CHIVUKULA, DIVYA, M.F.A. Makerspaces-The Future of Public Libraries. (2019)
Directed by Stoel Burrowes. 130 pp.

Public libraries have always been regarded as the center of knowledge and
information, but today the same public libraries have been challenged by the rise of
mobile technology and digitization. Public libraries are facing a design shift in their focus
from storing books to an active public space of learning which involves more engaging
and reading. This thesis addresses the need for citizens to manifest the knowledge, skills,
and attitudes required to take part in a complex and increasingly digitized world of
personal and societal prosperity. Digital competence significantly involves
communication, collaboration, content creation, and problem-solving. The definition of
digital skill underscores confident, productive, creative and critical use of digital
technologies for diverse purposes in various social contexts and with multiple tools (Ala-
Mutka, 2011).

Presently, there is a lack of knowledge, on creating learning opportunities
for digital literacies that are inclusive for diverse learners with different capabilities and
interests, which can accommodate different personal situations, objectives and combine,
for example, formal and everyday learning practices (Erstad et al., 2016).

This research aims at understanding makerspaces and public library makerspaces,
including the people and practices involved in these spaces. Makerspaces align with the
fact that public libraries meet the needs and interests of their local communities. This
research employs site visits, case studies, and analysis to examine the journal articles and
blog posts published from 2008 to 2015 that focus on makerspaces and public libraries.

The first part of the research highlights the literature concerning the history of making through Maker concept, Maker Movement. The methodology reviews the mission of providing access to digital resources in public library makerspaces in order to meet the needs of diverse communities. The analysis highlights some of the benefits and issues that emerge through the new trend of making and makerspaces in the field of Public Libraries. The researcher provides a review of library makerspaces both in India and North America, which are supported by several case studies. This thesis reimagines a public library, by evaluating a design that engages and responds to the local community it supports.

MAKERSPACE-THE FUTURE OF PUBLIC LIBRARIES

by

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A Thesis Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Master of Fine Arts

Greensboro
2019

Approved by

_____
Committee Chair

To my parents, Prabhakar Chivukula and Mynavathy Prabhakar, Sister Seshu Chivukula and Brother-in-law Ajit Prasad; thank you for your unconditional love and support, for always believing in me and reminding me that, I am capable of accomplishing anything I put my mind. I wouldn't have been able to accomplish this without you.

APPROVAL PAGE

This thesis written by Divya Chivukula has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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ACKNOWLEDGMENTS

I wish to express my gratitude to everyone that has supported me throughout these past three years. To my thesis committee: Thank you to Mr. Stoel Burrowes, Thesis chair, who continually offered me his guidance and encouragement, motivating me to put my best foot forward. Thank you for sharing your knowledge with me, investing your time in me, and believing in me from the very beginning. This accomplishment would not have been possible without you.

To Felicia Dean for being a consistent source of support and providing me with opportunities to enrich my thesis through CAM, always allowing me to think in many different ways and encouraging me to think out of the box.

To Tommy Lambeth for helping me approach my research from a different point of view and helping me complete my thesis.

Thank you to the UNCG Interior Architecture Department, the Graduate School, for their support throughout my research.

Thank you to Greensboro Public Library, particularly Antuan Hawkins, and Jim Young the manager of Greensboro Public Library, for their constant support and for allowing me to grow as a student and designer through the organization.

A special thank you to everybody in my family. To my immediate family, Mom, Dad, Sister, Brother-in-law and my nephew. Your incredible love and support were and will always be my source of strength and motivation. Thank you for always believing in me.

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CHAPTER I

INTRODUCTION

Public libraries today face unprecedented changes in usage pattern, purpose of books and shifts in user-borrower behaviors. The internet has revolutionized the fundamental forms of information and how users access it. Makerspaces of all kinds are growing rapidly and have been emerging as a worldwide phenomenon. The growth of the Maker Movement within the past few years (2009-2013) has prompted significance on making such as creating things with hands and tools within schools, community centers and libraries across the globe.

Makerspaces prescribe a model of learning-by-doing in which individuals can work on creative design projects that are personally and collectively meaningful. The possibility to play with material objects acts as "a social glue" for people to come together and engage in collaborative and creative endeavors (Gauntlett & Thomsen, 2013). Most simply defined as 'Public workshops' where makers can share tools and knowledge, makerspaces are currently a much talked about topic within the library world. An increasing number of libraries are establishing or planning to establish spaces where their users can create. Though the concept of makerspaces within libraries may seem unusual, their "values strongly echo libraries' core mission of providing equal access to knowledge resources" (Taylor & Connolly, 2016, p. 2).

Are Public Libraries Becoming Extinct?

What are libraries for, if not storing and circulating books? With their struggle to breathe, how can they survive? The libraries, at the dawn of a digital era, are in the midst of an identity crisis in the 21st-century. Somerville and Harlan (2008) view libraries as a "third iteration of the Commons concept" by their recognition of spaces that encourage social interactions and knowledge exchange to facilitate and support learning. They state that: "libraries acknowledge the essential social dimension of knowledge and learning." Makerspaces are an extension of the 'social interactions and knowledge exchange' in library spaces (pp. 1-36). Agresta's (2014) study found the following:

> 2012 marked the third consecutive year in which more than 40 percent of states decreased funding for libraries. In 2009, Pennsylvania, the keystone of the old Carnegie library system, came within 15 Senate votes of closing the Free Library of Philadelphia. In the United Kingdom, a much more severe austerity program shuttered 200 public libraries in 2012 alone (p. 4).

Toronto Public Library conducted a survey of the five years trend of the libraries from 2012 to 2016, and the analysis concluded that the visits at North American libraries which serves more than two million visitors decreased by 12.2%. Los Angeles Public Library had -2.3% which is noticed as the smallest drop and Toronto Public Library experienced a decrease of -3.4%. Whereas there was an increase of 3.4% in the virtual visits in the Toronto Public Library which included website content, self-service features, and electronic services (TPL, 2017).

Matthew Battles, associate director of MetaLAB (knowledge-design lab which explores the digital arts and humanities) at Harvard, published about the history of libraries and believes that the future of libraries must be decided not by nostalgic scholars or librarians hoping to save their jobs, but in conversation with communities. According to Agresta (2014), Librarians, scholars, policymakers all have to be part of that dialogue, but it must embrace a civic context, not the institutional context, he says "If you do that, having spent a lot of time in libraries and meetings with library administration, you end up in this conversation of how to save the library. People say, 'We know we have to change, but we don't know how.' There's a death spiral in that dialogue" (p. 30).

The libraries of the era will survive, only if the communities they serve want and need them. Libraries have been trying to counterbalance shift by reformulating their mission around providing access to new technologies. Already Americans access the internet at home, with both broadband and mobile access rising steadily, especially among the younger generation. Across the United States, librarians have been experimenting with ways of expanding on the newly elaborated mission. For instance:

1) The idea of libraries as an incubator project was promoted by a group of young artisans of libraries, as a vision of "third place." Third places, as defined by Oldenburg (1989), are the, 'good places' that foster community and communication among people outside of home and work, the first and second places of daily life (Jeffres et al., 2009).

2) The public library at Iowa city, talk about their favorite project which is a local music project, where the librarians bought recordings from the local artists and offered them online to cardholders for free.

3) The Brooklyn public library organized "The sketchbook project "– donated 32-page sketchbooks from both the professional and amateur artists and displayed them around the country.

The ancillary public benefits have become the rationale for the survival of public libraries, particularly the principle of a "Third place" focused on learning (Agresta, 2014, p.13). So, what does it mean for our communities to re-imagine, remake and redesign our public libraries?

Making is seen as the new path towards exploring the creative aspects through learning by library visitors. Subsequently, Participants are developing brand-new skills, for example, a novice computer user can learn basics in programming. Participants initially start with programs, and tools to accomplish various project like creating cards or books for gifts. Library makerspaces give everyone the opportunity to see the world around them differently, to explore and imagine new possibilities for a future they help create.

According to Stowe (2013), Zeke Leonard, assistant professor of Syracuse University School of Design offers an interesting social and political view of musical instruments, along with this bit of philosophy:

Making anything for yourself is a political act... The further we get from
the creation of an object, the less we have a connection with the people,

resources, and process. This limits how we assign value to objects. If we can all start to make more and consume less, then we can be more thoughtful about the resources used to create the objects and food and garments that we fill our lives with (p.4).

Library users learn the value of material and time only when they start working on a project or an idea that they have developed on. Through the learning process people connect and engage with different sets of artists and make a connection. According to Zeke Leonard, an assistant professor at Syracuse School of design says,

Maybe the urge to make manifests in putting a patch on a worn pair of jeans instead of buying new ones. Maybe it manifests in having friends over for a 'pot-luck' instead of meeting at a restaurant, as sharing the food you have made is an immediate joy that is a long-standing tradition, these seemingly trivial actions are making activism, a way in the modern world that we can have some control over our surroundings that is not dictated by the limit on our credit card" (as cited in Britton, 2012, p.16).

The new form of art where attendees learn to create instills an idea of creation rather than the traditional Library mode of only consumption. Making can play a major role in economy of a community, region or even of the country.

The statements continue to remind libraries, librarians and communities they serve that effective and relevant library services are driven not only by the technological advances but the user needs. As the digitization of existing material progresses and continues to empty the book shelves, it makes more information available to more people in different forms. How does the library of the future answer the needs of a changing information culture?

Significance

The research conducted in this thesis, encourage the expert's work in outlining and showcasing potential changes in facilities, informational assets, administrations, and staff. This research is intending to tactically improve the library services, implement ideas of how the library could better serve the community, into librarians and for professionals working towards a change. Makerspaces can be incorporated into library services, to have a life-changing impact on community members, who can have access to tools and training required to make and remake their world. Innovation hubs can reflect the needs of local community just as libraries are reflection of their patrons.

Role of Community

Community members play an essential role in a makerspace and are the heart of any such spaces which creates transformative experiences by incorporating such areas in public libraries. For example, a library user can learn how to fix a machine by designing and then 3-D printing the replacement part. Another person might learn to operate something through a robot. By sharing knowledge and experience, people try to learn from their peers.

Dixon (2017), describe typically, makerspaces will:

- Encourage play and exploration
- Promote informal learning opportunities
- Nourish peer-to-peer training
- Engaging the local community as of right partners, not as users.
- Incorporate a culture of creating as opposed to consuming.

Tech Trendy

Maker activities are viral among users these days, and the credit goes to programs that engage digital literacy which promote new technologies, especially for young adults. The most recent survey conducted in April of 2017 for 7000 public librarians by Library Journal in United States and Canada with 404 responses, reports that, most of the adult programs do not use high- technology, they are mostly considered as low-tech like crafts (30%), Cooking (28%), and sewing (25%). However, for teenagers cooking (27%), Coding (26%), 3-D printing (22%) and crafts (20%); are the most popular programs offered in makerspaces.

There has been a tech shift over the last three years (2014-2017) about what activities attendees ask for. The results of the Library journal program survey conducted in 2014 revealed that people asked for crafts, crocheting, Lego kits, gardening and cooking as the most popular ones. Whereas in 2017, the same survey showed respondents are more interested in coding/programming (from 36% of public libraries to 65%), painting/ drawing (43% to 69%), 3-D printing (23% to 45%), robotics (32% to 53%) and building kits (71% to 87%) (Dixon, 2017).

Research Goals

- Evolution of new form of a library as 'third place.'
- To transform the library's image from a place of consumption to one of creation.
- To Make the experiences and services of technology transparent to the users.
- To include enriched community engagement.

Research Context

The significant context for this research is the rapid rise in curiosity about makerspaces from public libraries in the USA. The interest in library makerspaces is not new but has been persisting as an idea for many years now, for example, in 2013, American Libraries Magazine published a short, "History of Making" timeline. The timeline begins with making activities situated in the Gowanda Free Library (N.Y.) in 1873 such as quilting, knitting, and sewing. It ends with the opening of the 21st Century's first Makerspace in the Fayetteville (N.Y.) Free Library in 2011 (Loertscher, Preddy, & Derry, 2013). Loertscher et al. (2013) asserts that "Making has always been a part of any vibrant library program; it is just now blossoming into a major movement utilizing much more technology, tools, and advanced resources in a variety of ways unlike ever before" (p.48).

In the 21st century, schools and public libraries are becoming a natural placement of makerspaces. One of the most compelling reason comes from Fleming (2015) who states, "The library has long been an engine for the democratization of knowledge and information, but we have to recognize today that a library's role is no longer simply about providing access to information." (p.45). Makerspaces can be a means of "future-proofing" libraries to ensure that the library evolves along with advances in technology and changes in client or student needs (as cited in Moorefield-Lang, 2015). According to YALSA (2014) library makerspaces and making experiences can help to provide the following benefits for students: bridge the growing gap in the digital and knowledge

divide; motivate teens to learn; provide needed training for the workforce and connect teens with community members and agencies.

Research Questions

- How can the libraries survive to add value to the digital experience of the 21st century users?

- What are the implications of the advent of makerspaces into Public libraries?

- What benefits can a creative space bring to our library and our community?

Why is a Public Library an Ideal Place for Making?

Although makers can join private makerspaces for free, Participants are going to their local or campus libraries to make (Van Holm, 2015). Libraries are stepping into the fold after the "Making" becomes the new democracy and Maker Movement being categorized as informative in the 21st century. Johnson (2012) said that libraries build social capital with their communities by the resources and relationships they create.

CHAPTER II

LITERATURE REVIEW

The literature review provides a context and limited overview of current

makerspaces along with origins through research which covering two main areas:

- Research into the Maker Movement,

- The LIS (Library and Information Science) perspective on makerspaces.

Investigating the activities within the literature will provide us with an abstract of

historical development of makerspaces, examples of methodologies to examine them and

also emphasize the benefits that are provided by these makerspaces getting integrated

with educational institutions and libraries.

The Maker Movement

According to Halverson & Sheridan (2014), "The development of Maker

Movement is linked with the emergence of makerspaces – A term which describes the

upsurge of interest in "constructing and sharing personal inventions and creative

artifacts" (p. 496). Makerspace consists of amorphous grassroots grouping of individuals

with different objectives "united by a common desire to be involved in the production of

things" (Dellot, 2015, p. 13). Public libraries in the present context will be specifically

looking into the value of Maker Movement and its success stories, which becomes an

inspiration for innovative library services.

Hielscher and Smith (2014), define some of the key elements of the Maker Movement ethos:

- The importance of informal hands-on learning play and tinkering.
- Collaborative work practices.
- Knowledge sharing and advocacy for open source and open access.
- The impact of new technologies on manufacturing and culture, as a "new industrial revolution" (p. 2).

However, it should be taken into consideration that many of the claims within the literature appear to some commentators to be highly speculative, in that they are based on an emergent sector. The hype surrounding the Maker Movement sometimes risks "extrapolating and inflating" claims without considering participants' activities, aims, and motivations ((Hielscher and Smith 2014, p. 5).

Origins of the Maker Movement

Making has been discussed throughout all of history and the developments of culture are congruent, so the Maker Movement sounds unremarkable. However, because of the emergence of the internet and the economical availability of digital fabrication technology which brings out the interests of common man making physical objects. Burke (2014) highlights the importance of lowering cost of technology such as 3-D printing, which enables people to manufacture complex objects previously only achievable by industrial methods, while the internet has allowed people to learn how to make use of these technologies: seek advice, share ideas and collaborate online.

