The makerspace, modeled after hackerspaces, is the result of the efforts of MAKE: magazine, which started in January 2005 to promote 'do-it-yourself' (DYI) projects. Maker Media publishes the MAKE: magazine, organizes Maker Faires and supports the Maker movement through DIY electronics, tools, kits and books (Maker Media, Spring 2013; MAKE:, n.d.). Maker Faires showcase maker projects as well as celebrate innovation and the do-it-yourself culture. Annual Maker Faire events take place across the U.S., including at the Henry Ford Museum in Dearborn, MI and San Mateo, CA (the original event). These events attract a diverse audience and present projects ranging from traditional crafts to advanced technology and robots geared to attract all ages (Figures 1 and 2).

Hakerspace – A hackerspace or a hack space is a membership-based location featuring workshops, tools, and people; it is a location where people with common interests, usually in computers, technology, science, digital and electronic art can meet, socialize and/or collaborate. Many hackerspaces participate in the use and development of free software and alternative media. Hackerspaces have been a self-forming organic concept. European hackerspaces are places where local programmers meet and collectively work (Borland, August 11, 2007). Examples of hackerspaces include NYC Resistor, Brooklyn, New York, Hackerbot Labs and the 911 Media Arts Center, Seattle, WA, and Noisebridge, San Francisco, CA. Website links for these groups are included in Appendix.

Fab Lab (fabrication laboratory) – A Fab Lab provides digital technologies and machines that allow users to develop products and move ideas to products (Gershenfeld, 12; Mott Community College, n.d.). The concept is similar to a hackerspace, but Fab Labs were started before the hackerspaces. The concept was created at the Massachusetts Institute of Technology (MIT) by Professor Dr. Neil Gershenfeld, and is the result of the MIT Center for Bits and Atoms which focused on laboratory research on technologies for personal fabrication. In general, Fab Labs are associated with a sponsored or academic organization, such as the Stanford Learning Fab Lab, Champaign-Urbana Community Fab Lab, Mott Community College Fab Lab, Michigan State University Creativity Exploratory, and the Chicago Museum of Science and Industry Wanger Family Fab Lab. The United States FABLAB Network (USFLN) represents a rapidly growing network of colleges in the U.S. with FABLAB operations. At the MIT's Center for Bits and Atoms, activities range from technological empowerment, peer-to-peer project-based technical training, local problem-solving, small-scale high-tech business incubation and grass-roots research (MIT, n.d.). Some of the projects developed and produced in Fab Labs include

solar and wind-powered turbines, thin-client computers, wireless data networks, analytical instrumentation for agriculture and healthcare, and custom housing (MIT, n.d.).

Fab Labs in Michigan: The Mott Community College FABLAB – The FABLAB allows existing businesses, students, inventors, homemakers, and engineers to use an extensive array of digital fabrication and prototyping equipment. The purpose is to enable the lab user to create a rapid, proof-of-concept prototype to validate product design and assist in determining market viability. The lab equipment includes a Laser Engraving Cutter, a Vinyl Cutter, ShopBot CNC Router, a TorchMate CNC Plasma Cutter, DaVinci CNC Bench Top Mill, Electronics Fabrication and Testing Bench, Polycom Videoconferencing Bridge and software. Completion of a safety module for each piece of equipment and certification by the project staff before the machines may be used is required by all users.

In order to use the lab, Mott Community College students must enroll in the course TECH-120 'Introduction to FABLAB', while community members enroll in one of the two offered workshops. The Digital Fabrication Workshop allows individuals to work and learn only what they need to know to develop their product ideas. The workshop provides access to the equipment, software and limited help with the software applications. The workshop lasts for either 10 or 20 working days. The workshop fees are $59 and $109 respectively. The second workshop is the Digital Fabrication Seminar which is designed for individuals who require additional support to complete the design development process and the creation of a prototype component. The Digital Fabrication Seminar provides a more comprehensive level of support with the prototype development process and requires the user to have a product idea and design. MCC provides access to a student or staff member to support the CAD modeling activity and the operation of required equipment. There are four workshop formats, ranging from $125 for up to five working days of lab access plus up to five hours of product development support to more customized support for complex projects (MCC, n.d.).

The Michigan State University College of Arts and Letters Creativity Exploratory – The MSU Creativity Exploratory offers a unique learning environment designed to enhance students' education. Located in Linton Hall, the Creativity Exploratory hosts a Fabrication Laboratory that allows MSU students, faculty and staff to construct prototypes and engage in more hands-on creative activities. The lab equipment includes a MakerBot Thing-O-Matic 3D printer, a HP Large-format printer, a Roland Stika Precision Vinyl Cutter, a thermal book binding machine, a sewing machine and a variety of tools including a drill press and grinder. The Creativity Exploratory facilities also include a Documentary Film Lab where students use equipment, software and tools to work on documentary projects. During the 2013 spring semester, the Creativity Exploratory hosted a maker-focused short series designed to give students the skills to turn ideas into functioning prototypes and products.

TechShop – A TechShop is a commercial venture that combines the concepts of hackerspace, Fab Lab, prototyping studio and learning center. The TechShop provides member access to a significant list of equipment and software, in general over $1 million worth of professional equipment and software (Torrone, March 10, 2011). The TechShop offers comprehensive instruction and expert staff to its members. There are currently seven locations in the U.S.: Menlo Park, CA (the first location, which opened in 2006), Raleigh, NC, San Francisco, CA, San Jose, CA, Detroit - Allen Park, MI, Austin - Round Rock, TX, and Pittsburgh, PA. Several other locations are in the planning stages to be opened (Vance, May 23, 2012). In Michigan, TechShop partnered with Ford Motor to open a 33,000-plus-square-foot TechShop location adjacent to Ford's Dearborn product development campus (Vance, July 30, 2010). TechShop uses corporate sponsorships to open new workshop locations (Vance, May 23, 2012).

People interested in the workshop can join for a monthly or annual fee which includes unlimited access to the TechShop facilities. A list of membership fees for this facility and other makerspaces is included in Table 1. In order to use the TechShop's tools, members must successfully complete equipment-specific safety and basic use classes. TechShop organizes a number of experience-driven corporate events developed specifically to bring teams together and engage them in the act of making. The TechShop's staff members are available during the hours of operation to assist members on developing their ideas and improving their technical skills. For instance, the TechShop Detroit-Allen Park is open from 9:00 AM to midnight every day.

Overview of General Characteristics

Legal Status and Governance – In general, the majority of the makerspace groups are stand-alone organizations organized as a 501(c)(3) non-profit organization and governed by elected boards that are selected by active members. Elected officers may serve predetermined terms as well as help direct decision-making with regard to purchasing new equipment, recruiting new members, formulating policy, conforming to safety requirements, and other administrative issues (Roush, May 22, 2009). Some hackerspaces in the U.S. have chosen to run as a corporation (i.e. TechShop).

Some makerspaces are created inside an existing organization (e.g. university, public library, museums). The last two years have seen a growing interest among museums and libraries in developing 'making' programs (Hildreth, December 20, 2012). Private founders, including the Cognizant, MacArthur and J.D. Bechtel, Jr. Foundations, have started to support museum- and library-based maker programs. The Institute for Museums and Library Services (IMLS) has provided support for STEM and creative learning projects and Maker-type programs including digital studios, teen-focused technology toolkits, and mobile digital media labs for youth (Institute for Library and Museum Services, n.d.). Examples of museums and libraries embracing the maker initiative include the Exploratorium (CA), the Henry Ford Museum (MI), the Westport Public Library (CT), the Fayetteville Free Library (NY), the Newark Museum (NJ),

Anythink Public Library (CO), Detroit Public Library (MI), Chicago Public Library (IL), and the Chicago Museum of Science and Industry (IL).

Membership Fees and Benefits – In general, membership fees are the main income of a makerspace, but some groups accept additional donations and sponsorship. University-affiliated hackerspaces often do not charge a fee, but are generally limited to students, staff or alumni. Some makerspaces accept volunteer labor in lieu of membership fees. In general, the makerspaces monthly dues are between $50 and $175. Some makerspaces have a single membership rate, some have sliding scales based on the ability to pay (e.g. monthly or annual fees) and some groups offer various membership levels for different levels of access to the makerspace (e.g. standard, coder, hobbyist, part-time, student, family). Many makerspaces raise revenues through classes and events. Some may partner with a variety of local private sponsors or apply for grants.

