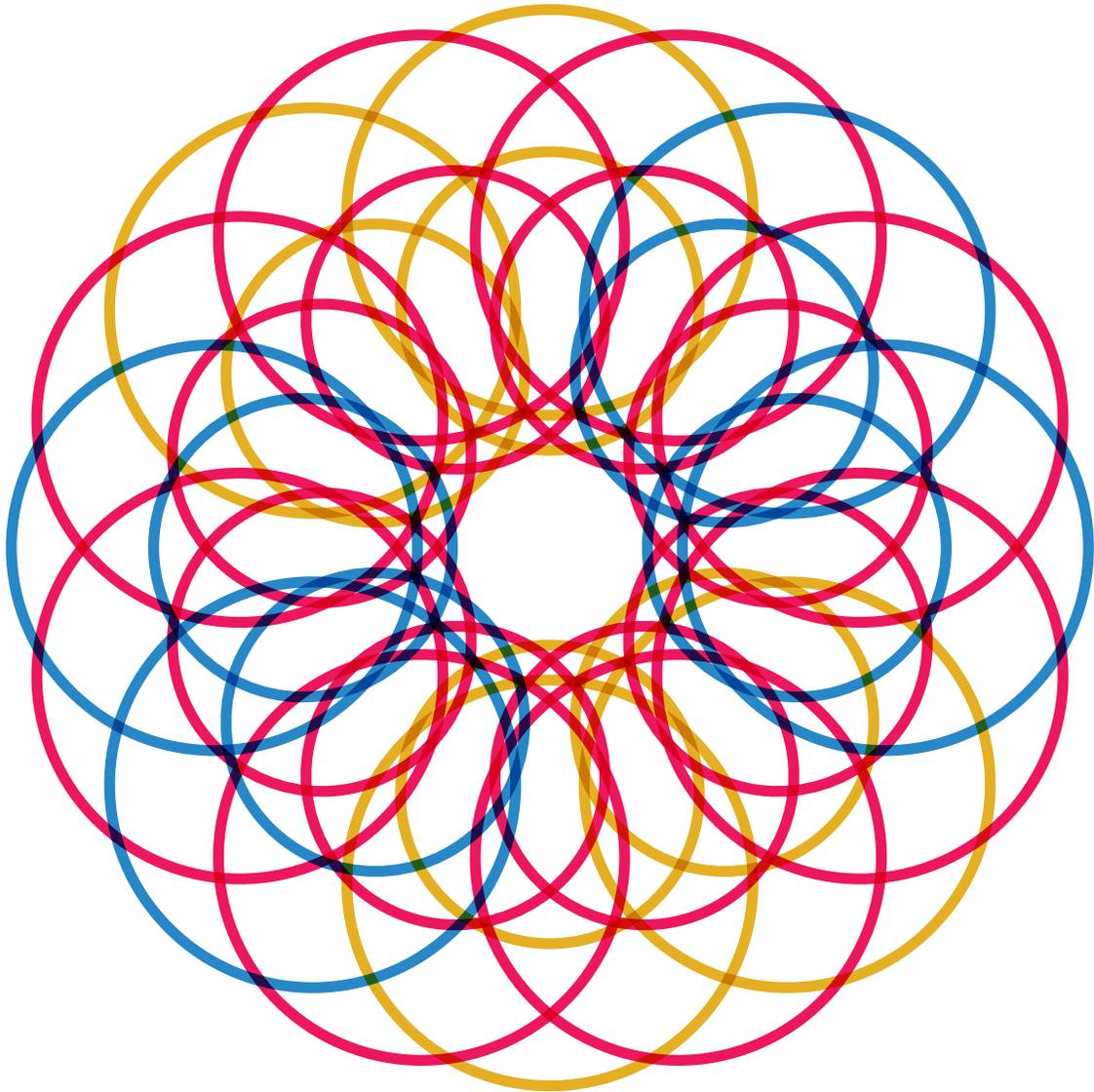# MAKERSPACES
HIGHLIGHTS OF SELECT LITERATURE

Steve Davee, Lisa Regalla, and Stephanie Chang   **May 2015**

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OVERVIEW

In the two years since the release of the MENTOR Makerspace Project's *Makerspace Playbook: School Edition (2013)*, makerspaces of various types, settings, and names have increased exponentially. Google Trends shows the search term "makerspace" has quadrupled in the past two years and is currently in its highest rate of growth in search frequency. Anecdotally, the playbook has been frequently named as a favorite resource among educators and parents seeking to support places to make. As well, it has been frequently cited in academic papers, articles, blogs, and published books (Halverson & Sheridan 2014; Burke 2014).