The Maker Movement is a relatively recent term coined by Dale Dougherty, and its particular emphasis on the word "Make" is largely derived from the popularity of the

DIY magazine Make (founded by Dougherty in 2005) and the Maker Fairs associated with the publication, started in 2006 (Anderson, 2013). Though the 'Make' brand plays an important role in popularizing the concept, the Maker Movement is quite an amorphous one "comprised of individual makers, local and regional maker events and publications, and a host of do-it-yourself digital resources" (Sheridan et al., 2014, p. 505). Dougherty's (2012) inspiration for founding Make magazine was from publications such as Popular Mechanics, which had their peak in the mid-twentieth century, a period he describes as "a time when most Americans commonly thought of themselves as tinkerers" (p. 11).

Though the name making, or maker is entirely new, a common theme in the literature is that making is a fundamental human activity and precursors to the Maker Movement can be traced through history (Halverson & Sheridan, 2014). Dellot (2015) outlines four movements, which champion making, from the Luddite and the Arts and Craft movements of the nineteenth century; through to the development of early home computing led by the Hacker movement of the 1960s and 70s and finally, the contemporary Maker Movement. Dougherty (2012) claims that "we are all Makers" (p. 13) – Making is intrinsic to almost everyone, but some of these skills have been lost because of a declining sense of the necessity for these skills. Like Dellot, several commentators also trace a precedent for the Maker Movement in the early pioneers of the computing industry in Silicon Valley (Dougherty, 2012).

The computing industry of Silicon was founded largely on a DIY ethic – such as Apple's origins from the "garage tinkerers" of the Homebrew Computer Club. It is ironic

that the spectacular success of these companies has led to a sense of technological

disconnect with making because the "devices they create have become so widespread and

people no longer need to be enthusiasts to use them" (Dougherty, 2012, p. 12).

Reconnecting with Technology

One of the most significant advantages of the Maker Movement was the

connection of people through technology which encourages playful experimentation, also

a considerable move for catalyzing technology (Dellot, 2015). Dellot (2015) also

describes this as a three-phase process:

> Access, acumen and agency. The first phase is access to technology,
> which has been addressed by supplying personal computer technology and
> connecting them to the internet; the second phase is technological acumen,
> which involves instilling digital literacy to operate the technology (p. 10).

The first two phases are already being addressed mainly in society, according to

Dellot. Also, he claims that the problem of technological 'agency', the third phase, is the

most pressing, with the Maker Movement uniquely placed to help people understand and

use technology to accomplish their own needs (Dellot, 2015, p. 17).

Educational Benefits of the Maker Movement

Burke (2014) describes the Maker Movement as a "collective concept," with the

community as the "defining element of the Maker Movement on both a local and

international scale" (p. 11). The concept of DIY, Do-it-yourself becomes Do-it-together

as there is a vibrant impact on learning applicable skills and sharing that knowledge

(Burke, 2014).

Projects are shared online to become an inspiration for others and opportunities for collaboration. Individual makers, globally connected this way, become a movement, millions of DIYers, once working alone, suddenly start working together. Thus, ideas shared, turn into bigger ideas and the projects can become the seeds of products, movements or even industries. The simple act of "Making in public" can become the engine of innovation, even if that was not the intent (Anderson, 2014,).

Public making ties in with the solid connection between the Maker Movement and education, particularly non-traditional free forms of learning. In particular, Seymour Paper's, *Educational theory of Constructionism* is applied to the context of Making (Burke, 2014). Constructionism is based on the theory that learners create mental models to help them learn, and that by extension creating actual products or artifacts help strengthen students' learning. The artifact, and the process of creating the artifact functions as an evolving representation of the learner's thinking (Sheridan et al., 2014). The creation is often approached through problem-based learning exercises "in which a student is given a problem to overcome that will teach him or her about the subject being covered" (Burke, 2014, p.11). As Burke points out, problem-solving is often central to making, as the necessity to fix a problem is often the motivation behind starting many projects (Burke, 2014).

The Maker Movement became very prominent in orienting student's careers by promoting STEM (Science, Technology, Engineering, and Math) learning opportunities in many ways that engage student's imaginations. The motivation behind this emphasis on STEM education can be related to increasing national competitiveness, filling open

positions in high-technology fields, or broadening the intellectual capacities of students

(Burke, 2014). Closely related to this is the drive to include arts into these educational

programmers creating the acronym STEAM (Science, Technology, Engineering, Art,

Math). As Burke points out, the creativity associated with skills has applications in other

fields of problem-solving and is particularly suited to the "breadth of creativity available

in many makerspaces, where engineering and artistic creations can exist side by side as

well as integrated efforts" (Burke, 2014, p. 13). The Makers Movement and makerspaces

generate spaces for the energetic and innovative combination of Arts with STEM.

Economic Benefits of the Maker Movement

Maker Movement is not only seen as a benefit for education, but it also brings

significant economic benefits by encouraging inventors and entrepreneurs. Van Holm

(2015) claims that there are three ways in which Maker Movement supports

entrepreneurs:

- The Maker Movement attracts more individuals into product design and thus may launch more "accidental entrepreneurs" if they find that their user solutions have a market.
- The Maker Movement generates dense but diverse networks, creating new ideas and innovative thinking.
- The Maker Movement lowers the costs for prototyping, making early sales and acquiring outside funding more realistic (p. 24).

Anderson (2012) also lists three similar characteristics of the Maker Movement:

1. People using digital desktop tools to create designs for new products and them.
2. A cultural norm to share those designs and collaborate with others in online communities.

3. The use of common design file standards that allow anyone, if they desire, to send their files to commercial manufacturing services to be produced in any number, just as easily as they can fabricate them on the desktop which radically foreshortens the path from idea to entrepreneurship, just as the Web did in software, information, and content (p.21).

Anderson (2012) argues that this is leading to people "industrializing the do-it-yourself (DIY) spirit" (p. 9) to such an extent that he terms it a "third Industrial Revolution" – the combination of low cost manufacturing technologies such as 3D Printing and the sharing of open source ideas online "dramatically amplify the productivity of people" in ways that they could disrupt industrial scale manufacturing (p. 30). According to Dougherty (2012), these benefits could also be taken advantage of by companies as well as individuals. Companies could look out to the maker community as a source of talent and ideas, as well as engaging their own employees with Makerspace type environments, in order to "get to the heart of what they are passionate about and what they're working on outside the confines of the company walls" (p. 13-14).

Makerspaces in Libraries

By raising awareness of what the characteristics of makerspaces are, it will be easier to connect a public library and a makerspace. The role of the libraries is changing because of the digital revolution. Public libraries, once perceived as repositories of information and knowledge, are digitizing content and access and including skills in the traditions of information and knowledge sharing. Wang et al. (2016) explained, "the Maker Movement in libraries is about teaching our users to think for themselves, to think creatively, and to look for do-it-yourself solutions before running off to the store." (p. 5)

Therefore, a key role for a library makerspace is to help improve access to creative people.

According to Tashjian (2014), makerspaces are shifting educational and public organizations from being places where things are made, or information is found to places where knowledge and ideas are developed, and imagination and creativity are fostered". As an educational and public organization, the library is also enjoying the advantage of the social expectations of undergoing the transformative shift. In 1873 the Gowanda Free Library started as the Gowanda Ladies Social Society, where a group of local women would meet regularly to socialize, quilt, knit, sew, and discuss books they had read. In 1905, as the Head of the Children's Department at the Carnegie Library of Pittsburgh, Ms. Frances Jenkins Olcott, helped create home libraries in working-class houses. In these home libraries, the library staff would teach children about crafts such as sewing and basketry (Borman, 2013).

Practical Advice for Practitioners

The majority of Library information science (LIS) literature consists of practitioner reports of how particular makerspaces were set up in variety of contexts, for example school libraries, public libraries, academic libraries or particular types of makerspace such as mobile makerspaces (Craddock, 2015). The various studies provide us with examples of best practices for multiple practitioners considering establishing makerspaces based on the writer's experiences of designing and constructing makerspaces within their institutions.

Boyle et al. (2016) provide a list of four recommendations for other libraries, based on a literature review of library practitioner reports.

- To adapt equipment and activities to reflect local staffing, hours, budget and most importantly community needs.

- To engage your community – consulting to find pre-existing needs, interests, and expertise; build a self-sustaining maker community and to recruit volunteers.

- To be flexible, allowing for experimentation and changing interests, for a space to develop. Starting small and scale up, regularly reviewing to make continuous improvements

- To promote a space to advocate for the benefits of a makerspace, both out to the community and also into library staff, which may be skeptical (pp. 37-38).

According to Boyle et al. (2016),

> The benefits of makerspaces include: empowering the community, fostering community collaboration and co-creation, growing a larger, more engaged user base, enabling inter-generational learning and social connectedness, facilitating trans-literacy, developing a culture of lifelong learning and adding socio-economic advantage to communities. Creative spaces also provide an opportunity for libraries to future-proof themselves and adapt to meet the changing nature of society (p.31).

Slatter and Howard (2013) identify three common challenges for libraries implementing makerspaces the new nature of makerspaces, means there is a steep learning curve for space organizers, and also makes it challenging to communicate the value of makerspace to people used to more traditional library models; budgetary constraints limiting what equipment can be purchased; and legal concerns over copyright,

liability, and ownership. Despite these challenges, Boyle et al, (2016) suggest that there are substantive benefits.

> Empowering your community, fostering community collaboration and co-creation, growing a larger, more engaged user base, enabling inter-generational learning and social connectedness, facilitating trans-literacy, developing a culture of lifelong learning and adding socio-economic advantage to communities. Creative spaces also provide an opportunity for libraries to future-proof themselves and adapt to meet the changing nature of society (p. 30).

There is evidence in the LIS literature that elements of the Maker Movement ethos are being incorporated into the education of new librarians and information professionals. Bowler (2014) and Luthy (2015) both describe pilot studies within University Library and Information Science departments to test ways of equipping students with new skills and knowledge "needed to understand, start, and manage makerspaces and maker-related technology" (Luthy, 2015, p. 5).

Luthy's (2015) study focuses on the creation of resources (including online workshops and tutorials, and an online toolkit) that would be readily accessible to students and current practitioners. Bowler's (2014) study aims to develop ways to integrate design challenges and maker experiences into a formal LIS curriculum, to expand "opportunities for creativity" out to school and public libraries (p. 61).

Koh & Abbas (2015) also identifies a lack of research studies into the skills and competencies required to run makerspaces within libraries or museums, nor any official list of competencies by professional bodies (in the USA) (p. 115). Through interviews

with information professionals currently running a library or museum makerspaces or learning labs, Koh & Abbas (2015) identify a list of five top competencies and five skills needed to run these spaces successfully:

- Competencies: (1) ability to learn, (2) ability to adapt to changing situations, (3) ability to collaborate, (4) ability to advocate for the Learning Lab or makerspace, and (5) ability to serve diverse people (p. 119).

- Skills: (1) management, (2) program development, (3) grant writing and fundraising, (4) technology literacy, and (5) facilitating learning based on learning theories and user behaviors (p. 121).

Criticism of Makerspaces in Libraries

Rebekah Willet, an assistant professor from University of Wisconsin-Madison, analyses a study of LIS Makerspace suggesting the "ways professional journal articles and blog posts aimed at public librarians define public library makerspaces, including the people and practices involved in these spaces" (Willett, 2016, p. 318). By analyzing this body of literature, Willet discerned common themes in how makerspaces are being discussed and promoted, but also highlights several tensions and conflicting or unfounded claims.

The three common themes identified are makerspaces and the future of public libraries, DIY/maker cultures, and public library. Some of the tensions Willet (2016) highlights include:

- Whether makerspaces are a radically new approach, or a continuation of what libraries have always done.

- Making bold claims about community empowerment, encourage people to create rather than consume culture and reaching non-traditional audiences, but with no clarity from the literature whether library makerspaces are fulfilling these aims.

- A framing of creativity in terms of productive or economic benefits, rather than for individual creative expression.

- An oversimplified opposition between informal and formal education, which risks ignoring "who might benefit or be excluded from different teaching styles" (p. 326).

The Social Impact of Makerspaces

Tools and facilities initially draw most of the users who then continue to attend because of the socialization aspects. Makerspaces can turn "otherwise solitary activities such as coding into communal activities that could be shared with others" (Taylor et al., 2016, p. 4). Linked to this socialization is the impact makerspaces can have on wellbeing – though it may not be a stated aim of makerspaces, the shared activity of making with other people can help people who have difficulty interacting with others "to develop skills and to engage with the world in a productive way" (Taylor et al., 2016, p. 7).

As for serving local community needs, some spaces take on a very active role – taking on projects for local schools or councils, starting apprenticeship schemes. For example, FabLab in Belfast serving to "bring together people from both sides of the Northern Ireland conflict around shared, constructive tasks and activities that helped to develop skills and economic prosperity" (Taylor et al., 2016, p. 6).

Taylor et al. (2016) claim that despite the best intentions, many makerspaces struggle to appear accessible to wider audiences beyond "early adopters with technical or creative backgrounds and a large proportion are affluent males" (p. 1) and advocate that makerspace organizers should seek to vocally highlight and promote their beneficial qualities in order to be able to widen the access and impact of makerspaces as community resources. Not all makerspaces will fill all of the roles in equal measure, but most should be able to bring at least some of these benefits to their users and communities – and the researcher would argue that libraries could play an essential role in breaking down barriers to broader accessibility (Taylor et al., 2016).

In the study titled *Learning in the Making*: A comparative case study of three makerspaces, Sheridan et al. (2014) use a comparative case study of the three makerspaces, to analyze how they function as learning environments in which he employed qualitative methods to draw detailed pictures of the activities and interactions of users within the makerspaces – conducting over 150 hours of field observations and interviews as well as extensive analyses of web-based archives, such as blog postings, online community discussions, and video and photo documentation of making activities and finished works.

Sheridian et al. (2014), based his guiding research questions on Who the participates in these makerspaces were, what are the tools, materials, and processes used in each makerspace and the arrangements for learning, teaching, and collaborating in each space. Sheridan et al. (2014) also drew analysis from the literature on formal and informal learning environments and at the more formal end of their

educational activities, the makerspaces are comparable to visual arts studio learning environments, in which participants work independently or collaboratively with materials to design and make.

Based on earlier research into visual art studio classes by Sheridan et al. (2014), four key "studio structures" are identified as central to the design of studio learning environments:

1. In demonstration-lectures, teachers pose open-ended challenges, show exemplars, and demonstrate processes to engage and inform students,

2. In students-at-work, students work on their art and teachers circle the room observing and giving "just-in-time" instruction,

3. In critiques, the working process is paused as the group collectively reflects on student work, and

4. In exhibitions, students' work is shared with a community beyond the studio classroom.

Though makerspaces often tend to be more informally structured than in visual arts studio education, Sheridan et al. claim that many of the characteristics of these studio structures can be identified in them, and that making use of this studio model can help them see the "pedagogical structure in the flow of the multiple informal interactions and activities" in the makerspaces they observed (Sheridan et al., 2014, p. 509).

Sheridan et al. (2014) also use the concept of communities of practice as the lens through which to analyze makerspaces. This concept, developed by Lave and Wenger, describes how groups of people who work in a common domain share knowledge within

their chosen community. According to Sheridan et al. (2014) the communities of practice framework is particularly applicable to makerspaces because of the way learning is an ongoing part of social interaction in these spaces, rather than a discrete activity, such as classes or lectures.