There are a few issues in regard to membership. Some of these makerspaces provide services to a specific group: students, faculty members, paying adults. Some makerspaces are not easily accessible to everyone because they charge monthly membership fees. In order to engage its membership and recruit mentors, some makerspaces have open houses and other promotions to attract members to the program. Attracting enough members to cover space and program costs is critical. In the case of The Mill in Minneapolis, MN, the hackerspace closed after more than a year in existence due to the inability to build up enough membership to cover operational costs. The Mill opened in February 1, 2012 and had 90 members and 306 participants in classes ranging from soap making and sewing to Arduino microcontrollers (Baichtal, March 29, 2013).

Location, Space and Equipment Needs – The majority of makerspace programs start small, in garages and coffee shops. They eventually may move to bigger locations as their membership grows and their space, equipment requirements and assets also grow. For instance, Willoughby & Baltic, a "hackerspace" in Somerville, MA, was located initially in a space above a Subway sandwich shop and moved later to a former machine shop (Roush, May 22, 2009). Some maker groups are located in rented studios, lofts or commercial spaces. The space and the tools are shared by all members (Tweney, March 29, 2009). The equipment of the makerspaces grows based on members' needs and projects. In general, makerspaces have tools necessary for the following activities: woodworking, metal working, welding, electronics, crafting, robotics, sewing, and other creative activities. Many makerspaces have Laser Cutter, Makerbot, PrintrBot, Vinyl Cutter, T-shirt Press, Button Maker, and a Plotter.

Makerspaces usually encounter challenges in finding an adequate and affordable space or facility where all types of craft, metal, wood work, electronics or computer-related activities can legally take place. Opening the space and finding resources are a concern for many emerging maker groups and for groups that wish to expand due to increased

membership. The majority of the tools and equipment are costly. In addition to equipping a space, it is very critical for makerspace programs to have and provide adequate staffing and expertise. Many makerspace groups provide mandatory training for the more expensive and complex machines and willing members train other users on various tools.

Outreach Activities – Makerspaces offer numerous classes to community members depending on their expertise and interest. Members and non-members teach workshops classes for a wide variety of machines and practices, needed for members (i.e. Arduino Bootcamp, an introduction to the open-source Arduino electronics prototyping platform). Some makerspaces have collaborated with schools, public libraries, neighborhoods or the community-at-large. For instance, All Hands Active (Ann Arbor, MI) worked on a project in conjunction with the Eastern Michigan University's Bright Futures Institute for the Study of Children, Families, and Communities. The Allen County Public Library (Fort Wayne, IN) partnered with the local makerspace group, TekVenture, to provide maker workshops to library patrons. The Lansing Makers Network attended the Michigan State University Science Festival and provided hands-on activities for all ages. These outreach events are important to attract members, funding and donations in addition to developing community partnerships with private and institutional partners, such as public schools, museums or public libraries.

Safety Aspects – Members share their knowledge with other affiliates, including how to use specific tools and equipment. For dangerous or expensive equipment, prior knowledge or training within the makerspace is required. Proper building ventilation and fire systems are critical. For example, in the case of MakeIt Labs, a makerspace that opened in 2011 in Nashua, New Hampshire, the city ordered that the former foundry temporarily close because of concern about permits and building codes (i.e. insufficient venting of vehicle fumes near heat sources such as welding) (Brooks, December 15, 2011). In addition to physical building requirements, due to the nature of activities taking place in a makerspace, getting liability insurance is a major concern for makerspace groups (Makers Media, Spring 2013). For instance, The Mill in Minneapolis, MN and All Hands Active bought general liability insurance and required members and participants in classes to sign a Liability Release Waiver. In addition, members of The Mill were required to complete a Basic Skills and Safety (BSS) class for a piece of equipment before they could use it. Some makerspaces have safety rules with regard to the type of clothing, shoes and jewelry worn when using specific equipment.

Makerspace Projects – Projects in makerspace groups tend to develop organically. In many cases, individuals will propose a project, mention an idea or begin to tackle a complicated problem. Other members would share ideas, knowledge, tools, and expertise (Kalish, November 21, 2010; Levin, December 26, 2011). Some of the resulting projects led to successful start-ups (Vance, July 30, 2010; Vance, May, 23, 2012) such as the

DODO case (at the TechShop, Menlo Park, CA). Some of the projects are not immediately commercial-sizable technologies and are showcased at the Maker Faires (Roush, May 22, 2009). Some makerspaces, such as Columbus Idea Foundry and Lansing Makers Network, design and build things directly for consumers and businesses. For instance, Columbus Idea Foundry serves a number of artists, businesses and designers through the creation of prototypes and micro-manufacturing services. Many of these products and the interaction among makerspace members advance innovation and creativity and allow members to develop skills relevant in the 21st economy. A variety of the products developed by makerspace members have social, economic or artistic value. Examples of projects at makerspaces or hackerspaces include: milling tools, a 3D printable prosthetic hand, LED headlights, glass objects, a PCB table, a fire hydrant tap, an electric motorcycle, an automatic French press-style coffee maker, cast iron artwork, restored vintage camera, GreeterBot robot, and Strawberry DNA (website links are provided in the Appendix).

Examples of Makerspaces in the U.S.

Sector67, Madison, WI – Sector67 is a non-profit collaborative space in Madison, WI dedicated to providing an environment to learn, teach, work-on, build and create next generation technology. Currently, Sector67 is a fiscally-sponsored program of The School Factory, a Wisconsin 501(c)(3) non-profit corporation. The School Factory is a 501(c)(3) non-profit organization that supports makerspaces through providing them with fiscal sponsorship, so makerspaces can act as a 501(c)(3) without having to gain tax-deductible status and remain independent entities.

Sector67 is housed in a 6,600 square feet building with two complete garage bays. A list of membership fees for the makerspaces introduced in this document is included in Table 1. Membership allows access to the space, tools and equipment for persons interested in software, hardware, electronics, art, sewing, pottery, glass, metalwork, and iPhone/Android applications, and games. While prior knowledge is not required, the group offers classes to members and non-members on complex equipment (i.e. welders, mills, lathes, 3D printers) for a flat rate of $20/hour, participants are also required to take a safety orientation class. Sector67 also provides desk space in a shared office environment for $200/month (cost includes a membership). The makerspace has many supporters in the community and has received grants as well as donated tools and equipment from various local partners.

Milwaukee Makerspace, WI – Milwaukee Makerspace defines itself as a social club for people who like to build, invent, tinker and/or collect new skills and expand their minds. They have a diverse number of members including people interested in electronics, robots, wood working, embedded software, metal working, music, art, video, photography, electric cars and much more. Founded in 2009, the Milwaukee Makerspace acquired a rental space in November 2010 and the founding group expanded. Due to the

need for more space, the makerspace moved to a larger building in 2012 and the membership had grown to more than 60 members. In light of its substantial membership growth, the makerspace elected a Board of Directors to manage the program. They selected to organize a Milwaukee Makerspace Investor's Group to manage the property and a Makerspace of Milwaukee, Inc., a non-stock corporation in the State of Wisconsin. Most of the equipment is leased to the makerspace by members. The equipment includes a metal shop, casting, metalworking equipment, welders, wood chop, laser cutters, 3D printing area, electronics lab, textiles and crafting.

LA Makerspace, Los Angeles, CA – LA Makerspace is a non-profit member-driven community space for makers, tinkerers and DIYers of all ages to create and collaborate. Their mission is to provide a place where kids can make and learn alongside adults and members can work on their own projects while learning new, unique maker skills through workshops, mentorship all in a peer-learning environment. They offer classes, access to equipment, as well as member work and storage space. LA Makerspace is currently under a one-year fiscal sponsorship beneath the umbrella organization, home & community, inc., and is in the process of getting 501(c)(3) non-profit status. Classes and events have included programming, Arduino, fashion tech, food hacking, soldering, circuits, and more.

MakerKids, Toronto, Canada – Makerkids is a workshop space for kids located in Roncesvalles Village, Canada. MakerKids is a non-profit organization that enables kids to build their ideas with real tools and materials. Kids get involved in electronics, woodworking, sewing, crafting, cooking, programming, 3D printing, tinkering and making of all kinds. The founders started with a summer program and school events in 2010 and expanded to a permanent space in 2011. The program relies on a strong volunteer base and mentorship. There are also adult collaborators that act as facilitators for the kids. Teenage collaborators help the younger kids as a part of their high school volunteer hours, as well as work on their own projects.