In this review, we look at a selection of the latest discourse and thinking emerging from the growth of makerspaces and their developing roles in education and communities. We have selected recent seminal academic papers, articles, blog posts, and published books that help provide foundational context, content, and insights for the development of a new Makerspace Playbook. The new playbook focuses on youth-oriented makerspaces, showcasing the varieties of spaces and the many ways to get started. While this paper is not intended to be a fully comprehensive review of the current literature, it summarizes key points gleaned about youth makerspaces and the learning they enable. These findings help to inform and shape the creation of the new playbook, particularly in ways that serve the mission of Maker Ed: to create more opportunities for *all* young people to develop confidence, creativity, and interest in science, technology, engineering, math, art, and learning as a whole through making.

WE LOOK AT

Makerspaces:
Types and Names

Emerging Categories
of Makerspaces

Benefits for Participants
and Communities

Interdisciplinary Roles
of Makerspaces

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MAKERSPACES: TYPES AND NAMES

''Makerspaces come in all shapes and sizes, but they all serve as a gathering point for tools, projects, mentors, and expertise.
A collection of tools does not define a makerspace. Rather, we define it by what it enables: making.''

— MAKERSPACE PLAYBOOK: SCHOOL EDITION 2013

In the years since the term "makerspace" was coined, a multitude of new examples have emerged to learn from and add to the landscape of early makerspaces. All play a role in supporting the development of what makerspaces have demonstrated that they can be and what they can become.

Makerspaces, by any name, are fundamentally places to design, explore, and create. Despite its continued growth as a search term, the term makerspace has yet to officially enter the dictionary lexicon (though the related term "hackerspace" has). Still, makerspace is rapidly becoming a widely recognized word and is well represented by the large variety of spaces (Burke 2014; OPP Research Brief Series 2015). At the most basic levels, a makerspace can be as simple as a table or a backyard with sticks, mud, and bricks (Davee 2014). The definition can be even simpler and more personal, as Gary Stager, co-author of *Invent to Learn*, describes: "I like to say that the best makerspace is between your ears" (Stager 2014). John Burke, author of *Makerspaces: A Practical Guide for Librarians*, states it simply: "Wherever making happens is a makerspace" (2014).

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Other terms often associated with making and spaces include Fab Labs and hackerspaces. Fab Labs are spaces that commonly share a core set of digital fabrication and prototyping tools, for example, laser cutters, vinyl cutters, CNC routers, and 3D printers. Founded at MIT's Center for Bits and Atoms by Neil Gershenfeld, the Fab Lab network is supported by the Fab Foundation and by FabEd, which is specifically geared toward supporting educational institutions. Hackerspaces are largely associated with adult, computationally focused making (Cavalcanti 2013). Thus, both hackerspaces and Fab Labs emphasize forms of making that utilize digital technology.

Makerspaces, as a more generic and inclusive term, has increasingly come to represent an extremely wide variety of creative endeavors, tools, demographics, and types of places where making happens. Reflecting this, these spaces go by many names. A recent Maker Ed Open Portfolio Project (OPP) survey of 51 youth-serving organizations self-identified as makerspaces reveals a rich diversity of types, specializations, and forms of making supported.

Out of 51 sites, a range of 45 descriptions and names were reported including variations of the following.		
Active-Play	After-School Program	Arts Camp
Art Center	Audio Studio	Children's Creativity Museum
Club Home	Community Space	Creativity Lab
Design-Lab	DJ Studio	Drop-in Space
FabLab	Gallery Space	Hakerspace
Hands-on Learning Space	Idea Lab	Informal Learning Environment
Innovation Lab	Lab	Learning Lab
Make Space	Maker Art	Maker Lab
Makery	Media Lab	Museum as Play
Place for Collaboration & Creation	Production Studio	Robotics Learning Lab
Sandbox	Science Lab	Studio
Tech Center	Teen/Youth Center	Teen Media Lab
Teen Tech Studio	Tinkering Space	Workshop

Evident in these names are a diverse range of making forms, including robotics, music, media, arts, and technology. Various approaches to making are also revealed, including those emphasizing play, design, the arts, science, tinkering, collaboration, informal and hands-on learning, as well as lab and studio approaches. These names represent a small snapshot of the diversity of making forms enabled by the varieties of makerspaces.

EMERGING CATEGORIES OF MAKERSPACES

Our review of the variety of youth makerspaces in libraries, museums, schools, and community organizations revealed three broad categories: dedicated, distributed, and mobile.