The concept is useful in that it allows all the diverse elements and activities which make up a makerspace to be considered, helping to frame how "the shared use of space, tools, and materials; shifting teaching and learning arrangements; individual and collective goals; and emergent documentation of rules, protocols, and processes for participation and action work together to form each community of practice with its particular features" (Sheridan et al., 2014, p. 509). Furthermore, other activities peripheral to making, such as taking walks, socializing or playing, are "central to learning and forming a sense of community and are important to providing space and time for idea generation" (Sheridan et al., 2014, p. 509).

Literature Review Conclusion

The literature reviewed, is consistent in stating that makerspaces have many potential social benefits, but that it is difficult to study and prove these benefits. From the research, these benefits include: developing technological agency, encouraging recycling and sustainability promoting civic engagement work as successful learning environments serving as social spaces which support wellbeing, community needs and excluded groups promote learning in STEM (and STEAM) subjects support and encourage creativity support entrepreneurs and innovation and possibly leading to "third Industrial Revolution" (Anderson, 2012). For libraries, in addition to the above benefits, it is

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claimed makerspace could support libraries' core mission of providing equal access to knowledge resources, in addition to helping to future-proof and transform the perception of libraries (Boyle et al., 2016).

The framework and designing of the methodology use the benefits listed above and also analyze the findings of the research.

CHAPTER III

METHODOLOGY

The steps utilized to gather the data to study:

- Study the need for makerspaces in libraries for the future.

- Understand identities of makerspaces.

- Determine how makerspaces fit into the structure of public libraries and

- Identify how makerspaces are tools of pedagogy for libraries.

 The first part of the methodology chapter describes the mixed method of research

and the reasons why it fits within the parameters of the study. Also, the first selection

enumerates a different kind of practice that strategize the design of the study.

After the explanation of the methodology, the chapter details the procedures

employed to collect the data and analyze the information. A description follows of the

differences and selection of case studies utilized. This chapter concludes with a review of

the framework that helps analyze the information and answer the research questions.

Mixed Methods

The methodology implemented in this research is a mixed methods approach.

Mixed methodology "represents the complete level of integration among two or more

research designs" (Groat & Wang, 2013, p. 368). A reason for using mixed methods in

this research is due to the evaluative process of the study, some data can be collected simultaneously, but other data builds up sequentially from the different phases of the research (Creswell & Plano Clark, 2011).

The methodology consists of three steps. Step 1 is the study of five different community makerspaces both in the USA and in India. The step 2 is to study six public library makerspaces through case studies and site visits. Step 3 is a survey conducted by the Greensboro Public Library for a proposal for a new makerspace and users' reaction towards the proposal. The research for this project will take the form of comparative case studies. The three initial stages will include research into the current level of provision of makerspaces in both USA and India. Content analysis of websites and social media postings will be used to determine: What facilities the makerspaces provide; what are the kinds of tools or machines that libraries use, what are the particular audiences that they aim at (Children, Artists, businesses, etc.), gauge the level of the community involvement.

Community Makerspace
Step 1:
Study 5 different community makerspaces from both India and America to completely understand how a makerpsace is benefitting a communtiy

Public library Makerspace
Step 2:
Study 6 public library makerspaces to understand how makerspaces could serve the community more efficiently

Greensboro Public Library
Step 3:
Survey by Greensboro public library which has no makerspace to see how people react to the proposal of a new makerspace.

Figure 1. Research Methodology Design

Data Collection

Discursive Interviews was the primary data collection method which seemed the most appropriate for this research. Interviews are commonly used in case studies, such as this makerspace project and it's suitable for situations where a researcher wants to obtain detailed information; ask questions that are complex, or open-ended; or explore emotions, experiences or feelings that cannot be readily observed via pre-set questionnaires (Briony, 2006).

There are three main types of interview approaches: structured, semi-structured and unstructured (Briony, 2006). A semi-structured interview approach was taken, which Oates (2006) describes as having a list of themes to be covered and questions you want to ask but allowing the order to change or for new questions to be requested depending on the flow of the conversation, and unexpected issues being raised by the interviewee (as sited in Briony, 2006, p. 187). Semi-structured interviews are appropriate in this context

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because they allow for a large degree of interaction and flexibility, while still allowing the researcher to guide the discussion in seeking answers to the research questions. The interviews were primarily exploratory, with the type of data needed to be gathered being opinion rather than fact-based, to help build a picture of how individuals feel they benefit from using the makerspace.

In designing the interview schedule, Pickard (2017) recommends that "thematizing" is carried out first – that is establishing what the purpose of the research is, and what topics and themes are being investigated (p. 173). The purpose of this research was to mainly investigate the benefits of the makerspaces to the library users. The researcher employed questions from a theme by Taylor et al. (2016) who asked interviewees about the history, motivations and ambitions of the facility, its user base, typical activities, promotion and outreach.

Table 1. addresses questionnaires that were addressed through the discussion of generic categories which were chosen as the structure rather than the list of benefits, as they are more open, and provide the interviewees with the opportunity to explain the benefits in their own terms, rather than lead them towards pre-determined responses.

Table 1. Semi-Structured Interview Guide (Calvo, 2017a)

Personal Information
What is your role in this makerspace/Library makerspace Have you been trained in this technology?
Spatial information How long has this makerspace been established? What equipment do you host? Opening hours? Where in the library is it situated?
Organizational Information How many people visit your makerspace? How do people access the makerspace? E.g., membership, drop-in, bookable workshops/classes, off-site events What are the charges? For each machine. How many staff /volunteers involved? How are the makerspace and its events funded?
Community and its users What is the kind of projects attendees work? What attracts people to this makerspace? Which audience does this makerspace cater? What is the standard benefits people mention about this makerspace?

What would they want to add?
Marketing   How do you measure success? E.g., do you keep any stats, perform surveys?   How do you promote the makerspace/ attract new users?   Challenges and difficulties   Plans/Future of libraries?

The research started to practically explore more about how makerspaces work, who are the stakeholders to include, Board members, administration, Culture of the space, what tools to pick based on the scope, what are the different kinds of programs offered at different makerspaces based on location, institution, community and demographics. It was not only the physical space that was thought about, but questions like: How will one teach and assess competence for the students to get familiar with all the tools in the area? How to instill the habit of employing design thinking to solve the complex challenges of the community? Or how will one like the users learn the backward mapping for a project? So, "the researcher" started to explore locally available makerspace which is the Greensboro Makerspace "The Forge."

<div align="center">

Step 1 - Community Makerspaces

</div>

The Forge

The Forge Greensboro is a community makerspace for artisans, entrepreneurs, inventors, artists and tinkerers to make, collaborate, ideate and learn. The forge works much like a gym. Members pay month to month for 24/7 access to space, tools, and

equipment. The Forge is the only space granting access to a woodshop, machining, welding, 3D printers, laser engraving, sewing, ceramics and a creative community in Greensboro. The Forge Greensboro is membership driven, and the members range from entrepreneurs and trade students to hobbyists and curious tinkerers. Anyone who enjoys learning new skills and meeting out of the box thinkers is a welcome candidate for membership.

Outcome: The research explored how hands-on people can gather to work on projects while participants share ideas, equipment's, tools and knowledge. The members of the forge come from a diverse variety of backgrounds. The Forge includes spaces like co-working space, textiles and sewing, electronics, 3D printing, computer lab, laser engraving, Staff office, conference room, kiln room, ceramics studio, machine shop, welding shop, wood shop, back patio, wood storage, and loading dock. Joe Rotondi -the executive director speaks about how they have an open format and variety of resources available and introduce a broad spectrum of skills and possibilities. The hands-on learning programs in Forge catalyzes innovative thinking, personal empowerment, and career development.

They have classes scheduled at different times for different tools. The income that 'The Forge' Makes from classes help them sustain workforce development programs and partnerships. While the Forge offers a lot of the physical tools to help entrepreneurs create and operate their businesses, space also aims to connect the industry to other great services to help them succeed in the community and in their personal careers which creates an entrepreneur ecosystem. The spur and support of the membership growth have

emboldened The Forge to expand their open community engagement offerings which include innovation education programs, meet-ups, and basic skills training. The Forge also partners with Universities in Greensboro and sponsors to offer students with "Maker ships" as a means of furthering their studies, developing businesses and prototyping their ideas.

Indian Makerspaces

Global Context: A Brief Idea about India and its Making

After Massachusetts Institute of Technology (MIT) started recognizing the first few makerspaces in 2013 that were equipped with machinery, making was gradually initiated in different parts of the world. This flourishing Maker Movement was very soon exported from the USA to India and India has welcomed it solicitously in the last five years (2012-2017). Makerspaces in India were analyzed and experienced through studying the locations on site by the author.

Why Making in India?

The strive for human making that dates back to millennia becomes an ideal base for India because of its varied levels of economic status, high demographic and complexity. Though India has always been facing the challenges of financial situation in terms of agriculture and education, it is still considered a growing economy with a wide range of opportunities through boosting startups, openly ended market size and high intellectual capital. As a part of the challenge, making still finds its way into the process of evolution, and manifest as solutions to pull out of poverty into the middle class and create a more significant opportunity for global interactions.

It is very common in the westerner's household to renovate their own houses or repairing things with the small tools available. Similarly, in India fixing things with simple solutions is an inherent process, which has also been called Jugaad- that is making our stuff or projects with simple things available. Makers Movement has been growing in the last five years (2012-2017) in India, and now there are approximately 15 makerspaces in different parts of the country. Before plunging into the making in India, it is vital to understand the origins of making.

Makerspaces are a new concept in Indian libraries. There is a compelling need to study and publish models of successful makerspaces. Constant training programs are salient features of constructing successful and inclusive makerspaces. The management and users of makerspaces work together to form a safe environment. There is an immediate need for makerspaces in Indian libraries to establish new technologies and boost the library's image. An enormous amount of effort is required from both the librarians, and the users. All are expected to be open-eyed, have a curious mind and should be passionate about learning and embracing new technologies and ideas to make successful makerspaces. The Maker Movement is getting attention in India, but more widespread awareness and usage can make this initiative a successful platform.

Global Disruption

As demonstrated by those visited, makerspaces in India are enabling entrepreneurs to form a network by providing physical infrastructure. Significant breakthroughs are impacting both research and development and academia through digitalization. A major part of the population are still disconnected with digitized new

part of innovation, and this is where the makerspaces can play significant roles in connecting both people and technology for the betterment of the community.

Key Challenges Faced by Makerspaces in India

The founding director of Work Bench projects, Anupama Gowda in an interview speaks about, how given that makerspaces in India fall between the gaps between academia and practice, people are often unable to ascribe a value to them in terms of certification or placements. These two primary factors hinder persons in the age group of 18-30, from voluntarily taking to makerspaces. There is a lot more to do at the advocacy level which is another set of problems given that the governmental administration has a limited understanding of the merits of makerspaces. The DIY culture brings up a new set of challenges among young working professionals calling for a well-planned active engagement with a cross-section of demographics. Makerspaces have proactively begun conversations and are creating conditions for all kinds of makers. It is not about creating simplified 'want' to engage in these spaces but creating a 'need' for all stakeholders to participate actively and continually sustain the joy and benefits of creation and innovation.

The makerspace awareness survey that was conducted in India by Defense Research and Development Organization, explored the use and awareness of Indian academic library makerspaces. The study was projected to collect preferred information about the use of library makerspaces, state-of-the-art facilities, and comprehensive support to the users. Random sampling technique was used for conducting the study. Overall 700 well-structured questionnaires were distributed among the library

professionals in India. A total of 500 filled in questionnaires were received, out of which, only 470 surveys were selected for analysis of the data, and 30 questionnaires were rejected due to incomplete responses from the users. The final response rate was 67.14% (Hussain & Nisha, 2017).

The significant findings of Hussain & Nisha, (2017) indicate:

a) Male users are 70% more aware whereas female users are only 30% aware of the usage of makerspaces in Academic libraries

b) 68.3% using makerspaces in Academic libraries are pursuing Master's degree

c) 73% of academic libraries employees are utilizing makerspaces facilities

d) 90% of respondents indicated that their library makerspaces launched recently in 2016

e) 68.09% of respondents are using makerspaces for academic and research purpose

f) 42.55% submitted makerspaces as a tool to educate students for the local and global economy

g) 44.68% cited that their library makerspaces are equipped with computer workstations and state-of-the-art technologies

h) 51.06% indicated that library's makerspaces engage in student's workshops/ seminars/conferences

i) The study established that 36% evaluated library's makerspaces valuable.

International Collaboration

While local interactions occur in India with the organization of maker events like Maker Mela3, Maker Fest4 or Bangalore Mini Maker Faire, to list a few, the Indian

maker ecosystem has always been globally connected since the maker culture in India has mostly been brought in from the USA. Some Indian spaces received grants from the USA to startup their activities. A lot of collaborations also occur with the MIT (Massachusetts Institute of Technology) hub in USA and CAMTech (Consortium for affordable medical technologies) hackathons in Bangalore (Rao, 2016).

Indian makers have also launched their initiatives abroad, such as Project-DEFY Makerspace in Bangalore, who successfully created and started a self-sustainable space in a refugee camp in Uganda. Another Indian initiative The-Workshop Fablab in Bangalore, which is oriented towards alternative education, has partnered with European institutions to conduct workshops. French institutions and makerspaces have also been collaborating with India such as the S.T.E.A.M. (Science, Technology, Engineering, Arts and Management) Schools at Maker's Asylum or the maker Tour that has recently been collecting data on Indian makerspaces.

Given the survey of Defense Research and Development organization, covering 15+ makers and enablers from India, the diversity of uniqueness of each space, some successful models and stories could inspire Indians to do more. Among the impressive variety, Switzerland has progressed in the similar evolution as Maker Movement in India (India, 2017). Indian spaces appear to share similar goals and values and hence could join strengths to share useful insights on more ups and downs of programs, lead sustainable activities, and make the change happen. Why should a good idea from India not be adapted and developed in Switzerland and vice-versa? Furthermore, makerspaces naturally motivate people to connect, innovate and accept new challenges. Switzerland to

some extent, but India, in particular, has shown its capacity to build bridges with other countries. Encouraged by many success stories, organizations should spot the opportunities by their fellow makers and generate an even richer diversity of backgrounds and skills to launch fruitful collaborations.

To drive the collaborations, Swissnex India which is a global network that connects dots between India and Switzerland in education, research, and innovation, will organize a platform in India for an Indo- Swiss delegation of making great leaders.

Swissnex India associates Switzerland and India in the fields of science, education, art, and innovation. A drive of the Swiss State Secretariat for Education, Research and Innovation (SERI) in association with the Swiss Federal Department of Foreign Affairs, Swissnex India is part of the Consulate General of Switzerland in Bangalore-India (India, 2017). Through visits, panel discussions and personalized meetings the program aims to give Swiss actors a comprehensive overview of the Indian ecosystem and to foster meaningful interactions with their Indian counterparts.

The following are a few examples of collaborations that could arise from such a platform:

- Organization of Swiss-Indian Maker events, such as Maker Faire, Hackathons, workshops or conferences: This would be a fusion of Swiss and Indian making where spaces and people from different backgrounds, professions and aspirations would showcase their work, exchange opinions, bring their expertise and create bonds because of launching projects (India, 2017).