Other Makerspaces – MakeIt Labs, Nashua, NH is a registered NH non-profit organization offering 6,000 square feet of space in a former foundry building. It opened in 2010 in Lowell, MA and re-opened in 2011 in Nashua, NH. Dallas Makerspace, TX has been a membership based, 501(c)(3) non-profit, shared community workshop and laboratory since 2010. The purpose is to work together to collect tools and resources for their membership, who could not otherwise afford, store, or use them individually.

Examples of Makerspaces in Michigan

Mt. Elliott Makerspace, Detroit, MI – The Mt. Elliott Makerspace was created in 2010 in Detroit seeking to be a community workshop where people make, tinker and learn

together. Located within the Church of the Messiah, the space houses a woodshop, bike repair, screen printing equipment, and electronics. The Mt. Elliott Makerspace focuses their programs on young adults. There are many local partners associated with the makerspace and they have received financial support from several foundations and national programs including The Kresge Foundation, Cognizant Technology Solutions, Capuchin Soup Kitchen, The Knight Foundation and CEOs for Cities. Their projects are designed based on the needs and passions of their community members in the Southeast Detroit community. The Mt. Elliott Makerspace works to further the learning experience and entrepreneurial opportunities related to: transportation, electronics, digital tools, wearables, design & fabrication, food, and music & arts. They also collaborate with the Detroit Public Library on their H.Y.P.E. Teen Center makerspace.

The founder of Mt. Elliott, Jeff Sturges had helped launch the Sustainable South Bronx GreenLab and the NYC Resistor hackerspace in New York and OmniCorp Detroit (Kuras, December 18, 2012). Sturges argues that "We're trying to change the mindset of waiting for something to happen, to making things happen. We're encouraging individual agency, so people can create the world they want to live in and increase people's ability to create happy lives for themselves" (quoted in Kuras, December 18, 2012). One of the program successes is a young adult, who has learned how to use the soldering iron and is now a resident soldering iron expert, teaching other teens how to use tool and participate in many other projects (Kuras, December 18, 2012).

All Hands Active, Ann Arbor, MI – All Hands Active is the Ann Arbor makerspace that allows for people of all ages to relax, share what they know, learn by doing and entertain via social gaming. All Hands Active was formed in 2009 during a series of meetings of a group of hobbyists and tech enthusiasts who met to share their projects and problems (Levin, December 26, 2011). Later in 2009, the group became a hackerspace when Digital Ops offered the group space in their building. The makerspace was formally incorporated in January 2010 and formed a fiscal sponsorship relationship with the School Factory in 2011. Since then, they started to acquire more equipment and space. More recently, they began to work on their own 501(c)(3) application to become a nonprofit entity. Currently, the makerspace occupies 1,700 square feet and the standard membership includes 24/7 access to the facility, a locker, server space, discounted classes and materials.

In general, members bring their own tools to share with others, and the makerspace takes full responsibility for maintaining them and promoting proper use. Equipment can be personally owned or is lent from a local business for use by the makers (Levin, December 26, 2011). All Hands Active's membership base is around 40% technology professionals, 40% local students and the remainder hobbyists and enthusiasts (Levin, December 26, 2011). The makerspace organizes many classes in Arduino, soldering, 3D printer, laser cutter and CNC router classes, Linux command-line, and so on. Other courses are required for the operation of some of the makerspace's most complex or expensive

machines. Their budget includes income from classes, workshops, and memberships in addition to donations. All Hands Active received a Bright Futures grant partly funded by Eastern Michigan University, which allowed All Hands Active members to teach maker classes with middle school students.

I3Detroit, MI – I3 Detroit is a collaborative environment for people to explore the balance between technology, art and culture. The makerspace, organized as a 501(c)(3) organization, started in 2009 in Royal Oak and is currently located in Ferndale. In order to raise funds for the new location, the makerspace group used word of mouth and a 'help save the robots' campaign on Kickstarter. Revenues include membership dues, sponsorships, fundraisers and donations. Expenses include rent, utilities, insurance and tools. Currently, there are around 70-80 dues-paying members. I3 Detroit organizes numerous community events and classes, which help to build the organization.

OmniCorp Detroit, MI – OmniCorp is 7,500 square feet of workshop space in the Eastern Market section of Detroit. OmniCorp includes a group of designers, artists, engineers, musicians, thinkers and makers that get together to build new things as well as share and collaborate. The group does not have a hierarchical structure, as new members need to be voted in by all members.

Maker Works, Ann Arbor, MI – Maker Works is an 11,000 square-foot makerspace located in Ann Arbor, MI. Opened in 2012, the makerspace features four areas: metal, circuits, wood and craft, classes and a retail store (Good, February 6, 2013). Maker Works offers three types of membership: individual, family and business which allow access to all four areas and their tools, access to computers, software and free WIFI. The makerspace provides adult, family and business memberships.

Lansing Makerspace Network, MI – In early 2012 a group of Lansing inventors and makers groups formed the Lansing Makerspace Network. In 2013, the makers network applied for 501(c)(3) status and moved into a space. Their mission is "to bring diverse people, experiences, and ideas together in a safe environment; to meld technology, art, and culture in new and exciting ways; to share skills, tools, and inspiration; and to marvel at what we make together" (Lansing Makers Network, n.d.). The board of the Lansing Makerspace Network meets the first and third Tuesday of every month. High Impedance Air Gap group is a member of the Lansing Makers Network and focuses on electronics and robotics projects.

Dewitt Creativity Group, MI – The DeWitt Creativity Group, founded in 2008 by two DeWitt High School teachers, promotes student creativity in connection with public

service, lifelong learning and entrepreneurialism as well as prepares students for the 21st Century economy. In early 2013, the group, in partnership with Stockbridge Underwater Robotics Team and Williamston High School InventsTeam created the Capital Area Schools of Innovation Network (CASIN). The purpose of this network is to share innovative practices and ideas on cutting edge project-based learning throughout the Lansing region. The network focuses on projects in STEM (science, technology, engineering and math), entrepreneurship and the arts. Since 2010, the DeWitt Creativity Group organizes the Michigan Creative Educators Summit which features innovative K-12 school-based project-learning.

The Information Technology Empowerment Center, Lansing, MI – The Information Technology Empowerment Center (ITEC) is a 501(c)(3) nonprofit organization that works with students and families in the Capital Region to build excitement for coursework and careers in science, technology, engineering and math. One of its programs is a Lego Robotics class where a group of students learn creativity, cooperation, problem solving and prepare for participating in the regional competition Spartan First Lego League Challenge at Michigan State University. Local company TechSmith supported this project through a donation that covered instructor costs, Lego Robot Kits and team t-shirts.

Comments – Makerspaces fulfill the need to make, innovate or create in the community by providing a physical space where users have access to a wide array of equipment and expertise. For larger or more established makerspaces, the wide range of skill sets in their membership is conducive for meaningful interactions and collaborations with community partners and other members. Many makerspace groups are growing across the U.S., some of the makerspaces have reported such a strong growing membership base and wide-spread interest in the community for such an innovative environment. In some cases, groups are expanding into bigger spaces due to the growing interest and a higher number of members. Although, many challenges abound for makerspaces including raising funds to support the space and equipment needs of the growing membership base. Within this creative and learning environment, free exchange of ideas, skills, and knowledge are encouraged and open house events continue to attract new members and entrepreneurs.

MAKERSPACE PROGRAMS WITHIN PUBLIC LIBRARIES

Overview

Public libraries have a long history of hosting workshops about making and building patrons' literacies in different fields (i.e. computer literacy skills). Since late 2011 and into the present, there has been a growing interest among public libraries for organizing specially branded hands-on 'making' events. Public libraries across the nation are interested in providing how-to workshops and other active learning opportunities to their patrons. Lauren Britton of the Fayetteville Free Library, NY argued that "Maker spaces in libraries are the latest step in the evolving debate over what public libraries' core mission is or should be" (Britton, October 1, 2012). Fayetteville Free Library, NY and a growing number of public libraries in the U.S. are exploring ways to incorporate co-creation which allows library patrons to produce their own works of art or information and learn by doing. The growing DIY (do-it-yourself) movements, the resources offered by the MAKE Magazine and the many open source websites are fueling this trend among public libraries. The following libraries have developed maker programs: Westport Public Library (CT), Fayetteville Free Library (NY), Anythink Library (CO), Allen County Public Library (IN) and Detroit Public Library (MI). The Chicago Public Library (IL) has recently received a grant to start an all-ages makerspace at the library's main branch (IMLS, December 20, 2012). More recently, the American Library Association started holding webinars and conferences that focus on makerspaces and how it fits within the library's existing service model.