- Creating internship and sabbatical programs: Exchange of human capital between the spaces brings skills, social and cultural knowledge exchange that will benefit communities from both countries. For Swiss students, it is the occasion to live an experience abroad while gaining hands-on practice to complete their academic knowledge (India, 2017).

- Launching a maker competition: This would encourage Swiss and Indian makers to think about how their creativity and innovation could be channelized to solve real technical problems experienced by Indian rural communities. Furthermore, it would allow the unique combination of solutions viewed through two different lenses (India, 2017).

The researcher interned at one of the makerspaces of Bangalore-The Workbench Projects. Along with the internship, other makerspaces were studied in Bangalore to see how differently they worked from the makerspaces in the USA and began to master the impacts of makerspaces in India by studying about them and also visiting a few locally available makerspaces. Four examples of makerspaces locations studied by the author, on site in India followed:

1. **Work Bench Projects**

Location: Bangalore, India

Focus areas: Making, Entrepreneurship, Social entrepreneurship, Biohacking, Corporate Innovation, Maker Fairs.

Workbench Projects is a Bangalore Makerspace, founded in December 2013, which has also been called FabLab, Co-creation space, public laboratory, think tank or

strategy group that enhances the many ways of making. From open source making they explore the entrepreneurial opportunities of the movement, unique cross-disciplinary platform for ideators to transform as well as how to link it with corporate innovation while developing an interest for social entrepreneurship. Workbench Project supports their maker community with a well-equipped makerspace (3D printing, laser cutter, sewing, woodworking, maker shop as well as with their coworking space and café, innovative minds meet and work together. The success of the present makerspace, a new biohacking space is already in planning. Their main vision statement is "To put the power of innovation in every hand." Being a part of a makerspace, users can clearly understand the difference between teaching and facilitating where a teacher takes charge of the learning environment, but the facilitator creates a discussion environment (India, 2017).

Workbench projects proudly associate with organizations that prospered by building something for their community (India, 2017).

Some of the success stories of Workbench projects:

- The Makerspace Partnered with Hyperloop India to develop the prototype of a pod (Figure 2) that was featured in the global design competition at California-United States of America, in 2017 for the super-fast transportation system using magnetic levitation technology. The pod is hypothetically claimed to be two times faster than a plane and immune to all kinds of weather conditions.
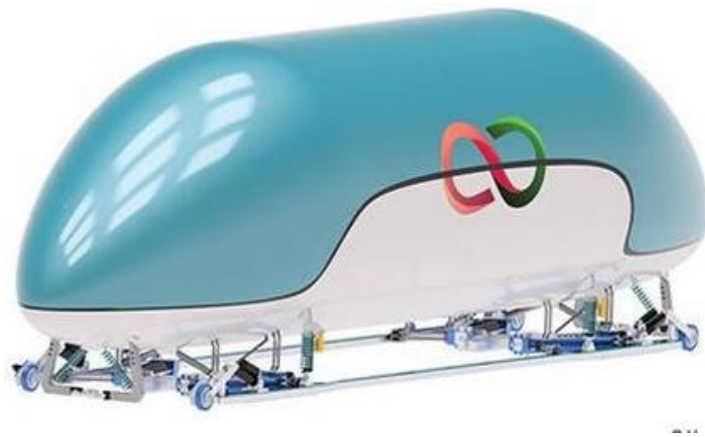
Figure 2. Hyperloop Pod Designed at Workbench Projects

- Rise Legs company making cost-effective, lightweight, elastic, cane-based
  prosthetic leg (Figure 3) designed for amputees to walk/work longer and also run,
  play and dance.
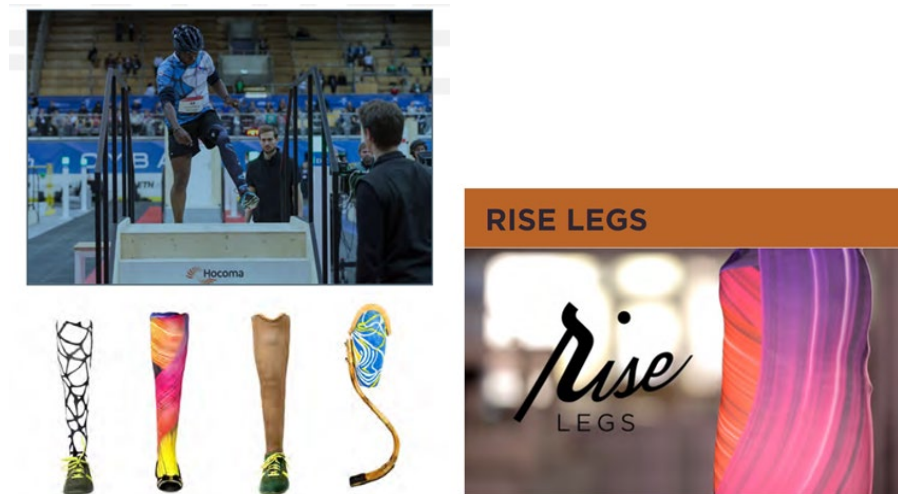
Figure 3. Prosthetic Leg Designed by Rise Legs

- SMTHN is a multipurpose bag (Figure 4) that transforms itself to user's needs. The bag was called as swiss army knife of bags.

Figure 4. SMTHN Bag Designed by Workbench Projects

- Workbench projects started a new movement for the disables where they produce products and services for disabilities, and the lab is called ARTILAB (Figure 5) which stands for assistive and rehabilitation technologies innovation lab.

Figure 5. Award Winning Movement for Workbench Projects through ARTILAB

- A flagship product of 'Muse Inc.' was conceived, tinkered and developed by their team, while at Workbench Projects. Taal is a smart stethoscope (Figure 6) that

provides high-quality diagnostics at an inexpensive price that can be viewed via a

mobile app on your smartphone. The makers of Taal are also a fantastic bunch

working on several such responsible innovations.

Figure 6. Taal-Smart Stethoscope

- The makerspace also collaborated and spent several months with a young maker

  and a braille reader, Paul D'souza. He was a budding maker selected to showcase

  at workbench project's Mini Maker Faire in 2015 which was India's first Mini

  Maker Faire. His product inspired the sponsors Sapient Nitro to finance fine

  tuning and refining his product (Figure 7) at the makerspace for the blind.

Figure 7. Paul D Souza's Braille Reader for the Blind

The researcher studied Workbench Projects Makerspace, through a two months Internship. Details regarding the spatial arrangements (Figure 10 and 11), lighting, ventilation, funding, movement pattern (Figure 8), and furniture (Figure 10) were studied. Proposal and renderings for a Bangalore public library were presented studio projects in Spring and Fall 2018.

Figure 8. The Café and Informal Meeting Space at Workbench Projects.

Figure 9. The Extension of Workbench Projects into a Small Woodshop

The architectural design of Fab Lab: The Workbench Projects Makerspace is one of a kind in the country, which was constructed under Bangalore metro station. The space is very wisely thought out, using of every square foot, with a minimal extension of the space, for the heavy machines in the area Figure 9. The Bangalore metro station also has 24 hours electricity, which helped all the users of the makerspace save on current and energy. Space also has a very well divided noise area and tech area. The café acted as the buffer between these two spaces and also becomes an informal meeting space. The researcher's education in Architecture and Interior Architecture proved invaluable in the careful observation and analysis of the Workbench Projects Makerspace.

Figure 10. The Main Workspace with Formal and Informal Meetings of Workbench Projects

Figure 11. The Co-working Space at Work Bench Projects Bangalore

So far Workbench projects have become a channel to connect corporates,

governments, startups, community, and individuals from the lens of responsible

innovation. Workbench Project is an excellent example of the positive contributions of

makerspaces to individuals and communities.

Internship Outcomes at Workbench Projects

- Conducting events for a better understanding of makerspaces.

- Making: The researcher explored what being a maker at a makerspace would be. Being a maker, as well as observing what clients outside the makerspace need., learning everything through conceptualizing, designing and building products in a workshop with power tools, design sketches and shared technologies.

- Fabricated products by learning new software in 3D fab lab space: By learning new software's, the researcher understood what the software requirements for each tool are and how it can vary with machines and different kind of teaching.

- An innovative project for the external client

- Represent the company at public events

- Learnt skills, operation, and scope of makerspaces.

- Meeting and talking to new people regarding a makerspace.

- Visiting different makerspaces and libraries analyzing the space:

- Exploring the designs of other New Fablabs (Figure 12)
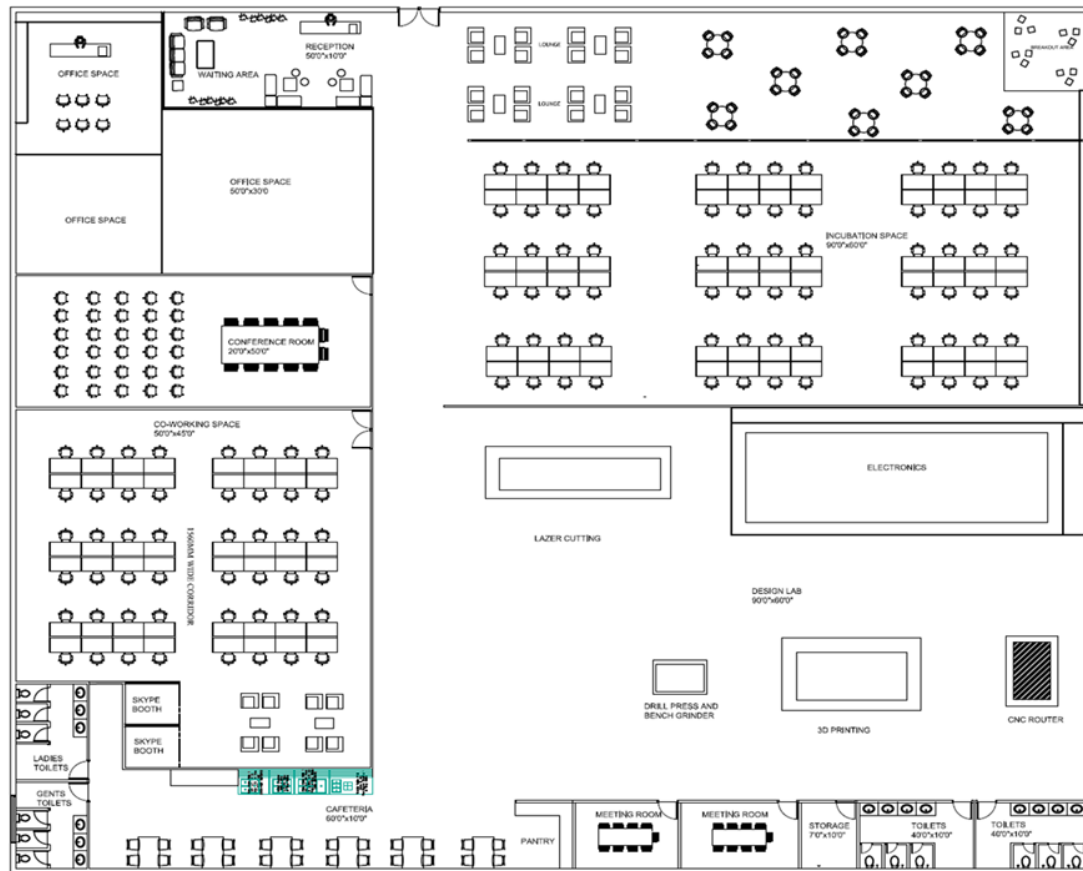
Figure 12. New Fablab Layout Designed by the Researcher at Workbench Projects-Bangalore

2.   The-Think Workshop

Location: Bangalore, India,

The researcher studied the location on site.

Focus areas: Making, Education, Design & Architecture.

The-Think Workshop (Think Happy Everyday - Workshop) was created by a group of architects who wanted to allow professionals and students to develop practical skills in design, architecture, and engineering. Collaborating with institutions from India and around the world, they propose various workshops integrating a variety of

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competences applied to a given problem. They also support their members to lead their projects in their makerspace and collaborate with professionals, designers, and artists attracted by the offering equipment, facilities, and expertise.

Beside their trained staff, The Think Workshop employs interns who have the opportunity to learn while bringing their valuable skills to the various projects. The workshop conducted a three days project: "Service Design with CIID" - In this intensive 3-day workshop, participants learned and applied advanced service design and experience prototyping techniques both in the digital and physical realm. Participants gained complete toolkit for rapid user-focused innovation and a certificate from CIID (Copenhagen Institute of Interaction Design).

Outcome

The Think Workshop played an important part in the thesis through two factors:

- Figure 13 shows how the Participants of the Think Makerspace built their own furniture which were height adjustable and could be moved around to make it a more flexible space.

- The space was an existing garage (Figure 14) for moldings which was converted into a makerspace, hence it helped analyze adaptive reuse of a space.

Figure 13. Creative Space at Think Happy Makerspace with Flexible Furniture
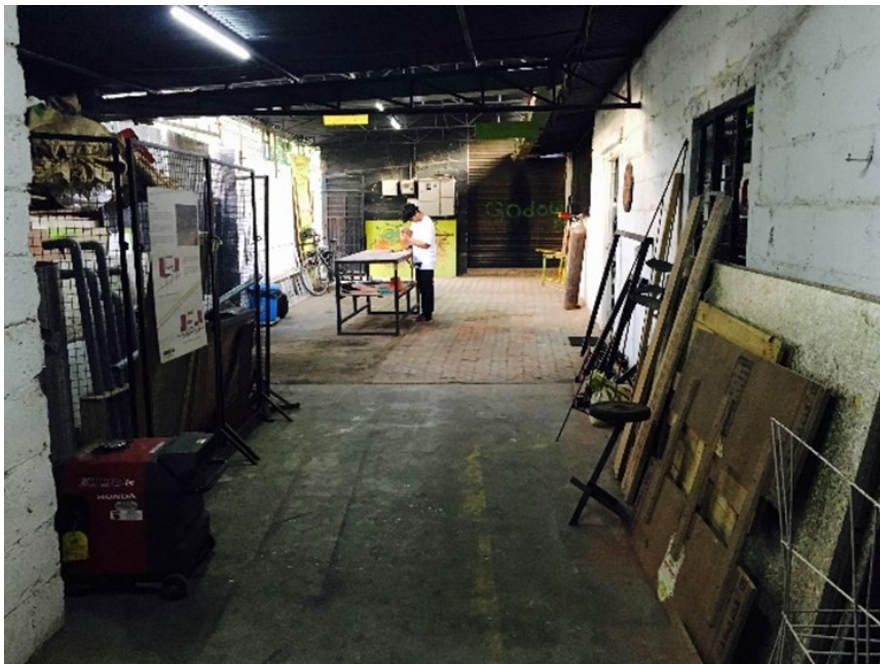
Figure 14. The Outer Space Where All the Workshops and Events Take Place for Think Happy Makerspace

3.   IKP-EDEN

Location: Bangalore, India

The researcher studied the location on site.

Focus areas: Making, Entrepreneurship

IKP-EDEN is the largest hardware-oriented (figure 16) startup incubator of India. Its founders believe in the development of businesses from successful ideas through making and coworking. Funded by governmental grants from India and the USA, it has the potential of turning its startups into bigger companies. They are currently hosting 23 (Figure 15) startups and following three projects at the pre-incorporation stage. IKP-EDEN provides member startups with private space, a fully equipped makerspace with mentors as well as a co-working space. Their activities will soon expand to life sciences with the opening of a new biological lab (Eden, 2015).

Outcome

IKP-EDEN has a significant concept of coworking space which gives the bare essentials needed for just getting things done. With an air conditioning supply, a dedicated table space, a comfortable chair, and 15 other busy people around, makes it perfect to get in the zone and just wire in. The researcher learned that incorporating a coworking space along with a makerspace is a great source to raise funds and also collaborate with many groups (Eden, 2015).

Figure 15. Co-working Space at IKP EDEN

Figure 16. The Creative Space at IKP EDEN

4.   Project-DEFY

Location: Bangalore (based) - Bangalore, Mangalore, Uganda (Makerspaces)

The researcher studied the location on site.

Focus areas: Social entrepreneurship, Sustainable Development.

India's education system provides the country with 1.5 million well-trained graduate students every year. However, a lot of people do not enjoy the access to quality education, especially in poorer and rural areas where children drop out of school at a young age. Project-DEFY aims at filling the gap by empowering rural communities and putting education in their own hands. They build makerspaces run by and for local people where they implement the concept of Nooks. Nooks are local classes, in which community members choose projects they want to achieve. The Project-DEFY organizers teach them the basics of computers, electronics, and building but the community becomes quickly self-sufficient, learning new skills through peers, external people or directly from the internet. Such sustainable spaces have already been launched in Bangalore and Mangalore in India and a refugee camp in Uganda in Africa (India, 2017).

Projects

Makerspaces and nooks launched in rural villages close to Mangalore and Bangalore and also internationally, in a refugee camp in Uganda. A second space is being launched in the outskirts of Bangalore.

Data Analysis of Community Makerspaces

The six makerspaces visit, contributed strong factors for the study. Things like space planning, administration support, challenges and key factors, patron usage,

materials, and everything could be analyzed on site. The six makerspaces had similar contents and faced quite a few similar problems.

The analysis is a report on critical factors participants expressly volunteered as instrumental for their makerspace's success and challenges. The analysis summarizes, (Vision, Develop the space around the need, Staff, Trust autonomy and within the Community) as characteristically expressed by participants from The Forge in Greensboro, NC and the five examples of Indian community makerspaces. Each interview spoke about approach, manifestation, and execution of the spaces. The interviews conducted were unstructured to provoke responses that were unclouded by the interviewer's preconceived notions of what successful makerspaces look and participants volunteered the information they found most relevant in their case.

Vision

The makerspaces start with a guiding vision to accomplish specific goals, keep the space accountable for unique creations and to stay on track. Whether tinkering or teaching, learning or making, and access to the tools all the makerspaces credit their success to an articulated mission. Leaders who envisaged and shared their thoughts on the purpose of their makerspaces made clear that such vision helped them to meet the goal and contribute something concrete to the workings of any area.

The goals also helped them bring in funds to develop the space. It is easier for the message to resonate outside everyone's contacts apart from funds when the area has a clear and developing mission. Potential users are attracted when they know that new technology exists and why.

Develop the Space around the Need

Determining the needs of the users became the main criteria for all the community makerspaces as they make plans and purchase. Conducting a needs assessment was spoken about as one of the essential continual processes from conception to execution of the makerspace. Anupama Gowda from Workbench Project says, "Before starting the whole process of a makerspace, the big question we all had was "what kind of equipment we needed to get? Do these tools give the space to fill the need?" was our big question and I think the question gave us a more valuable starting point." Every need of the user was carefully determined as budget constraints were one of the primary motivations for all the makerspaces and attaining funds was a common challenge.

The goal of every makerspace is to create the best opportunities for users, to reflect trends in technology use by determining and evaluating what users need the most. Studying the needs of the equipment, became the first step and then came the programming, organizing the programs allowed for the continuum of growth of the space to be more natural and driven directly by usage of the equipment and the user need. makerspaces also start small which empowers them to invest in the tools that the users are most interested in and not burden themselves from making unessential purchases.

Staff

The most common problems that makerspaces face are the staffing model or the consistency of the staff. How can a makerspace be successful when the staff has to run the space and also take care of all the responsibilities? is a persistent question. Staff in makerspaces are trying to work in a relatively new and niche aspect keeping in mind the

high user demand with little additional support. Organizations are trying to bring

sustainable staffing models to alleviate problems as much as possible.

The Think Makerspace in Bangalore hire's students to reduce the workload. The

method enables student staff who are genuinely interested to volunteer in makerspace

work, to become more beneficial in learning and getting more involved in the making.

The process of hiring students allows the makerspace to further the aims of their space

without the fulltime staff to take the entire load upon them. Students also act as

ambassadors between the organization and the community. The ideal situation works

when the students themselves see a valuable learning experience than students who do

not have any interest in makerspaces.

The student working plan at Think Happy Makerspace comes only after having an

all-time dedicated staff which meant for persistence, goal, and accountability, enhancing

the space's potential. So, The Think Happy Makerspace model became the best solution

when makerspaces thought about how they could avoid staff exhaustion and enhance

staff to work within their limits.

Trust Autonomy

A new trend in makerspaces is that of how different users are treated in this kind

of space apart from regular workspaces which can be seen as one of the formulas of

success. When users were given their freedom to explore the tools, it encouraged them to

experiment and learn in many different ways. The freedom not only inspired the

individuals but brought more people to the concept of makerspaces. Shankar from IKP

EDEN Fablab in Bangalore states that "when a student innovatively works on something

new and completes his project, it is more than him, his friends get excited to see how he could explore with new things or experiment with his project." Also, the freedom of granting the users to use the space like how they needed in flexible ways, developed a sense of ownership within the users of the community.

Within the Community

Making connections with the community is a topic that's spoken about in all 5 of the community Makerspace. It can either be in the immediate surroundings of the city or ways of partnerships with different groups. Nevertheless, it is the enthusiastic users that bring about a makerspace success. Project DEFY in Bangalore states that encouraging more student-led groups brought explicit success to their makerspace which created immediate user base leveraging into higher chances of programming and equipment.

As an idea from student-led groups, Project-DEFY believes that bringing the makerspaces into academic libraries will help the community and the future of the country grow better. Networking with other makerspaces both nationally and also internationally improves the makerspaces development individually and socially.

Step 2 - Library Makerspaces

After studying community makerspaces, the researcher looks into what library makerspaces are. As the Maker Movement flourished, public libraries have embraced the opportunity to create makerspaces. Library makerspaces offer programs that inspire and empower people with programs serving youth and adults alike to make, create and learn new skills where participants of different ages can work together. The spaces often give access to tools, technology and social connections that may not be easily accessible

otherwise. Makerspaces in libraries need changes in existing areas rather than additionally adding to the construction of new rooms and build a whole new space gradually. Two Library makerspaces 1) North Carolina state university Library Makerspace and 2) Chicago Public Library Makerspace were studied and experienced on site by the researcher.

North Carolina State University Libraries

The researcher studied and experienced the location on-site.

Figure 17. Library Fellow Lauren Di Monte Orients Students to Some of the Technologies Available in the Makerspace. (Rea, 2016)

The D.H. Hill Makerspace, which opened in June 2015, offers an open, do it yourself learning environment (Figure 17) where all NC State students, faculty, and staff are encouraged to experiment and learn new technology skills. Unfortunately, this is not open to the public. Easy-access to tools and skills attracts students to the creative experimentation and cross-collaboration from the very moment it opened on the first floor of the library.

The Hill Makerspace tried to lower the barriers to access as much as possible in terms of cost, software availability, and ease of use and learning," Access alone is not the activation point, but the makerspace here provides the invaluable expertise in disciplinary research, industry and market research, patent searching and filing, digital product development, data management, and curriculum development, establishing a collaborative spirit in the busy 900-square-foot space.

"Fyfe's", a professor's group used a Raspberry Pi to incorporate a motion-sensitive camera into a book that surveils its reader, sparking class discussions about data collection and privacy issues in contemporary media. Another group designed and laser-cut a social media board game called "Monopopular," which treats "likes" and friends as currency in an informational economy, and for which a player 3D prints individualized game pieces using a selfie or other icons or avatars.

Victoria Rind exemplifies the strong knack that makers have for crossing the humanities and sciences. A junior studying Textile Engineering, Rind has gone from messing around with wearable technology to an accelerated career path in a matter of

months. But she is matter-of-fact about it—e-textiles are precisely what she came to NC State to do.

Image courtesy of Victoria Rind

Figure 18. Pulse Dress Created by Jazsalyn McNeil. (SpringshareBlog, 2016)

There were also student teams who worked to better their campus through the library makerspace. 42 students in 11 groups researched, designed and prototyped solutions to improve sustainability in one of the areas of energy, water or waste. Teams used real campus information provided by the sustainability office, and tools and expertise offered by the NCSU libraries Makerspace program.

Jazsalyn McNeil, a student from the college of textiles, used her design skills and a flair for fashion to explain ideas like biometric sensing and nanomaterials to a general audience. McNeil created the pulse dress (Figure 18) which incorporates LED's that blink with the wearer's heartbeat. Pulse was developed through NC State's Nano-Extended Textiles Research (NEXT) group, a team of researchers focused on developing new

processes and products for wearable electronics. McNeil had her training in art and textile and fashion design and was very clear on what she was doing but was not clear on electrical engineering. So she took support from the makerspace at the D.H.Hill library to learn how to work with electronics.

In June 2016, the NCSU Libraries' Makerspace program won Special Libraries Association's Spring Share Innovation in Libraries Award. In addition to the incredible work with 3D technology, wearable electronics, programming with Arduino & Raspberry Pi, and milling with CNC machines, the makerspace is also recognized for their unique work targeting women in STEM fields with their on-going speaker series, and by integrating their makerspace program into the curriculum of disciplines that aren't generally associated with technology (SpringshareBlog, 2016).

Chicago Public Library

"The researcher" studied and experienced the location on-site.

In 2009, the Chicago Public Library (CPL) launched a unique collaborative learning center known as YOUmedia, the first dedicated space at the CPL for high school teens to learn digital media skills. YOUmedia consists of 5,500 square feet of space in the Harold Washington Library Center, the CPL's central library in downtown Chicago. The design of the YOUmedia space is based on a three-year ethnographic study of youth participation in the new media ecology, which concluded that young people are living and learning with digital media in three ways: "hanging out" with friends in social spaces, "messing around" with digital media, and "geeking out" to explore interests (Zupon, 2013). YOUmedia provides a drop-in, out-of-school learning environment to

teens. Based on teen interest, programs such as book discussions, low-tech Maker crafts, and recycled crafts were also created. All the programs in YOUmedia aim to inspire young people to create rather than consume. Every teen who uses the YOUmedia space is encouraged to learn based on self-interest and collaboration (Zupon, 2013).

YOUmedia started as a learning space equipped with computers and digital media software. In the summer of 2013, the CPL used the IMLS grant they received to create a Maker lab, an addition to YOUmedia, which has made the CPL a library leader in digital learning and collaborative creativity (Zupon, 2013). Later the CPL's Maker lab was created in partnership with the Museum of Science and Industry. It allows the general public to access cutting-edge technologies such as three 3D printers, two laser cutters, one milling machine, one vinyl cutter, and design software on a fleet of computers. Free workshops and drop-in demonstrations related to these technologies and tools are offered to the public (Chicago Public Library, 2014).

For the overwhelmingly positive feedback that the makerspace got from the attendees, that was an initial project of only six months, Chicago Public Library Extended this successful initiative for one more year of hands-on experience. Seeing its success, Google also offered new machines of technology to train people for basic skills. More and more organizations have donated after seeing the successful growing usage of the Makerspace in the Chicago Public Library. The Library also runs programs to encourage women into the traditionally male-dominated technology field. The makerspace has now become an integral part of the Library enabling the City of Chicago to become a significant hub of advanced manufacturing over the next few decades (Rutkin, 2014).

Recently, CPL's Maker lab established a connection between library users and the City Colleges of Chicago, which offers degrees in advanced manufacturing. College recruiters have offered several information sessions at the maker lab. This initiative provides an excellent opportunity for the library visitors who are interested in taking the skills they have learned from the maker lab programs a step further (Inklebarger, 2014).

Figure 19. Success Stories of Chicago Public Library. (Chicago Public Library, 2014)

Chicago public library surveyed in its first six months of operation from June 2013 through December 2013 and share their learning for the other libraries thinking of growing big with the new concept of makerspaces. The goal of the research was to get insights into what attendees are learning inside the Maker Lab. With the help of board members, the library defined three underlying research areas to explore through the Maker Lab project (Chicago Public Library, 2014).

A summary of Chicago Public Library 2013 survey follows.

How Useful is Makerspace in Helping Library Patrons' Guild 21st Century Skills?

      A total of 1063 participant surveys were collected from 4385 attendees. The Library received high-level satisfaction consistently from the respondents when they were asked to rate their satisfaction with the aspects of the Maker Lab. 95% visitors wanted to recommend the Lab to their friends and family (Figure 19).

- Session Content (Workshops) — 93% satisfied or very satisfied

- Instructor Knowledge and Quality (Workshops) — 94% satisfied or very satisfied

- Session Length (Workshops) — 89% satisfied or very satisfied

- Library Staff Knowledge and Quality (Open Shop) 97% satisfied or very satisfied

      One of the male participants of age 26-35, from the survey, stated that "It was fascinating to find out the resources that are being made available through this class. The resources were a great opportunity to get some of the basics down". People in the community are willing to welcome something new. This was proved because 70% of the participants who took the survey said that they visited the Maker Lab out of curiosity or to try something new (Chicago Public Library, 2014).

Challenges Faced by CPL

      Chicago public Library Maker lab stated that staffing had been their biggest challenge so far and the expenses for programming. The Maker Lab required a full-time manager who managed all the activities, took care of the safety, and willingness to explore new things. They came up with shift-based solutions for operations to ensure that the staff was always sharp with all the notifications (Chicago Public Library, 2014).

Learning Outcomes of the Survey

Majority of the participants reported that they gained knowledge from Digital Literacy. Through the results, Chicago Public Library discovered that they could enhance on the following outcomes.

- Build Digital, Information, and Cultural Literacy

- Advance Critical Thinking and Problem Solving

- Advance Creativity and Innovation

- Foster Communication and Collaboration

Chicago Public Library Maker Lab brought a completely different and positive scenario to how people see libraries and how they are better served by library services, through a successful experiment. The survey assessment also shows that visitors are very interested in the exposure of the new technological era (Chicago Public Library, 2014).

After visiting two Public Library Makerspaces, studying and experiencing the locations on-site, the research analyzes different survey reports and assessments of 4 other Public Library Makerspaces, Fayetteville Free Library, West Port Public Library, Ottawa Public Library and Toronto Public Library.

Fayetteville Free Library

The Fayetteville Free Library (FFL)in Fayetteville, New York was the first to start the Modern Library Makerspace, which was the first of its kind in North America in 2011. Lauren Smedley, a graduate student from Syracuse University, proposed to create a Makerspace in public library when she was working on a graduate school project paper. The Fayetteville Free Library, interested in Ms. Smedley's Makerspace idea, hired her to

realize her dream at FFL. The new Makerspace facility was called "Fab Lab," short for "Fabulous Laboratory" (McCue, 2011).