These public libraries understand the potential for tremendous benefits to their community members from organizing makerspaces within their system. With regard to the makerspace developed by the Fayetteville Free Library, NY, the creator Lauren (Smedley) Britton notes that "Public libraries exist to provide free and open access to information, technology and ideas" (quoted in Forbes, November 15, 2011). Public libraries already offer formal or informal technology training, in particular for developing computer skills, general software applications and Internet use (Newcombe and Belbin, September 25, 2012). Depending on the specific needs of the community, a library-offered makerspace could facilitate informal learning opportunities, nurture peer-to-peer training and develop a culture of innovation (Britton, October 1, 2012). The goal of these maker programs is to provide community members free access to technologies and support their learning needs in an informal, play-focused environment.

The makerspace initiatives developed by the public libraries are in general addressed and accessible to the entire community. This is in contrast to many of the makerspaces already launched in the U.S. which limit the access to their facilities and use of equipment to their adult paying members exclusively. In general, the public libraries that developed a makerspace allow free access to cutting-edge technologies (such as 3D printers) to their community members. Free access to many learning tools is also part of

the library model. Public libraries seek to leverage their community or library resources to provide free-of-charge learning environments for children and teens in addition to adults. While some makerspaces offer family membership, insurance policies limit the use of space by children or teens. In contrast, children and teens are particularly targeted by library or museum-based makerspaces.

A core component of makerspace groups is the idea of sharing knowledge. The makerspace programs developed by the public libraries rely on community members acting as mentors and sharing their knowledge in particular fields to other community members. For instance, individuals who have skills in electronics or programming are tapped into teaching hands-on workshops. Public libraries seek to encourage innovation, collaboration and learning, enabling more children and teens to cultivate an interest in STEM fields (science, math, engineering, and technology) through play (Britton, October 1, 2012). With makerspaces, public libraries develop creative ways to encourage young people to actively learn, create and innovate. As Gershenfeld notes, "Instead of trying to interest kids in science as received knowledge, it's possible to equip them to do science, giving them both the knowledge and the tools to discover it" (quoted in Britton, October 1, 2012). Some are concerned about limited revenues and whether libraries could be better off buying books. To critics of makerspace programs within public libraries, Teeri notes, research and reading skills nurtured by learning to make things, spark knowledge and creativity (Kuras, December 18, 2013).

Examples of Makerspace Programs in Public Libraries in the U.S.

Fayetteville Free Library, NY – The Fayetteville Free Library is considered to be the first public library to create a makerspace program in the United States (McCue, November 15, 2011). It was initiated by Lauren Smedley, student support staff member working on a LIS degree at Syracuse University, who wrote a graduate school project paper proposing the creation of a makerspace within a public library. The library's director liked the idea and hired Smedley to develop the program. The Fayetteville Free Library named the makerspace the 'Fab Lab' (Fabulous Laboratory). The lab initially featured a MakerBot Thing-O-Matic 3D printer, donated by a local private technology company. Since then, the library has developed a 'Creation Lab,' which is a makerspace that focuses on digital creation. In this space, the library allows its patrons free access during library hours to the following technologies: Mac & PC computers, Makerbot Thing-O-Matic 3D printers, Bits from Bytes 3D Touch 3D printer, Green screen wall, Video camera, Podcasting equipment, Adobe Creative Suite 6 - Production Premium, iLife Creative Suite, and more. To use the lab, interested persons simply need to ask a librarian to unlock the lab.

The library is in the process of renovating the East Wing of their building (8,000 square feet) where they plan to create the permanent location for the makerspace. The library also plans to create a business center and allow local entrepreneurs to use the tools and equipment of the Fab Lab (Britton and Considine, October 1, 2012; Kalish, November

21, 2010; Reeder, November 21, 2011). Different funding sources were tapped for the makerspace project. The Fayetteville Free Library received a NY State Library Construction Grant for $260,000 to renovate the East Wing and an Innovation Award of $10,000 from the Contact Summit. In addition, the library raised $20,000 through the crowd-funding website, Indiego, for the Fab Lab equipment (i.e. the 3D Printer plastic) and experts to run workshops and presentations. In general, the library's maker programs employ library staff, along with volunteers (Newcombe and Belbin, September 25, 2012).

Currently, the library offers several makers workshops for either children/teens or adults. For adults, the library offers craft and sewing classes. For children and teens there are three programs:

1. *Creation Club*, offered for students in 6^{th}-9^{th} grade. Students create and edit videos, podcasts, images, 3D models and more
2. *Mission Lego*, offered for students in 5^{th}-8^{th} grade. Students learn to build and program LEGO robots.
3. *STEAMpunk Club*, offered for students in 6^{th}-9^{th} grade. Student discuss popular steampunk novels and do experiments and projects that go with the books.

Initially, the library intended to launch the Fab Lab in an unused space that needed significant renovation. However, once it was determined that this would take a number of years, the library decided to make the lab mobile, organizing open house and makerspace events in the library's community room (Britton and Considine, October 1, 2012). In addition, the library converted a small tutoring room into a creation lab. For users interested in using the 3D printers independently, the library requires free one-on-one 3D printer training. After successful training, the library marks the library card to indicate that a person is '3D Printer Certified.' The library charges a fee for printing, to offset the cost of the printer plastic. Since the creation of the program, the library staff experienced substantial community interest in the maker programs which brought more library members. The makerspace events facilitated networking and knowledge sharing as well as allowed community members to create their own library-supported content (Britton and Considine, October 1, 2012).

Allen County Public Library, Fort Wayne, IN – In 2011, Allen County Public Library partnered with local nonprofit TekVenture, a makerspace group, to permit them to park their 50-foot mobile classroom makerspace in the library parking lot, in the heart of Downtown Fort Wayne. Explaining the library's agreement with the local makerspace program, the library's director noted that "The library is in the learning business, not just the book business." (Quoted in Newcombe and Belbin, September 25, 2012).
When TekVenture struggled with finding an affordable building in downtown Fort Wayne, the public library approached them in 2011 to operate in its parking lot. As part of the agreement, TekVenture conducts demonstrations and workshops for library patrons. Most workshops took place inside the TekVenture Maker Station, a handicapped-

accessible heated trailer. For instance, TekVenture offered FAB FALL, a series of workshops, demonstrations, talks and "MeetUps" designed to match local experts with people interested in making things. Many of these workshops were offered free of charge to the public as the public library sponsored the workshops. Workshops were open to adults and children 12 years and older. Because training took place inside the TekVenture Maker Station, workshops were limited to six persons with one or more instructors. Some workshops charged a fee between $15 and $35 a person. Some recent workshops covered the following topics: Electricity Made Easy, Invention: Mind to Market, SketchUp Basics, Circuit Bending: History and Geography, Arduino Basics, 3D Printing for Beginners and Frame-working Glass. This partnership has no upfront costs and less involvement for the Allen County's Public library. Members and volunteers from TekVenture conduct training programs and maintain the makerspace equipment.

TekVenture is an art and technology laboratory where the public engages with tools, materials and mentors to make things. TekVenture is organized as a 501(c)(3) not-for-profit organization. They started offering membership opportunities in 2012, asking monthly membership dues of $30. To fully use the equipment, members are required to follow a basic introduction to safe use of the machines and receive safety glasses and ear plugs. In general, the maker group allows the general public to visit and observe Maker Station activities during public hours. Community members cannot use the tools without becoming a member of the Maker Station and children ages 6-12 must be accompanied by an adult or mentor. The makerspace is currently raising awareness and funds to find a permanent space. The library's director is exploring the option of housing the makerspace in one of the library buildings which would allow for the expansion of the makerspace programs to more users (Newcombe and Belbin, September 25, 2012).