The Fab Lab focuses on fabrication tools and related resources and programs; where in community members can come together to learn and use technologies and tools such as 3D printing, 3D scanning, laser cutting, vinyl cutting, sewing, crafting, hand tools, and electronics to make tangible objects. Besides the 2,500 square foot Fab Lab, the FFL has two additional makerspaces, the Creation Lab and Little Makers. Both facilities are approximately 250 square feet.

The Creation Lab is a digital media lab focused on digital creation, which includes a wide range of digital media hardware and software such as video cameras, podcasting equipment, a green screen wall, and computers geared for media creation. The Little Makers is a play zone outfitted with toys, tools, and supplies including a DIY gallery wall and an "invention box" for children to learn, create and build. A series of hands-on making and learning opportunities are offered through the FFL's Maker programs, including family craft night, home repair, knitting, microcomputers and controllers, painting, robotics, sewing, quilting, 3D design, and 3D printing.

Before using the 3D printers, vinyl cutter or laser cutter independently, library users have to be certified by the library. They can book a 45-minute one-on-one certification appointment to receive basic safety and operational training. Makerspace usage is free at the FFL, but small fees are required for using specific materials. There are also various maker clubs organized by the FFL for community members to meet and socialize, including the Adult Robotics Club (Fayetteville Free Library, 2014).

Susan Considine, the FFL's Executive Director, sees the creation of makerspaces as encouraging a culture of innovation and responding to the changing needs of its community (Doran, 2012). The FFL has introduced new opportunities for its population to learn, create and develop new ideas. Syracuse University's School of Information Studies professor David Lankes praised the FFL for setting an excellent example of what libraries can and should do in today's world (Doran, 2012). He also stated that libraries are increasingly becoming places of creation rather than places of consumption, and as such, they are helping the community get smarter (Moorefield-Lang, 2015).

Westport Public Library

Enis (2012) describes how, the Westport Public Library (WPL) in Connecticut launched its makerspace and had served as a model for many other public libraries. One of the goals of the WPL's makerspace is to nurture the entrepreneurial spirit within the community. WPL's director Maxine Bleiweis wanted to see the new space become a place where people from the community could invent. She believes learning should be at every stage of a person's life and that the makerspace is a great venue to support the library's lifelong learning mission (Enis, 2012). The WPL allows its makerspace to evolve naturally. Instead of deciding by itself, the library seeks community feedback to figure out the next steps for its makerspace and works with the community to implement changes. The WPL demonstrates an exciting model; the library provides the makerspace framework but is not in charge of its future direction, and community members form its heart. The WPL hosted Connecticut's first Mini Maker Faire in April 2012. Nearly 2,200 people attended the event. It was the community that proposed the Mini Maker Faire

idea. The creation of the WPL's makerspace was in response to the community's keen interest in the Maker Movement (Enis, 2012).

The WPL's makerspace has a unique structure, a large and open metal structure designed to look like the early airplane hangar where the Wright brothers built their plane. The concept of flight is used as a metaphor for imagination in the makerspace. This area of the library provides cutting edge equipment such as 3D printers and hosts various presentations and participatory workshops including topics such as robotics, arts, crafts, and intellectual property rights for inventors. The WPL is considering purchasing a programmable robot (Nao) for community members to learn coding, such as Python, to program the robot's behavior, voice, and movements (Enis, 2012).

Community members can also schedule an appointment with a 3D printer coach. The majority of these coaches are volunteers from the community. In the WPL's makerspace, people of all ages are interacting and working together. In September 2013, a significant grant from the Institute of Museum and Library Services (IMLS) was awarded to the WPL to enhance its makerspace and provide hands-on and innovative learning experiences. As a result, the Maker-in-Residence program was established. Community members can work with the Maker-in-Residence and participate in projects such as digital quilt making, book-making, and creating Makey-Makey musical instruments (Westport Public Library, 2014).

The WPL staff believes that they not only have the responsibility to improve the literacy levels of the community but also to help community members develop new skills and knowledge to prepare for future jobs and new business opportunities. They believe

entrepreneurship will be the key to America's economic prosperity in the 21st century (Westport Public Library, 2014).

Ottawa Public Library

Since 2013, Canadian libraries have started following the Maker Movement and creating their Makerspaces. As in the U.S., most library Makerspaces in Canada are housed in public libraries (Hendry, 2014). The Ottawa Public Library (OPL) collaborated with the U.S. Embassy in Ottawa to open the first Canadian public Makerspace in early 2014. The Makerspace is called the Imagine Space, sponsored by the American Corners Program as a one-year pilot project. The goal of the Imagine Space is to provide public access to new technologies and tools, enhance hands-on learning experiences, and create a collaborative environment for exchanging ideas and sparking innovation.

The U.S. Embassy contributed $58,000 to purchase equipment, space preparation, and programming and the OPL provided the space and staff to manage the activities of the Makerspace. The Imagine Space features a 3D printer, a laser cutter, a digital modeler, green screen, video, and audio editing software, hand tools and electronics, and a wall-to-wall whiteboard. The equipment is bookable by OPL users. 3D printing and laser cutter certification classes, along with other maker events, are also offered to the community. Digital literacy, innovation, and entrepreneurship are the essential elements that brought both the U.S. Embassy and OPL together to create the Imagine Space (Hendry, 2014).

Toronto Public Library

The Toronto Reference Library which is a branch of Toronto Public Library (TPL) opened a new digital media lab known as Digital Innovation Hub in February 2014, built in Toronto Downtown. The library Surveyed the users of the library and its community members and received immense support from different organizations and a fund of $44,000 to create the Hub. The Library also consulted the first Library Makerspace in North America which was the Fayetteville Free Public Library Makerspace. The Hub was designed to enhance collaborative learning within a community, and it attracted a lot of media attention. The Digital Innovation Hub was monitoring five trends in the Lab (Open Shelf, 2016).

- The intrigue of Virtual reality
- Experiencing Augmented reality
- Artificial Intelligence
- Service through Pop-Up Learning Labs
- Community partnerships and looking into community needs (Open Shelf, 2016).

Currently, the Digital Hub has one librarian and three design technicians who provide excellent support and service to the Hub. The Hub offers access to new technologies like 3D printers and scanners, Raspberry Pi computers, Arduino kits, Makey Makey kits, digital design workstations, high definition video cameras, and audio mixers. The Digital Hub has partnered with local makerspaces and innovators, and together they perform a variety of workshops ranging from 3D design to programming (TPL, 2017).

These partnerships have helped the Hub host regular meetups, speaker events, and Innovators in Residence programs on topics such as robotics, wearable computing, and art. With growing interest from the public, the Hub has become more and more appealing, even to visitors who rarely used or visited the TPL (TPL, 2017). To meet the emerging needs of high schools, the TPL has developed a School Visits Program to help build digital literacy among students. Another Metcalf Foundation $50,000 grant was received to strengthen the Hub's programming and expand its outreach to include youth in underemployed areas of the city (Gaitskell, 2014).

Toronto Public Library has developed a five-year trend plan (2012-2016) to see how the library will change with the new upcoming trend. According to the new trend, the programs offered and attendance for the programs have increased by 37.4% and 18.6% respectively. Whereas in North American Libraries, which serves a population of more than 2 million, there was an average increase of 67.1% in programs offered and 37.4% average increase in Program attendance. The areas in which growth was noticed also included school programs regarding culture and technology. Few factors that influenced the growth was an increase of pop-up learning labs and digital Innovation Hub (Open Shelf, 2016).

As the previous TPL City Librarian Jane Pyper stated, the Digital Innovation Hub is a space that inspires collaboration and creativity; it has broadened public access to emerging technologies and will create immense opportunities for Torontonians to gain digital skills needed to be successful in today's digital world (Price, 2014). This success of the Digital Hub has led the opening of many small Hubs in Toronto.

According to the 2017 survey report of Toronto Public Library, the library not only has an Innovation Hub (Figure 20) but is also progressing in different ways.

Figure 20. Customers Getting Free Access to High-end Tech Such as 3D Printers, Apple Computers, Video and Audio Equipment, and Professional-level Design and Editing Software at Toronto Public Library – Digital Innovation Lab (TPL, 2017)

Some of the achievements of the year 2017 in different areas have been:

Progressing in Digital Platforms

- Toronto public library accounts were renewed into new mobile-friendly customer accounts.

- Integrated Augmented reality elements into the gallery exhibits.

- Global online access and customer friendly accounts to search forms (TPL, 2017).

Breaking Down Barriers to Access, Driving Membership

- Freedom to speak for the libraries to connect with relevant library services.

- Increased hours on the weekends.

- Promoting library resources and helping the unemployed in finding jobs.

- Access for the members through passes to different performing arts.

- Summer programs for children (TPL, 2017).

Access to Technology and its Training

- Availability of major software.

- Doubling the pop-up learning centers which also increased the activities to 1,400 reaching 17,000 people.

- Toronto public library also launched three additional digital innovation hubs in 2017 delivering 500 programs and 6,600 participants.

- Technology assessment within the community libraries and its outcomes in Ontario (TPL, 2017).

Engaging the Community through Cultural Experiences

- Concluded another successful year in the Bram and Bluma Appel Salon at the Toronto Reference library which is a literary and cultural programming space with guests including high-profile artists.

- Developing culturally relevant programs and indigenous relationship with the communities, which includes reader's services conference for staff and indigenous initiatives.

- Intellectually disabled people were also encouraged with recreational programs developed specially for them (TPL, 2017).

Library Transformation for Service Excellence of the 21st Century

- Collaborated with Open Data Institute Toronto.

- Therapy programs for users who suffer from Seasonal Affective Disorder (SAD)

- Won a Toronto Urban Design award in the category of public buildings (TPL, 2017).

The Justification for a Public Library Makerspace

A compelling reason can be built for casting a makerspace into a public library. The following list of reasons could be helpful for all librarians to assemble their justifications.

- The Library serves the community with learning and collaboration with making activities.

- The libraries best tool to provide access to services, materials, and skills that attendees may not be able to obtain on their own is a makerspace.

- The library also has the prospects for funding a makerspace.

- The libraries have always supported the idea of makerspace.

- The library also can collaborate with many other partners of a larger community or even with academia. Not only the external collaboration but users can also collaborate with their peers and with more experienced tinkerers to design work together, learning teamwork, participation skills which Benefit from the inputs given by others.

- Participants can create a prototype of their models/designs and then rapidly test, alter, and enhance their products using the tools in the makerspace. Prototyping is seen as a significant advantage for manufacturing in various fields such as industrial, biotechnology and medical.

- Library users can experience an open design and sharing environment which creates a path to exchange ideas and information in this kind of a creative space.

Step 3- Greensboro Public Library Survey and Empirical Testing

"The researcher" visited the Greensboro public library, got a great opportunity to be a part of the library proposal of a makerspace, and the researcher takes, immense pleasure in designing a makerspace for the Greensboro Public Library. The design of the Greensboro Public Library was explored in the Studio project in Spring and Fall 2018 along with another makerspace design for an Indian Library

The survey at Greensboro Public Library was studied to understand if people who visit libraries ask for something more than books? What is the user requirement, when it comes to a new proposal of a makerspace for the public library? The results were very positive, and people are overwhelming about welcoming a new space like a makerspace into the public library.

Why Greensboro Public Library?

The researcher examined the surroundings of Greensboro Public Library and its Local Makerspaces which include the UNCG SELF-design studio and The Forge. The SELF provides maker materials that replicate a K12 school makerspace. It includes a laser cutter, 3d printing, robotics, circuitry, and a circuit letter cutter machine. It also has an abundance of small and large craft tools, such as a sewing machine. The learning space handles up to 20 laptops, and each learning space has a dedicated power supply. The forge has video editing software, heavy metal tools, and wood tools along with some programming. UNCG SELF- design studio is available to the UNCG community, while the Forge is membership-driven.

North Carolina Agriculture and Technology (NCAT) University is in the beginning stages of investigating an innovation hub that is aimed at disadvantaged communities; it is unclear whether membership will be restricted in any way. As a result, the innovation hub at the Greensboro Public Library would provide access to maker tools to community members currently with limited access.

Further afield, both public and academic library innovation hubs and makerspaces function as an essential part of the local entrepreneurial ecosystem.

Who is the Target Audience?

- Target audiences have implications for the future branding of the makerspace, how and whom to aim direct advertising and is seeking partners.

- Entrepreneurs, in particular, will benefit from 3D printed prototypes (testing manufacturing) and film production for commercials (which could later run on TV, Facebook, YouTube, etc.).

- Students at every level will be exposed to a variety of technologies, many of which will likely prove vital to our economy.

- Job preparation for many homeless/unemployed and for career changes is a particular benefit, developing skills, resume building, etc.

- Lifelong learners, enthusiasts, creators and all those not elsewhere classified will benefit in an innumerable way

Site Visit

The Greensboro public library has a record of 278,632 library cards, 1,763,155 materials circulated and 269,069 door count (central) per year. The Greensboro Public Library surveyed Lebaure Park. The questions asked at the study are:

Greensboro Public Library Makerspace Survey

Think • Create • Share

1. What is your age?
   a. 0-18
   b. 19-24
   c. 25-35
   d. 36-45
   e. 46-55
   f. 55+

2. How often do you use the library?
   a. Never
   b. 1-6 times a year
   c. More than 6 times/year

3. Would you be interested in using/learning any of the following:
   a. 3d printers
   b. Photo and video editing software
   c. Sewing machines
   d. Digital music editing
   e. High quality scanning technology
   f. Robotics
   g. Electronics and circuitry
   h. Crafting
   i. Animation software
   j. Coding or programming basics and/or meetups

4. Do you consider yourself a maker? Y/N
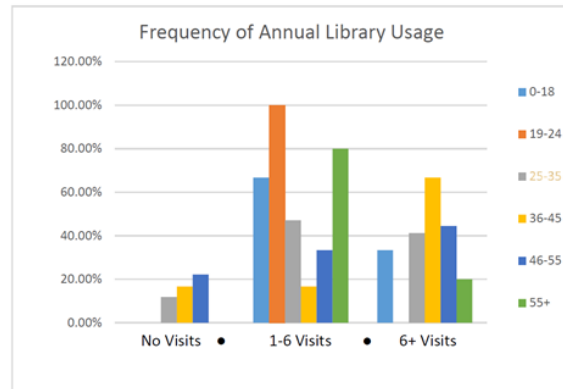
Greensboro Public Library

May 15 – 20, 2017

Figure 21. Survey Questionnaire at Lebaure Park Greensboro

Data were taken from surveys in Lebauer Park: May 15-19, 2017

79

Table 2. Library Usage at Greensboro Public Library

Makerspace Survey													
Library Usage													
Age Groups	0-18		19-24		25-35		36-45		46-55		55+		Totals	
	Num	% of Group	Num	% of Group	Num	% of Group	Num	% of Group	Num	% of Group	Num	% of Group	Num	% of Total
Totals	3	7.14%	2	4.76%	17	40.48%	6	14.29%	9	21.43%	5	11.90%	42	100.00%
Yearly Library Usage													
Never	0	0.00%	0	0.00%	2	11.76%	1	16.67%	2	22.22%	0	0.00%	5	11.90%
1-6 Times	2	66.67%	2	100.00%	8	47.06%	1	16.67%	3	33.33%	4	80.00%	20	47.62%
6+	1	33.33%	0	0.00%	7	41.18%	4	66.67%	4	44.44%	1	20.00%	17	40.48%
													42	100.00%
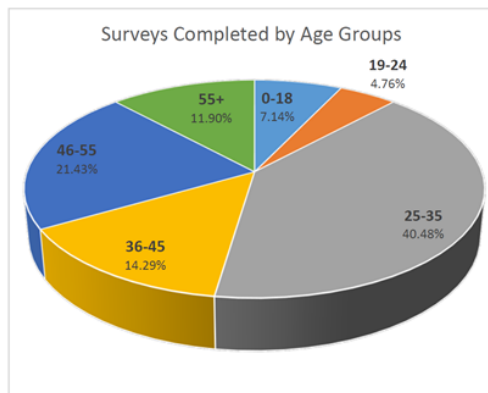
Data received from surveys in Lebauer Park: May 15-19, 2017

Table 3. Equipment Usage at Greensboro Public Library

Makerspace Survey								
Equipment Usage								
AGES	0-18	19-24	25-35	36-45	46-55	55+	TOTAL SURVEYS	
Total Completed	3	2	17	6	9	5	42	100.00%
EQUIPMENT								
3D Printers	2	2	10	3	5	3	25	59.52%
Photo/Video Editing	2	2	10	1	5	2	22	52.38%
Sewing Machines	1	1	10	3	1	2	18	42.86%
Digital Music Editing	2	1	10	2	5	2	22	52.38%
High Quality Scanning	1	2	6	1	2	1	13	30.95%
Robotics	2	1	7	2	2	2	16	38.10%
Electronics/Circuitry	2	1	5	3	1	3	15	35.71%
Crafting	2	2	13	5	1	1	24	57.14%
Animation Software	2	1	5	3	5	2	18	42.86%
Coding/Programming	2	1	8	1	4	0	16	38.10%
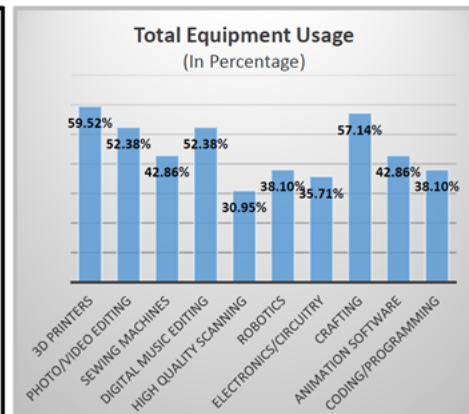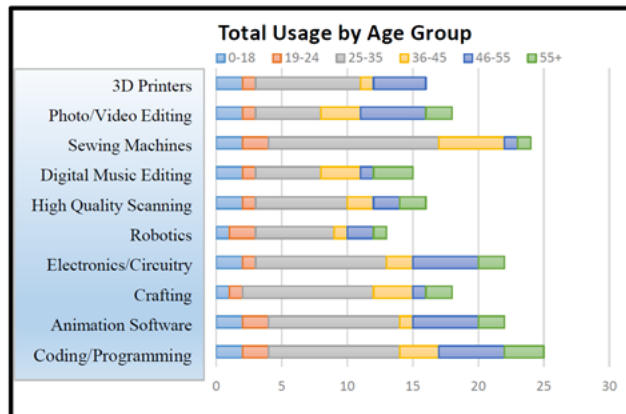
Data were taken from surveys in Lebauer Park: May 15-19, 2017

Survey Analysis

Visitors survey in Lebaure Park, Greensboro shows that respondents are interested in trying all the new equipment. Participants communicated a strong desire to learn more through a variety of means irrespective of people being makers.

Similarly, The Public Library Survey (PLS) conducts a survey of libraries every year, and when we compare four years that is, 2012 to 2016 of Visitation in Libraries, the Fiscal year 2012, we could see 1.5 billion in-person visits to public libraries across the

United States, which reflects a 10-year increase of 20.7 percent, there has been a peak decrease in physical visit since the fiscal year 2009 (IMLS, 2014).

Libraries have been trying very hard to increase the service outcome and resources to meet the needs of the 21st-century public. On the other hand, program attendance had begun to be in demand. According to IMLS (2014) there were 92.6 million attendees at public library programs in the fiscal year 2012 which is a 1-year increase of 4.1 percent and an 8-year increase of 37.6 percent from 2004.

The Fiscal year 2016 Public Library Survey shows that public libraries have been evolving to meet the changing needs and requirements of the community. More than 171 million registered users, representing over half of the nearly 311 million Americans who lived within a public library service area, visited public libraries over 1.35 billion times in 2016. Public libraries offered half a million more programs in 2016 than in 2015; 113 million people attended 5.2 million programs in 2016. Also, the number of electronic materials continued to grow, with public libraries offering over 391 million e-books to their users in the United States (IMLS, 2018).

Design Application

After studying and analyzing the design guidelines of a makerspace, the strategies were applied to a case. The present scenario of public library makerspaces were tested through the studio explorations in studio 501 and studio 601 under the guidance of Stoel Burrowes. This section describes how a makerspace was proposed to current public libraries in Greensboro and India.

Site Plan

Two sites were identified, one in Greensboro, North Carolina and the other in Bangalore, India to propose for a Public Library Makerspace. These two models were designed to test the design guidelines of a flexible makerspace with a concept of Active Learning incorporated into the design applied to two sites with different cultural aspects. The designs mainly incorporated how the space became more flexible with steel case furniture being a major part of the Active Learning concept. Overall four themes were kept in mind in the process of designing the Public Library Makerspace- exposure, flexibility and expansiveness.

The Greensboro Public Library had computer rooms on two floors that were re-imagined for the newly proposed (figure 22 and 23) Makerspace. Whereas the Bangalore Public Library had a newly added space (figure 24) that was proposed for a makerspace.
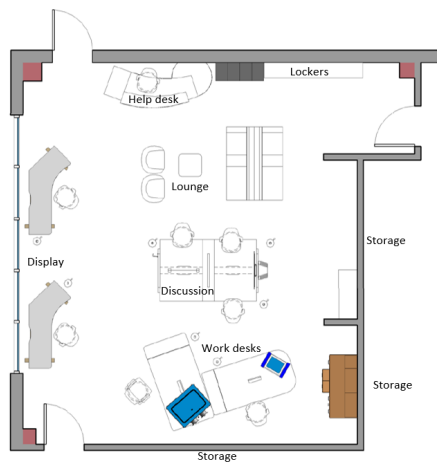
Figure 22. First Floor Lebaure Park Makerspace   Figure 23. Second Floor Lebaure Park Makerspace
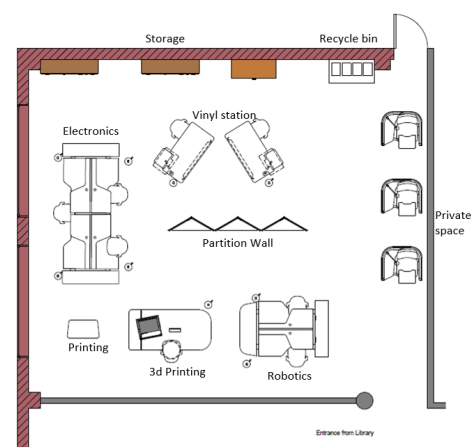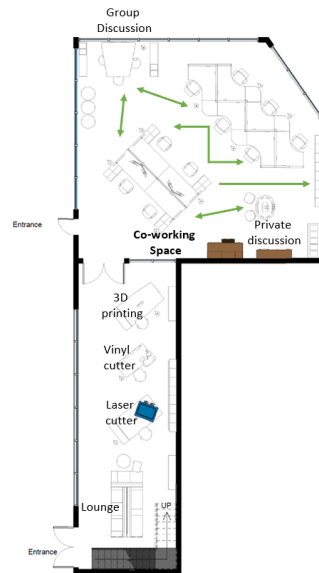
Figure 24. Bangalore Public Library Makerspace

Cultural Aspects

The sites were in two globally distinct locations and that took a major role in how the spatial arrangement was zoned out.

The Bangalore Public library Makerspace in India has an additional Co-working space as part of the makerspace to better fund the library through the funds they derive from the users of the Co-working space.

1) *Equipment*

Deciding on tools was a task. Based on the socio-cultural norms and community needs of the Bangalore Makerspace, the sewing machine and CNC machines were ruled out. As sewing machines for Indian women is a regular instrument at home, it was not given much importance. The other tools like 3D printer, Lazer Cutter, Vinyl Cutter and

3D scanner were all the same in both the design proposals for Greensboro and Bangalore Library makerspace.

2) *Furniture*

Makerspaces are a whole new era of change in Public libraries and its more mentor intensive, hence the idea of open lab- style. Instead the furniture from Steel Case (figure 26) which engaged more of learning-together style was incorporated. Interactive pedagogies (figure 25) require learning spaces where everyone can see and interact with content, instructors and other attendees, so the makerspace was driven by a concept of 'Space impacts learning'. This kind of space offers opportunities to socialize, collaborate, create and offer support and encouragement to one another.
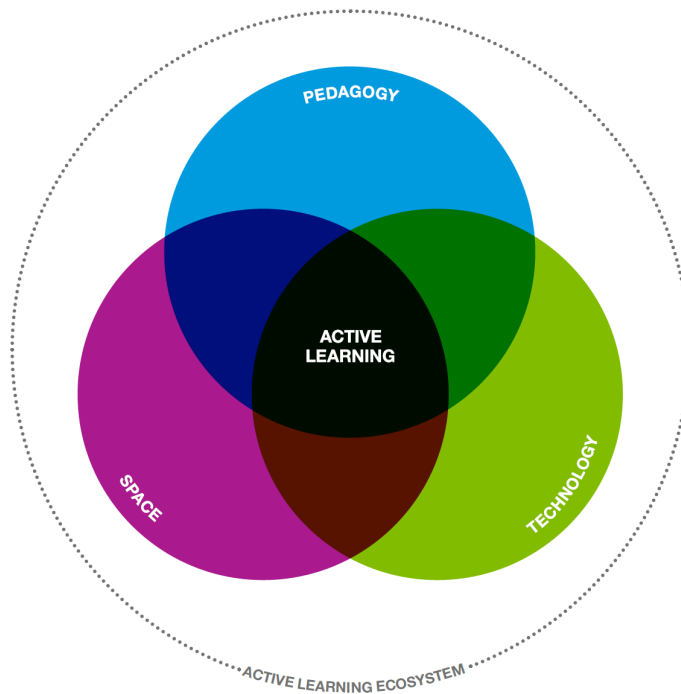
Figure 25. The Active Learning Ecosystem

Figure 26. Built-in Modularity Furniture

Also, the spatial arrangement of pulling all the furniture to a center of the room, creates a family style atmosphere and encourages users to engage with each other while they work on projects, allowing all the materials required to be hung on the wall.

3) *Power Supply*

Electricity is the most important criteria for a Makerspace and a new idea of flexible power supply was given a thought along with flexible furniture. So Underscore power supply (figure 27) was incorporated in the Greensboro public Library Makerspace.

Figure 27. Underscore Power Supply

Along with the power supply in the flooring, the electricity was produced from the ceiling (figure 28), which had a motorized ceiling mount power, as well as near the seating (figure 39). Ramps were provided to make it ADA accessible.

Figure 28. Motorized Ceiling Mount Power

Figure 29. Steel Case Thread Flexible Power Cord

Equipment (Figure 30) was planned in such a way that they had well supplied exhaust and they were compact.

Figure 30. Zing Lazer Cutter with its Compact Fume Extractor

CHAPTER IV

RESULTS AND FINDINGS

The researcher identified specific characteristics, activities, and outcomes which

serve as a possible indicator of the benefits that makerspaces offer through libraries.

Another four themes that emerged from these results are 1) challenges, 2) limitations, 3)

weakness and 4) safety process learned in the development process. The results also

highlight the tensions and the questions that arise through the process of Public Library

Makerspace.

Benefits of Makerspaces in Public Libraries

"Makerspaces are a natural extension of library services" (Britton, 2012, para.

18). This quote represents the fit between the traditional aspects of public libraries, new

ideologies, and the makerspaces.

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Table 4. Potential Indicators of Successful Makerspaces (Britton, 2012)

Benefit	Potential indicators
Creativity	art projects; mash-ups; original projects; interdisciplinary work; supporting artists and creatives (e.g. through facilities, skills, networking); encouraging creative thinking
Enterprise	supporting entrepreneurs and start-ups; business advice; IP advice; bureau manufacturing services; supporting inventors; commercial services
Learning	new skills; courses, workshops or formal learning; links to schools, colleges or universities; induction courses; informal and peer learning
Self-fulfilment	achieving personal goals; socialising; gaining new social skills; supporting mental health; tackling loneliness; improving employability

Although the participant experiences were individual from the onsite research, the participants all gave parallel benefits about these makerspaces. The advantage that was most significantly highlighted was community engagement. As makerspaces emerged in libraries, they have significant social impacts on the local communities.

Library Makerspaces not only give access to new technologies and fresh learning opportunities for the users but also connect with other members of the space (Slatter & Howard, 2013).

As Erinn Batykefer (2017) writes, "The Maker Movement emphasizes peer-to-peer skill sharing, collaborative learning, and hands-on practice, ideas, and techniques that fit into the library's focus on open education, lifelong learning, and information literacy—especially if we define 'information' broadly" (Calvo, 2017a).

Challenges Faced by Public Library Makerspaces

The new democracy of public library makerspaces not only has benefits that have been demonstrated both in the literature and life experiences of the participants but simultaneously comes the significant challenges which accompany the benefits. The makerspaces are identified as the new nature of cutting-edge process, and all the public libraries talk about budgetary constraints and have significant concerns towards liability, copyright, and ownership as potential problems. Makerspaces are a relatively new phenomenon, and this has developed a unique set of challenges for the participants, who are often trying to explore and discover. Library users find it difficult to understand the value and relevance of the new technology, especially the baby boomers who are more used to the traditional library model. It needs complete support of the community, as space itself dwells only on the members of the city. While the technology materials have become very popular with public librarians and their visitors, they do have a steep learning curve for all.

While libraries seek out exciting and new tools for their programs, some have encountered issues with troubleshooting. For example, Kiki Durney of Palm Harbor Library, Florida, wrote, "We tried to have CoderDojo (Global volunteer-led program workshop for young people of age 7-17) here, but our wireless couldn't support a large amount of downloading. We don't have the budget to increase our Internet speed, so the program had to pick another location" (Dixon, 2017).

The most significant factors that hold libraries back from trying out new tech-savvy programs is that they lack funding, materials, and staffing. Space is the second

biggest concern for many old libraries. Librarians also express concerns about reduced user interest.

Public Libraries Makerspaces examined on-site also state that they face problems in marketing and scheduling programs in their makerspace in a way that attracts users, while location could be a problem too. Sometimes the staff lack equipment skills which are way too technology-oriented and they go way beyond their capacity. According to Jane Jankowski, Warrenville Public Library, Illinois, adults who visit the library, like programs where they come in, sit still, and get lectured at, while Mary Lorenz, Grand Forks Public Library, North Dakota, found that programs planned for adults weren't well attended, and that's because they are not used to coming to the library for these types of programs. The Grand Forks Public Library recently started the maker programs for adult (Hoffert, 2018).

Making is a great way to connect with the community which offers a lot more than expected to the libraries in many unique ways, reinventing the library as a place for a creative outcome. As the Library-Journal survey responses indicate that public libraries are still in the research stage, testing what types of programs and equipment reverberate with their organization's resources and community needs (Hoffert, 2018). Makerspaces significantly contribute to a new iteration and aligns with statistical research conducted by The American Association (2013) who report that US libraries with Makerspaces are 'experiencing increased visits and demands as a result' of their inclusion. The primary goal of these spaces is to promote higher levels of community engagement; the literature

supports this idea of increased usage and successfully extending this third place (Dixon, 2017).