Westport Public Library, CT – Westport Public Library launched the makerspace initiative in July 2012. The library designed the makerspace as a place for people to connect and create, that provides experiences that take people from imagination to actual production, and that fosters entrepreneurship in the community. The makerspace is the result of several community members proposing the idea of a Maker Faire at the library. This proposal resulted in a library partnership with CLASP Homes to produce Connecticut's first Mini Maker Faire in the spring of 2012. The clear interest in the Maker movement resulted in the establishment of a makerspace at the library.

The program is located in the library's Great Hall and is 320 square feet. Makerspace programs at Westport Public Library include the current construction of two 15-foot wooden airplanes modeled after the Bee Gee Speedster of the 1930s. Library patrons may participate or watch the building of these two planes. In general, up to 12 people are allowed in the makerspace at one time. All participants are asked to sign a waiver form before working in the makerspace. The library relies on volunteers that allow patrons to participate in the creation of the two airplanes. The library is allowing the makerspace to evolve naturally based on what the community members want to see or do (Britton,

October 1, 2012). The Westport Public Library accepts applications for people interested in being a maker at the library. This is where the public can watch makers at work and be invited to participate if appropriate. The first maker at the library was a builder who displayed a plane he made with pre-school children at a Mini Maker Faire; he is now making two more planes interactively with library patrons.

In addition, the library purchased a 3D printer and has 3D printer coaches, the majority being teen volunteers. Interested people need to receive training in order to use the 3D printer. Westport residents do not have to pay to use 3D printing services. Non-residents pay $10 an hour for the training and $20 an hour to use the 3D printer. Since the opening, a substantial number of community members attended demonstrations of the 3D printer and were taught how to design and print their own designs. Donors who provided funding for the library's makerspace include Green Village Initiative, Friends of the Westport Library, Nancy Jones Beard Foundation, Destefano and Chamberlain, Ring's End, Renee B. Fisher Foundation and Sunrise Rotary.

Piscataway Public Library, Westergard Branch, NJ – Piscataway Public Library launched in early 2013 has the 'Make It Yourself' program, a makerspace designed for residents of all ages, with a particular focus on young adults. The program provides access to tools, techniques and hands-on learning experiences with the goal of inspiring teens' interest in science, technology, engineering and math. The makerspace program comprises a wide variety of equipment including: arduino micro processing kits, Legos, 3D scanners and printers, sewing machines, a button maker, musical instruments, robotics kits and a vinyl cutter. The January 2013 official opening featured live demonstrations of 3D scanning & printing, sewing & textile design, electronics programming with arduino single-board microcontrollers, robotics, and digital music production, t-shirt designing with vinyl cutter & heating press, button-making and free play with Legos. For the month of April, Piscataway Public Library is offering a Robotics class for patrons, ages 12 and up.

Ideabox, Oak Park Library, IL – The Oak Park Public Library launched Idea Box in 2012 in a first floor space located at the Oak Park Main Library. Each month, the Idea Box provides a new and dynamic participatory community experience where library visitors are encouraged to learn through tinkering, fun experimentation and play. Among the monthly programs, there are projects where patrons rearranged small LED lights to create constellations on the walls, or posed for a green-screen photo in their favorite exotic location to have superimposed in the background, with an oversized library card.

Anythink Brighton Library, CO – Anythink Brighton Library was awarded in 2012 a Library Services and Technology Act grant for $18,849 funded by the Institute of Museum and Library Services to design a makerspace for teenagers in the library. The library launched the makerspace program in December 2012 which serves as an idea lab

and creation space for teens to explore their creativity in interactive, hands-on ways. The makerspace is incorporated into the library's multipurpose room as a separate space. In that space, teens have free access to tools and materials for crafts, robotics, textile design, digital photography and 3D printing. Library staff mentors teens in the makerspace. In the future the library will build partnerships with community organizations to give teens more innovative opportunities at their library.

Missoula Public Library, MT – In June 2013, the Missoula Public Library opened a makerspace in its downtown location. Their initial areas of study are electronics on the Arduino and Raspberry Pi platforms, 3D scanning and printing, sewing and scrapbooking. Classes are offered for free. Some classes require participants obtain a kit which can be taken home after the workshop. The library currently has the following equipment: a Makerbot Replicator 2 3D printer, a Next Engine Desktop 3D scanner, a sewing machine, two craft cutters, two oscilloscope, two power suppliers, two soldering irons, generators, a variety of hand tools, and 6 computers in an adjacent room. Current classes are taught by volunteers and include the following: Introduction to Raspberry Pi, Introduction to Sketchup, Arduino Q&A, Off Grid Solar Power Systems, 3D Printing 101, and Basic Sewing Machine Use with class sizes ranging from 6 to 15 participants. While the makerspace is initially used for many classes, the library hopes to have over time the space available for users to drop in. For the safety of the users and the equipment, students will first be taught to use the equipment appropriately. Missoula Public Library is searching for local makers to volunteer as instructors and mentors for a variety of classes for the library patrons. Over time, the library intends to offer a variety of makerspace programs in their Large Meeting Room.

Mountain View Public Library, CA – Due to limited resources, staff and space, Mountain View Public Library decided on a program-based approach and a ‘pop-up space’, such as a 3D Printing open house or a Soldering workshop. For instance, in the spring of 2013, it held an e-Textile workshop where participants of age 16 and older created interactive costumes and electronic toys. The public library provided the materials. All event programming uses volunteers, including local makers, which drive the direction of the makerspace events. The library advertised for volunteers and applied for grants and donations of materials from private companies in the community. The library surveyed its workshop participants for their ideas for future maker-related events.

Makerspaces in Public Libraries in Process of Creation

Many more public libraries across the U.S. are exploring the development of maker-related programming within the library environment. For example, the East Baton Rouge Parish Library is planning to include a 1,200 square foot 'Maker Room' within the redevelopment of the River Center Branch. Other public libraries in the process of designing and developing maker initiatives include Madison Public Library, WI and

Chicago Public Library, IL.

Madison Public Library, WI – In conjunction with the redevelopment of its main branch, to be completed in 2013, the Madison Public Library is launching a new maker-focused program for all ages named 'The Bubbler.' The maker program will offer instruction in animation, screen printing, music, clothing design, dance, painting and more in the form of hands-on, pop-up workshops, presentations, day classes, lectures, or demonstrations. The design of the central library will include a dedicated room for the maker program; however, events will "pop up" in other public meeting spaces in the central library and the branch libraries (Schneider, December 26, 2012).

The library is planning to spend $100,000 in technological equipment as part of the $29.5 million central library reconstruction project. For the maker program, the library will focus on programming and creating partnerships with existing local makerspaces, artists, quilt-makers, welders and experts in the community. Workshops will be taught by local experts who will share their knowledge and physical resources. Madison Public Library already has some programming that fits the Bubbler model, including an animation program at the Goodman South Madison Branch Library developed with a $25,000 grant from the Irwin A. and Robert D. Goodman Foundation (Schneider, December 26, 2012). Here, the library is offering a series of after-school animation workshops for neighborhood teenagers to attend led by a professional animator.

Chicago Public Library, IL – The Chicago Public Library has recently received a $249,999 grant from the Institute for Museums and Library Services (IMLS, December 20, 2012) to develop a makerspace at the library's main branch in Chicago. The Chicago Public Library Foundation and the Chicago Public Library will partner with the Chicago Museum of Science and Industry and the STEM & Entrepreneurship Exchange to plan, design and pilot a digital design and fabrication lab that will be available to the general public within the library's main branch. The Chicago makerspace will introduce adults, families, teens and children to technology and equipment that enables new forms of personal manufacturing and business opportunities.

The Makerspace Program of the HYPE Teen Center at the Detroit Public Library

The HYPE (which stands for Helping Young People Excel) Teen Center provides teen-focused programs and services (for people age 13 through 18) (Detroit Public Library (DPL), n.d.). The program, located at the Library's main branch, is staffed by 4.5 staff members. In 2012, DPL created the HYPE Makerspace program within the HYPE Teen Center through a $30,000 grant from Cognizant - Making the Future initiative (grant received in April of 2012). The library was already exploring partnerships with local makerspace groups in Detroit. Steve Teeri, customer support assistant at HYPE, partnered with Jeff Sturges, founder of the Mt. Elliott Makerspace, to develop a library makerspace

for the Detroit Public Library. The grant from Cognizant allowed them to create HYPE Makerspace and provided funds for programming, equipment (six soldering irons, a digital vinyl cutter, bike repair toolkits, a wireless color printer, and eight Arduino kits) and workshop instructors. The grant allowed DPL to hire local experts for teaching the workshops. The workshop also incorporated the mentors or instructors who were found through community partners such as: Mt Elliott, i3 Detroit and Omnicorp Detroit (Figures 3-6).