Concerns and issues about the inclusion of makerspaces in libraries include:

• potential conflict with traditional services and expectations,

•provision of an appropriate range of making resources,

•funding that includes staffing, maintenance, and space needs.

Limitations

1) Makerspaces are Mentor Intensive

Makerspace mentors need to be well-versed in the new technology and techniques in order to advise users on the proper use and safety issues involved with the machines and tools. Libraries are trying to design the maker programs around the known skills of the librarians or train the staff for required skills or courses. Maker programs depend on the knowledge and experience of the supervising staff, and this need must become a factor in the staffing of libraries that include makerspaces. Librarians are also expressing a desire to nurture skills in more tech-savvy subjects like coding, robotics, animation, video game design, and circuitry. At the Randolph County Public Library, NC, a stop animation video program "could have gone much better," according to librarian Ann Przybylowski, but because "there were not enough leaders to assist/answer questions on time, and, as a result, the duration of the program was too short."

For example, the Highland Township Public Library, Michigan, invited a local University group to teach children about light bulbs and electricity. According to librarian Brenda Dunseth, the "University students who led the program were all women,

which was a plus because many girls signed up for the program, making for a nice mentoring opportunity" (Dixon, 2017, p. 17).

2) Weakness and Gaps

Makerspaces have been criticized for their narrowly defined goals, and thus failing to attract and engage the broader population of young people (Blikstein & Worsley 2016). Moorefield-Lang is a prolific author on makerspaces as she has published over 30 articles in peer-reviewed journals and (non-scholarly) periodicals. She, so far, has been the only researcher to research a weakness in the literature, which is the issue of copyright. Michele Moorefield-Lang (2014) examined user agreements in 24 public and academic libraries user agreements. From her research, she concluded that user agreements are vital as they outline rules of engagement that enhance learning and protection for makers, librarians, and libraries. Another limitation that needs to be addressed is intellectual freedom. Will or should makers be able to make anything like guns or narcotics in library makerspaces?

Research into makers and makerspaces is relatively new, so there is one gap in the LIS literature that has not been taken up yet. The issue is that there is only one scholarly article on the users' perspective of using makerspaces. Bieraugel & Neill (2017) conducted a questionnaire of students at a university who used a makerspace (in the engineering building) and other spaces in the library and around the campus. Other than this study, all other scholarly articles were based on librarians' perception of the information needs and information seeking behavior of maker in makerspaces. More

research needs to be done on users themselves to get a better understanding of what drives their needs and wants in makerspaces.

Libraries have learned from running makerspaces that it takes time and patience to find out how to use the tools, and other equipment, maintenance and fixing equipment also takes time (Cooper, 2015). In a review of public discourse related to makerspaces in libraries, undertaken by analyzing relevant publications, including journal articles and blogs (Willett, 2016), identifies a series of tensions and contradictions in the literature. Willet (2016) argues that "polarized accounts present in the data set position formal educational content, styles, and pedagogies in negative ways and oversimplify the distinctions between formal and informal learning settings" (p. 315).

The new learning setting raises questions about how makerspaces engage in a range of styles of teaching and learning and who might benefit or be excluded from different teaching styles. As the makerspace movement in public libraries progresses, these tensions and questions potentially offer space for dialogue about aims, purposes, and best practices concerning making and makers (Willett, 2016).

3) Safety

Promoting and rewarding creativity is not an easy task as the safety of the makerspace and tools in the space has to be maintained with stringent rules. Most importantly library makerspaces should also instill ethics of responsibility, safety, and ownership in each individual. Public libraries are trying to foster a balance in users, which both responsibility and self-awareness. Makerspaces have taken significant steps to maintain delicate stability with innovation, liberation and open access. The critical

success of a new transformation like library makerspaces requires a culture of ownership, personal awareness, and reliability which will allow each user to discover and forge unconventional ideas in a supportive environment.

The process of all the makerspaces includes tours and safety orientations initially for untrained users in general and specific machines as well. Equipment training which requires special assistance, is handled by special trainers/masters who are thoroughly knowledgeable about the machine safety, maintenance, and operation. Membership cards are one of the most essential training verification methods to implement locks on a critical machine.

CHAPTER V

CONCLUSION

Public libraries have played a significant role in facilitating literacy and learning. By providing the general public with access to new technologies, public library makerspaces can help develop a new generation of workers who will build a stronger economy (Scott, 2012).

The main aim of the study was to assess the impacts of the makerspaces on the public libraries and their communities. The literature review speaks about the assertions made for the social benefits of makerspaces which also act as a base for research. These were especially supportive and encouraging of creativity and enterprise learning. The openness of makerspaces in libraries means people feel comfortable to "stroll in" ask questions and get inspired to do more and learn more. Hence ease of accessibility becomes an essential factor (Calvo, 2017b).

Research indicates that embracing makerspaces within the libraries, has been rapidly growing. The influence of DIY and the Maker Movement in the growing generation has led to a resurgence in learning through making and creating. The whole process has laid a foundation for developing the power of innovation and creativity, expanding the foundation of a business idea and developing them towards manufacturing. Though public and academic libraries approach makerspaces differently, they aim to nurture for future learning and community engagement by involving people from varied

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fields. Public libraries are introducing learning environments for participants who lack access to new technology and equipment like 3D printers and virtual reality tools.

Most of the programs included in the workshops are very informative and suitable for all the age groups, whereas the Makerspaces in the educational institutions have the requirements to fulfill the pedagogical needs of the curriculum.

Literature study also reveals that users from the community are receiving the Makerspaces from the public libraries really well. They are slowly becoming significant priorities for public libraries seeking to be outstanding in the digital age. "The Horizon Report of 2016" reports that makerspaces in academic libraries have become increasingly popular as libraries respond to changes in curriculum and the societal need for active learning, cross-disciplinary approaches, and creativity. Being open and accessible is the key to building a successful makerspace in both public and academic libraries (Wang et al., 2016).

Makerspaces are Successful

The library Journal (Library Journal is an American trade publication for librarians) survey proves that participants are giving more attention to the library through maker activities. The more application-driven activities are causing the most substantial attendance bump. The most significant boost in attendance was seen in libraries that offer 3-D printing programs for kids and age groups of teens, and adults saw it with coding programs (Hoffert, 2018).

According to Nick Taylor, Arapahoe Libraries, Colorado, "Our most successful maker programs involve making a custom thing that a participant can take away. Our less

successful programs have been 'open hours' type programs that are meant to introduce people to space. Our participants need a specific project/thing to do and aren't as amenable to open-ended activities" (as cited in Dixon, 2017, p. 3).

The Community

The community- and scholarly-based sources make clear, a need for a maker's information could range anywhere from just looking up for a cooking recipe to the most complex use of new technology. Makers of different age can interact, connect and also contribute to each other' projects. The appealing idea about making is that anyone can make, and anyone can become a maker. This sharing gives other makers access to information through interactive websites and social media, thus fitting the traits of an information community as defined by Levinson & Christensen (2003). Although makers seek information online on how to make, they do not always make in isolation. Some makers go to physical locations for tinkering with the tools and face to face interaction with peers or other knowledgeable makers (Slatter & Howard, 2013).

The Future of Librarians

A San Jose State University study done in 2015 by the School of information shows that emerging technical skills are becoming more critical in library job descriptions. Analyzing over 400 librarian job postings, they discovered that 37% of the jobs advertised asked for technological skills. Although more public and academic libraries appear to be including makerspaces. Filar Williams & Folman (2017) indicate that librarians need training in operating 3D printers and other technologies in makerspaces which are essential to help the makers community. But it is not only the

technical side of practice that is required, libraries will need user agreements in place for safety of the users, librarians, and libraries. Both Stephens (2015) and Moorefield-Lang (2015) also reiterate that having an openness and willingness to explore new technologies is the way of the future.

Future Study

Mobile Makerspaces

Libraries have to break the structured walls, to efficiently serve the community. An excellent example of this is when a mobile library was set up during the Occupy Wall Street event to bring information to the masses (Lingel, 2012). Lingel, also states that, the 'people's library' is important, as it shows that libraries are more than their collections and emergent, digital and participatory technologies are vital for the endurance rather than the demise of libraries. Similarly, like the mobile people's library, some libraries have mobile Makerspaces as part of their community outreach.

The case study of librarians and educators of five different mobile workspaces in the United States, Canada, and the Netherlands revealed that mobile makerspaces wanted to give the wider maker information community a chance to look for and collaborate on emerging technologies. Both Library and mobile makerspaces are equally important spreading the information needs of the maker culture (Moorefield-Lang, 2015). Filar Williams & Folman (2017) state that,

> libraries could be a key player in the making culture and the growing
> making movement can revolutionize our country if libraries are willing, to
> provide a venue and support for users who might not otherwise have the
> tools, spaces, skills, or community of their own. One small grant, in less

than a year, provides library staff the impetus, confidence, basic skills, resources, and community to start the revolution (p.33).

Makerspaces that contribute to success have almost similar key points for virtually any kind of project like staffing, user interest, funding, management support. Through this research, "the researcher" was able to dive deeper and determine components that might not be very apparent.

1. Attracting new users and to keep the programs and equipment on track is a vision that can be instrumental.

2. Keeping user needs as the primary consideration for the development of any makerspace will allow for correct designation of the resources to be done wisely so that the creation can thrive without unnecessary waste.

3. Assigning a sustainable staffing model to provide the users with proper support, while not over-burden the users themselves, will enable makerspaces to meet the needs of the users.

4. All the successful makerspaces spoke of the way the users were differently treated in common. Trusting the attendees and giving them the freedom of exploring the space seemed to amend user's attitude of the area. When visitors are welcome to stop by the space at any time to take a tour, work on their projects or get help from the tools and the staff members, in this way the connections can be enhanced among users of similar interests.

5. A passion and enthusiasm for the making culture, and steadfast commitment to community engagement are the two characteristics noted in all the successful

makerspaces. The analysis in this research offers some starting points for potentially

fruitful dialogue. Elam-Handloff (2016) says,

> While my experiences seeing this process in action at the Hill
> Makerspace-North Carolina, have been positive and encouraging, there are
> larger issues at stake deserving of a critical lens: concerns of gender and
> political economy, or false promises of increased marketability for
> humanities graduates, or limitations placed on what it means to be a digital
> scholar, a doctoral student in Communication, Rhetoric, and Digital Media
> at NC State University (p. 6).

There have been prevailing discussions on public library makerspaces when

people compare to the history of DIY and Maker Movements and how they connect to

the current debate on politically charged DIY ethics and affinity spaces. Public libraries

would further, like to see how they can transform from experiential learning to

pedagogical innovation where the current scenario looks at the tools as more of research-

oriented especially for users from the non-engineering field. Our next step would be to

investigate how these makerspaces in libraries can be established as a business model to

integrate innovation into production.

This thesis reveals the importance of understanding the direction of their

communities and how attendees would like to use their local libraries, libraries can be

designed to answer shifting needs of the community. As the Mobile technology and

growing amount of data merge with each other, new type of experiences for public

libraries can be designed.

Designing a Makerspace

As is true when developing a makerspace plan, it's important to start with a vision for the space and outline the goals we hope to accomplish. vision and goals will help answer other critical questions, such as what the space should look like, how it will be equipped and so on. Once the plan for how the maker space will be used, then the actual space itself be designed. The researcher for the makerspaces projects in Greensboro and Bangalore started off with a question, How Space Design Influences Learning?

The design of a learning space can have a profound impact on the learning that takes place there, and through the use of modular furniture created led to flexible, creative and inviting spaces that enable a new kind of "connected learning" to take place, in which Library users learn while collaborating with mentors or even just hanging out with their friends. The modular furniture makes it easy for students to form quick collaborative groups or break off individually to do their own thing. And the power supplies that are embedded in the tables and soft seating allow them to sit anywhere and still plug in a laptop or other digital device for working. What's more, the use of comfortable seating creates a warm, inviting environment that draws students into the space and inspires their creativity.

Then comes the Issues to consider, which include location, configuration, tools and materials, storage and utility and safety. Here's a closer look at each of these aspects.

1) Configuration: making sure the space promotes creativity and collaboration. And encouraged both of those traits through the design of the space itself.

2) Storage and utility: The makerspaces were designed to be functional and large enough for students to work without getting in the way. It also included plenty of shelf or cabinet space to store equipment safely. Power cables which were ceiling mounted and power through the flexible flooring were proposed so that the power supply was always accessible and did not obstruct the working space.

3) Safety: The space was given various thoughts about the ventilation and exhaust along with acoustics. Compact equipment was chosen to avoid exhaust problems.

4) Finally launching a successful maker space program requires training Librarians to use the space effectively with their users. Librarians must learn not only how to design high-quality projects, but also how to transition into a new role they might not feel comfortable with.

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APPENDIX A

STARWORKS

Starworks (figure 31) North Carolina is an art-centered work community that
promotes community and economic development by providing outstanding artistic,
educational programs and business ventures as part of the site visits. They strive to
engage the community with artwork and artists of the highest caliber. This place was
studied, to understand how an existing building could be reused for a different purpose.
The Starworks was once a school for kindergarten kids, later converted to a socks factory
and now into a glass blowing factory. It was an excellent opportunity to experience how
the spaces were soulfully transformed into each individual.

Figure 31. School Converted into a Glass Factory

Figure 32. Exhibit Hall

This study of STAR works helped in better understanding how a space like public libraries can be converted or altered (figure 32) to the new spatial needs of the 21st century.

APPENDIX B

DEFINITION OF TERMS

Coworking space: Coworking is a self-directed, collaborative, flexible and voluntary work style that is based on mutual trust and the sharing of common core values between its participants. Coworking involves a shared workplace, often an office, and independent activity.

Makerspace: a place in which people with shared interests, especially in computing or technology, can gather to work on projects while sharing ideas, equipment, and knowledge.

Active learning: Active learning is any approach to instruction in which all students are asked to engage in the learning process. Active learning stands in contrast to "traditional" modes of instruction in which students are passive recipients of knowledge from an expert.

Steel case: Steelcase is a United States-based furniture company founded in 1912 in Grand Rapids, Michigan. The company produces office furniture, architectural and technology products for office environments and the education, health care and retail industries.

Underscore power flooring: Underscore floor is a raised platform of triangular tiles on 2 1¼2"H supports. It is designed for routing wiring and cabling to access tile locations determined by the user. It can be reconfigured to support changing utility needs.

ADA: The ADA is a civil rights law that prohibits discrimination against individuals with disabilities in all areas of public life, including jobs, schools, transportation, and all public and private places that are open to the general public.

Maker Movement: Maker Movement is a social movement with an artisan spirit.
Tinkering: attempt to repair or improve something in a casual or desultory way, often to no useful effect.

Digitalization: Digitalization is the integration of digital technologies into everyday life by the digitization of everything that can be digitized.

3d Printer: a machine allowing the creation of a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession.

Coding: the process of assigning a code to something for the purposes of classification or identification.

Pedagogy: the method and practice of teaching, especially as an academic subject or theoretical concept.

Virtual reality: Virtual reality is the term used to describe a three-dimensional, computer generated environment which can be explored and interacted with by a person