The current library's budget for the makerspace is at $11,000 which covers expenses with hiring instructors, assistants and workshop materials. The library currently hires instructors at $25/hour and student assistants at $8/hour for two-hour weekly sessions. Regular staff and other expenses are paid from the library's operating budget. The program does not charge teen participants; however, students need to have a valid library card. On a typical afternoon, 50-60 teens are in the HYPE Teen Center. The program uses 6 iMAC computers, appropriate for the computer design capabilities. A study room has been repurposed into a supplies room (Figure 6). Currently, HYPE Makerspace provides 5 workshops in the following fields:

1. *Electronics* – Teens learn the basics of how electronics work. Workshops include how to solder and circuit bending.
2. *DIY Crafting* – Teens work on papercraft, knitting, cross-stitch, and more.
3. *Graphic Design* – Teens learn to make vinyl stickers, spray paint stencils, and silk-screen prints.
4. *Sewing/Wearables* – Teens learn how to make and design clothing and accessories.
5. *Arduino Robotics* – Teens learn the basics of electronic circuits, then build and program their own robot.

With regard to safety concerns, when students work with more dangerous tools such as the soldering irons, the library has had no incidents in the program to date. Nevertheless, the makerspace staff, workshop instructors and assistants stress safety and watch workshop participants. For the future, the HYPE Teen Center staff is exploring extending the purpose of the program to all age groups, recognizing that would require more space and more resources. In the meantime, another Detroit Public Library branch is starting its own makerspace program with a $6,000 grant. The first workshops will focus on sewing and electronics.

THOUGHTS WITH REGARD TO ESTABLISHING A MAKERSPACE PROGRAM AT THE CITY'S PUBLIC LIBRARY

The last few years have seen the proliferation of Do-It-Yourself and maker groups with more individuals and groups becoming interested. The benefits of makerspaces are tremendous in supporting an entrepreneurial ecosystem through, fostering innovation, creativity and 'making' skills. Makerspaces allow experimentation, learning, creation and invention through play. In addition, the makerspace programs developed by public libraries have the potential to help communities and their children and youth, to learn science, math, technology, and engineering through hands-on activity. These programs foster exploration and encourage children and teens to seek careers in those fields, be entrepreneurial and creative as well as develop skills that would allow them to adapt to changes in the economy (Britton, October 1, 2012). Hildreth, Director of the Institute of Museum and Library Services, noted that "Because of the expertise and content we have to offer, museums and libraries are uniquely positioned to offer young people meaningful learning experiences that link to science, art, and technology" (Hildreth, December 20, 2012). With regard to libraries, she adds that "We need to leverage what we know about learning and our trusted role as learning places to help prepare our visitors for success in today's digital world" (Hildreth, December 20, 2012).

This co-learning plan suggests that communities across Michigan should explore the development of a makerspace program within the local public library for several reasons, outlined below. A makerspace program would complement the services offered by other innovation type centers, foster innovation and creativity as well as further the local innovation ecosystem. While the majority of makerspaces in the U.S. focus on the adult makers, libraries seek to cover the age gap and develop maker programs that allow people of all ages, children and teens in particular, to participate in maker workshops. While an independently-run makerspace operates on monthly membership dues, the library makerspaces would provide patrons with free workshops and access to tools. This would strengthen the role of the library as an invaluable asset to the community. Public libraries already have a central role in fostering an entrepreneurial environment in our communities. For example, they assist entrepreneurs by facilitating access to technology and information, including business information and referrals.

As an example, in East Lansing, the city's Public Library has emerged as a leading partner for the makerspace initiative. The director and the staff seek to develop maker events at the East Lansing Public Library. For instance, the staff will run a Code Camp for children age 5 through 9 this summer. A regional makers group (Lansing Makers Network) was established in 2012 and is in the process to acquire tax-exempt status. A makerspace program at the city's public library would complement the services offered by the East Lansing Technology Innovation Center, the maker groups and other innovation initiatives. The next paragraphs explore several aspects with regard to the design and implementation of a makerspace program at the city's public library. The

Appendix includes many useful resources with regard to makerspaces, projects and materials, information about creating a makerspace, and website links.

Design and Implementation Considerations

Equipment and Tools – As seen in the overview of makerspace programs, there is no fixed list of equipment or programming required to launch a makerspace or to make a program successful. While many groups have certain tools and technology, such as 3D printers, these machines are not required. Equipment and materials are selected based on the specific projects that the library wishes to provide. For example, a library could have a sewing class that would require sewing machines or it could have a robotics class which would require Arduino kits, and so on. In time, the list of equipment would grow as new projects are developed (Britton, October 1, 2012). Notable is that the required equipment would be different than what a public library normally acquires. It could include a 3D printer, laser cutters, sewing machines, Arduino robots, soldering tools, and so on. In addition, it could require computers with design related software. An option for public libraries seeking to keep program costs down is to partner with local maker groups, private businesses and other local creative organizations. Several libraries have not invested in substantial equipment; instead, they sought to develop partnerships with local makerspace groups and businesses which could share expertise and tools to workshop participants.

Reflecting on the experience of Fayetteville Free Library in developing their makerspace program, Britton and Considine stated that "3D printers are a great addition to any library and help promote and attract interest to the program" (Britton and Considine, October 1, 2012). However, their experience and the experience of HYPE Makerspace indicate that 3D printers are by no means required. Many maker programs that are low cost and utilize cheaper tools are equally popular. Such programs are easier and inexpensive to be implemented (Britton and Considine, October 1, 2012). In addition, as Teeri from HYPE Detroit noted, 3D printers and laser cutters are expensive and limit use of only one to two persons at any time (personal interview with Teeri, April 2, 2013). The Detroit Public Library acquired initially lower-cost tools and equipment that allow for more teens to interact and play at a time at the HYPE Teen Center Makerspace. DPL bought 8 soldering irons and kits for making LED badges as well as yarns and knitting tools which allowed them to conduct workshops with bigger groups.

Safety – Safety is a major consideration for public libraries developing makerspace programs. In general, the makerspace equipment requires staff training and safety classes for users. Public libraries that have a 3D printer require users to pass training with a staff or volunteer. An important component of the makerspace training could be to teach participants how to safely use the tools. Safety and responsible use of the tools are critical goals of the learning experience. Mentors and library staff are extremely critical in maintaining a safe workshop environment. Staff encourages users to watch out for the

safety of each other and responsibly use the equipment. Moreover, library staff could post safety guidelines next to or on each tool or equipment piece. Each tool requires a certain amount of space to operate safely and not endanger the users. This aspect needs to be included in the planning of the space and the equipment list. In addition, due to the nature of specific maker activities, the makerspace facility needs to be well lit and clean as well as have a ventilation and air filtering system, necessary for the use of certain equipment. For certain workshops, personal safety equipment, such as goggles, gloves, and earplugs, need to be provided to participants. Due to the nature of activities taking place in a makerspace, getting liability insurance is a major concern for makerspace groups (Makers Media, Spring 2013). Public libraries need to make sure that the general insurance would cover such activities. Makerspaces should consider asking all participants to sign a waiver form to limit the liability of the organization in the case of an incident.

Costs – Depending on the specific nature of the makerspace initiatives selected by public libraries, startup costs, annual operation costs and revenues need to be considered. The startup costs are based on the specific projects to be developed in a maker setting, and could include personnel and mentor costs, space built-out, tools and materials, and others. Sturges, from Mt. Elliott Makerspace, drafted the budget of the Detroit Public Library's HYPE Makerspace, shared online on the Mt. Elliott Makerspace's website. A budget template for makerspace startup and annual operations is included as well. Up to $30,000 was budgeted for startup activities for the HYPE Teen Center Makerspace. The startup budget included: people and services costs ($7,735), tools and supplies ($20,129) and taxes, contingency and shipping ($2,013). Currently, annual operation costs are at about $11,000 and include instruction costs as well as tools and materials costs. While the services of the HYPE Makerspace are free to Detroit Public Library teen members, in other cases, libraries have chosen to charge for services or materials. For example, the Fayetteville Free Library charges a fee for the 3D printing to cover the cost of the plastic used in the printing process.

Workshops and Mentors – Public libraries developed maker workshops based on what the community wants and is interested in learning, in addition, to looking at what other libraries have already done. DPL's HYPE Teen Center had reached out to the local makers groups to brainstorm about developing a makerspace along with workshop topics. At the HYPE Makerspace each of the programs are taught by a local expert paid through the makerspace's $11,000 budget. While the staff or volunteers might have the training or knowledge to teach specific classes, paid mentors or experts are more appropriate for teaching maker classes. HYPE makerspace program found the experts/mentors through the local connections with the maker community in Detroit. A library makerspace program based solely on community volunteers might not be sustainable (Britton, October 1, 2012). However, the costs of finding and paying for mentors might be challenging for smaller public libraries in Michigan affected by declining revenues and rising costs. Mentors are critical in the maker program's success. Volunteers could

provide a lot of assistance at some of the small public libraries. Some public libraries could train and use the existing staff in developing maker workshops (McCue, November 15, 2011).

Outreach and Partnerships – Outreach activities are important to attract users, funding and donations, in addition to developing community partnerships with private and institutional partners, such as public schools, museums or universities. Public libraries would benefit significantly from reaching out and collaborating with the local community of makers and inventors, Innovation Centers, the public schools, the private sector and the educational institutions (i.e. universities, colleges, museums) for equipment and expertise. In some cases, private companies donated tools, equipment and even a 3D printer to the public library (i.e. Fayetteville Free Library) for its makerspace use. In another case, the Allen County Public Library entered into a partnership with the local makerspace group to use their expertise and equipment in running workshops for library patrons. Based on his experience at the HYPE makerspace, Teeri suggested reaching out to local makerspaces to find a good fit for partnership and workshop mentors. The Madison and Detroit Public Libraries had both partnered with the local makerspaces to bring this concept to the library on a regular basis.

A critical component of the design and implementation of a makerspace program at a public library is the creation of a partnership network. In today's economy, communities and local governments need to be efficient in allocating limited resources and avoid duplicating efforts already taking place in the region. Regional partners, which have different and various specializations, would share expertise, tools and materials with the public library. Therefore, various collaborations with regional partners would enable the library to provide high-quality maker workshops and experiences to its patrons, and benefit from the diverse expertise and skill sets available in the community. Moreover, it would allow the library to be flexible and quickly provide the workshops and programming the community needs and wishes to have without substantial upfront investment.

Implementation Challenges

Noise and Physical Damage – Noise seems to be a challenge for public libraries looking to develop maker activities in their facilities. Makerspaces by their purpose are noisier and messier activities, which are vastly different than a quiet public library setting. Sturges suggested that this challenge could be addressed with design measures, for instance with an enclosed and insulated glass space that allows the activities to be visible without disrupting library patrons (Bagley, February 15, 2013). Makerspace activities could be located in a separate room and patrons could be notified in advance about the makerspace activities. At Detroit's HYPE Makerspace, the staff had substantial concerns about users making marks on desks or dropping things on the floor and attempted to address them with creative solutions such as insulated flooring.

Stakeholders Support – Getting buy-in from the library staff and the board of directors is an important aspect to be considered. Britton and Considine suggested open communication with all stakeholders, including staff and the Board of Directors, in order to build trust and support for the makerspace program. Initiators should provide a forum for discussion and invite everyone involved to share their concerns and ideas (Britton and Considine, October 1, 2012). At the Fayetteville Free Library, the staff reached out to gain the support of all their stakeholders and receive the assistance of local experts and partners to foster understanding among the staff, board of directors and patrons (Britton and Considine, October 1, 2012). Regarding this case as well as HYPE Makerspace, early successes and recognitions gathered more support from upper management.

Staff Training – At the Fayetteville Free Library, staff members were concerned about having to learn new skills in addition to their own responsibilities. The staff working directly at the makerspace needed to be trained to operate a 3D printer and the other tools and equipment available (Britton and Considine, October 1, 2012). All the staff members at the Fayetteville Free Library were given the opportunity to learn how to use the equipment and the majority of the staff elected to receive full training, provided by the library. All staff members were allowed to be part of the new program which secured more buy-in into the development of a makerspace in the library (Britton and Considine, October 1, 2012).

CONCLUSIONS AND RECOMMENDATIONS

The goal of the proposed co-learning plan is to recommend the best practices that allow for the creation of programs and networks. These programs are intended to foster an entrepreneurial ecosystem, resulting in more opportunities for talented people to innovate and create competitive products and businesses that contribute to the local economy. Generating effective strategies to support entrepreneurs through local entrepreneurial support ecosystems is critical in cultivating an entrepreneurial culture in Michigan, especially in the places struggling with unemployment, poverty and lack of private investment.

Communities across Michigan are home to numerous thinkers, inventors and creative people with a wide range of skills and talent. These communities should develop a local entrepreneurial ecosystem to support their innovators and encourage them to develop new skills, innovate and pursue their entrepreneurial ideas. Public libraries have emerged as leading partners in the makerspace movement. Therefore, a makerspace program developed by a local public library would be an appropriate direction in furthering the innovation ecosystem in a community. A public library can develop making programs that would be accessible to children, young adults, and families. These programs would result in more opportunities for innovation and creativity in the community. Programs that focus on learning and innovation among children and young adults have substantial benefits to the local community and the state. Individuals are able to gain skills and interests through play that result in fostering a more innovative and creative life. Makerspace programs have the potential to nurture timeless skills such as curiosity, problem-solving, collaboration, creativity and the ability to learn on one's own that will help prepare our children for their future careers. Many young adults will develop practical skills that can be applied to their own creative and entrepreneurial ideas.

A critical component of the design and implementation of a makerspace program at a public library is the creation of a partnership network. In today's economy, communities and local governments need to be efficient in allocating limited resources and avoid duplicating efforts already taking place in the region. Therefore, various collaborations with regional partners would enable the library to provide high-quality maker workshops and experiences to its patrons, and benefit from the diverse expertise and skill sets available in the community. Each community has a unique maker culture and a unique set of individuals, companies and organizations involved in creativity, innovation or making activities. These include: fashion designers, quilt makers, hobbyists, manufacturing suppliers, tech companies, museums, arts councils, and so on. The suggested partnership network could include the public library, the local makers groups, local education institutions (universities, community colleges), the Public Schools, economic development groups, Innovation Centers, museums, arts councils, local organizations involved in innovation and creativity and the private sector. These partners have specific strengths, such as expertise and access to tools and equipment, which could be shared with the public library in various maker-related programming. For instance, various

university programs work already in innovation or STEM-related fields. In addition, private businesses could help in the implementation of makerspace events through donations of funds and expertise as well as tools and equipment. These entities could all collaborate to develop and strengthen this partnership, which will foster an innovation hub and entrepreneurial ecosystem in the community.

FIGURES

Figure 1. Mini Robots, 2013 San Mateo Maker Faire.

Source: Jill Abood, 2013.

Figure 2. Redesigned Bicycle, 2013 San Mateo Maker Faire.

Source: Jill Abood, 2013.

Figure 3. HYPE Makerspace, Detroit Public Library

Source: Cristina Benton, 2013.

Figure 4. HYPE Makerspace, Detroit Public Library

Source: Cristina Benton, 2013.

Figure 5. HYPE Makerspace, Detroit Public Library

Source: Cristina Benton, 2013.

Figure 6. HYPE Makerspace, Detroit Public Library

Source: Cristina Benton, 2013.

TABLE 1
Membership fees* for the Makerspaces Discussed in the Plan

Makerspaces	Standard Membership (per month)	Standard Membership (year)	Student /Coder Member-ship	Part-time / Hobbyist Membership	Day Pass	Family Monthly Membership
All Hands Active, Ann Arbor, MI	$50				$20	
Dallas Makerspace, TX	$50					
I3Detroit, MI	$89					
LA Makerspace, Los Angeles, CA	$50	$550	$25		$20	
Lansing Makerspace Network, MI	$80		$50			
MakeIt Labs, Nashua, NH	$75			$40	$20	$80
Maker Works, Ann Arbor, MI	$90	$900			$35	$90 (1 person) + $45 for each additional person
Milwaukee Makerspace, WI	$80		$40	$40		
OmniCorp Detroit, MI	$95 (+$100 initiation fee)					
Sector67, Madison, WI	$100		$50			
TechShop Austin-Round Rock, TX; Menlo Park, CA; Pittsburgh, PA; San Francisco, CA; San Jose, CA	$175/$125 (recurring)	$1,395	$95			
TechShop Detroit-Allen Park, MI	$125/$99 (recurring)	1,200	$75			

* Data compiled by the author.

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APPENDIX

Makerspaces and similar programs (name and website link)

- All Hands Active, Ann Arbor, MI, http://www.allhandsactive.com/
- Allen County Public Library, Fort Wayne, IN, http://www.acpl.lib.in.us/
- Anythink Brighton Library, CO, http://www.anythinklibraries.org/location/anythink-brighton
- Champaign-Urbana Community Fab Lab, IL, http://cucfablab.org/
- Chicago Public Library Maker Space, IL, http://www.youmediachicago.org/
- Dallas Makerspace, TX, http://dallasmakerspace.org/blog/
- Dewitt Creativity Group, Dewitt Township, MI, http://dewittcreativitygroup.org/
- Fayetteville Free Library's FabLab, NY, http://fflib.org/fablab
- H.Y.P.E. Teen Center, Detroit Public Library, MI, http://www.detroit.lib.mi.us/hype/hype-makerspace
- Hackerbot Labs, Seattle WA, http://www.hackerbotlabs.com/
- High Impedance Air Gap, Lansing, MI, https://sites.google.com/a/highimpedanceairgap.com/www/
- I3Detroit, MI, http://www.i3detroit.com/about
- Ideabox, Oak Park Library, IL, http://oppl.org/events/idea-box
- LA Makerspace, Los Angeles, CA, http://lamakerspace.com/
- Lansing Makerspace Network, MI, http://www.lansingmakersnetwork.org/
- Madison Public Library, WI. http://www.madisonpubliclibrary.org/new/what-bubbler
- MakeIt Labs, Nashua, NH, http://makeitlabs.com/about/f-a-q/
- Maker Works, Ann Arbor, MI, http://maker-works.com/wordpress/
- MakerKids, Toronto, Canada, http://www.makerkids.ca/
- Michigan State University Creativity Exploratory, MI, http://ce.cal.msu.edu/
- Milwaukee Makerspace, WI, http://milwaukeemakerspace.org
- MIT Center for Bits and Atoms, Boston, MA, http://fab.cba.mit.edu/
- Mott Community College Fab Lab, MI, http://webserv.mcc.edu/FABlab/
- Mt Elliott Makerspace, Detroit, MI, http://www.mtelliottmakerspace.com/
- Noisebridge, San Francisco, CA https://noisebridge.net/
- NYC Resistor, Brooklyn, NY, http://www.nycresistor.com/
- OmniCorp Detroit, MI, http://omnicorpdetroit.com/blog/
- Piscataway Public Library, NJ, http://www.piscatawaylibrary.org/miy
- Sector67, Madison, WI, http://www.sector67.org/
- Stanford Learning FabLab, CA, http://tltl.stanford.edu/projects/fablabschool
- TechShop, http://www.techshop.ws/index.html
- TekVenture, Fort Wayne, IN, http://tekventure.org/
- The 911 Media Arts Center, Seattle, WA, http://www.911media.org/
- The Information Technology Empowerment Center, Lansing, MI, http://www.iteclansing.org/

- The Mill, Minneapolis, MN, (http://www.mnmill.org/
- The Portland Machinist Guild, Portland, MI, http://www.portlandmachinistguild.org/,
- The School Factory, http://schoolfactory.org/
- U.S. FABLAB Network, http://usfln.org/
- Chicago Museum of Science and Industry Wanger Family Fab Lab, IL, http://www.msichicago.org/whats-here/fab-lab/
- Columbus Idea Foundry, OH, http://columbusideafoundry.com/aboutcif/
- Missoula Public Library MakerSpace, MT, http://www.missoulapubliclibrary.org/makerspace

Examples of Projects at Makerspaces (name and website link)

- PCB table: http://wiki.makeitlabs.com/projects/pcb-table
- A Firehydrant tap: http://wiki.makeitlabs.com/projects/fire-hydrant-tap
- Milling Tools: http://wiki.makeitlabs.com/projects/milling-tools
- Electric Motorcycle: http://wiki.makeitlabs.com/projects/electric-motorcycle-project
- LED headlights: http://wiki.makeitlabs.com/projects/led-headlights
- Glass Objects: http://wiki.makeitlabs.com/projects/glass
- An automatic French press-style coffee maker: http://www.sector67.org/
- 3D printable prosthetic hand: http://www.sector67.org/
- Cast iron artwork: http://www.sector67.org/
- Repairing vintage camera: https://dallasmakerspace.org/wiki/Main_Page
- GreeterBot project (built rebots): https://dallasmakerspace.org/wiki/Main_Page
- Strawberry DNA Extraction Protocol: https://dallasmakerspace.org/wiki/Main_Page

Makerspace Resources

- Resources and tutorials for the open source Arduino micro-controller, http://www.arduino.cc
- Thingiverse, Ideas and digital designs for 3D printing, http://www.thingiverse.com
- Make to Learn, an online resource for students and teachers about digital fabrication, http://www.maketolearn.org/explore
- Maker Educational Initiative, its mission is to create more opportunities for young people to make and build confidence, foster creativity, and spark interest in science, technology, engineering, math, the arts—and learning as a whole, http://makered.org/
- Making The Future, a Cognizant education initiative, was created to unleash the passion of young people in STEM disciplines by creating fun, hands-on learning opportunities, http://www.cognizant.com/aboutus/makingthefuture
- Learning Labs in Libraries and Museums, Institute of Museum and Library Services, http://www.imls.gov/about/learning_labs.aspx
- Makerspace, directory and resources for Makerspaces, Makerspace.com
- Makerspace Playbook, information on setting up a makerspace

http://makerspace.com/maker-news/makerspace-playbook

- Make: Magazine, many resources and books including Make Magazine's Ultimate Guide to 3D Printing, http://makezine.com/
- Maker Faires, a family-friendly festival of invention, http://makerfaire.com/
- DIY – share project ideas https://diy.org/
- Making Makerspaces: Acquiring Insurance, http://blog.makezine.com/2013/05/23/making-makerspaces-acquiring-insurance/
- Adafruit Industries, resources, tutorials and electronics, http://adafruit.com/
- Ultimaker open source 3D printing, http://ultimaker.com/
- Resource for creating a youth makerspace: A Blueprint: Maker Programs for Youth, http://dmp.nysci.org/system/files/filedepot/1/NYSCI_MAKER_BLUEPRINT.pdf
- Detroit Public Library HYPE Teen Center Makerspace Budget, made by Jeff Sturges, Mt Elliott Makerspace, http://www.mtelliottmakerspace.com/?page_id=166
- Instructables, share projects and connect with makers, http://www.instructables.com/
- Make Projects, resources, project ideas and tutorials, http://blog.makezine.com/projects/
- LilyPond is a website that allows people to document and share projects that blend electronics and textiles, http://lilypond.media.mit.edu/,
- GrabCAD, Open Engineering platform, http://grabcad.com/
- Software resources: SketchUp http://www.sketchup.com/, Autodesk 123D http://www.123dapp.com/, Tinkercad https://tinkercad.com/, Blender http://www.blender.org/, OpenSCAD http://www.openscad.org/

About REI

The MSU EDA University Center for Regional Economic Innovation (REI) seeks to identify and develop new economic development tools, models, policies and practices to support innovative economic development high-growth enterprises and job creation in distressed regions across the state. REI has established a new economic development ecosystem to cope with the ever-changing global and regional dynamic. Through this ecosystem, we engage innovative and creative minds which result in new economic development practices.

The REI University Center was established in 2011 with support from the U.S. Department of Commerce, Economic Development Administration, and in collaboration with the following MSU offices:

Office of the Provost
Vice President for Research & Graduate Studies
University Outreach & Engagement
MSU Extension Office
Institution for Public Policy & Social Research
School of Planning, Design, & Construction
Department of Geography
College of Social Science

MICHIGAN STATE UNIVERSITY | Center for Community and Economic Development

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