Dedicated makerspaces concentrate equipment, tools, and materials in a single space, such as a center in a library or a workshop in a school used primarily as a makerspace. School examples include the resurrected industrial arts shop turned into a makerspace at Analy High School in Sebastopol, Calif. (Shea 2011); a former ROTC gun range turned into a Fab Lab space, including hydroponic gardens, at Castlemont High School in Oakland, Calif.; and any number of community organizations and library spaces. Examples of dedicated youth-oriented makerspaces include non-profits such as Assemble, a "community arts and technology center" in Pittsburgh, Pa.; the family makerspace Parts and Crafts in Somerville, Mass.; and Level-Up, a teen-oriented makerspace in Chicago, Ill. Libraries with makerspaces also tend to have their tools and materials consolidated in single areas. Dedicated spaces in these public settings are especially required for safety, security, and noise management for forms of making that require ventilation and dust control, such as the use of specialized tools like laser cutters and woodworking and metalworking tools (Burke 2014).

Distributed makerspaces are spaces to make that are found in many places within an organization. For example, within Albemarle County's Monticello High School in Charlottesville, Va., classrooms have access to a library learning commons with 3D printers and options for computer programming, a "genius bar" where students can give IT support to their peers, a recording studio, materials and tools for making in classrooms, and even the use of the cafeteria as a dance studio and rehearsal space (Harris 2013; OPP Maker Portfolios in Schools Brief 2015). At Opal Public Charter School of the Portland Children's Museum, every pre-K through 5th-grade classroom is equipped with a small studio space (an "atelier" or workshop) as well as being stocked with a wide array of arts and construction materials (Gandini et al. 2015). At Lighthouse Community Charter School in Oakland, Calif., a dedicated "Creativity Lab" space serves as a center to support makerspaces in every classroom (Parker 2014). Children's Museum of Pittsburgh serves as an example of the many children's museums with spaces to make in all kinds of ways distributed throughout the entire facility, including art studios, a theater space and other play areas, and a Makeshop supporting a huge variety of making, including crafts, sewing, electronics, construction, and design. Within the Children's Museum is also a youth-driven radio studio, Saturday Light Brigade, that gives children's voices active community roles, a form of making that brings neighborhoods and age groups together.

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2014 Maker Corps Possibility Box Components.
Photo: Brent Richardson, Children's Museum of Houston.

Mobile makerspaces can take the form of vehicles that travel throughout a region, such as SASTEMIC's Geekbus in San Antonio, Texas (Moritz 2015), and the SAM (Science, Art, Music) Academy on Wheels RV in Sanger, Calif., which serves California's central valley (Shepard 2014). Stanford University's SparkTruck has toured all of the continental states during two summers spent traveling the nation. SparkTruck visited 33 states in 2012 alone and is now focusing on serving as a creative catalyst for schools.

Mobility can also take place within an organization, such as on carts designed for making at the Monroe Carell Jr. Children's Hospitals in Nashville, Tenn. Project M@CH (Makerspace at Children's Hospital) has assembled these carts, complete with making tools and materials, to bring mini makerspaces directly to patients (*The Lebanon Democrat* 2015).

Mobile mini makerspaces are also a component of organizations, such as schools, distributing their maker programs throughout their buildings (Perlis, 2015). The *Makerspace Playbook: School Edition* introduced examples of "makerspaces in a box," compact boxes, often in mobile cabinets, full of select tools and materials.

Maker Ed commonly uses an even smaller, portable box model, called "Possibility Boxes," some as small as shoe boxes, which are intended to spark exploration, experimentation, and project development for Maker Corps Member training and teacher/educator professional development (Maker Ed Program Report 2013).

Approaches using portable carts and boxes are often cited as affordable ways to create makerspaces and seed creativity (McKibben 2014). Mobile makerspaces, such as the bus, RV, and truck models mentioned, are especially effective in bringing makerspaces directly to areas of high need and serving wider communities. These portable approaches provide additional ways to get started, as well as multiple pathways for reaching audiences, without requiring a dedicated space.

We see in these categories and examples that making can occur in all sorts of places and that the tools and materials to support various forms of making need not always be limited to single dedicated areas or even buildings.

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BENEFITS FOR PARTICIPANTS AND COMMUNITY

A common sentiment in the literature reviewed is that makerspaces are most successful when they emphasize collaboration with participants and ways of inviting ownership over the spaces and programming. Shirin Vossoughi and Bronwyn Bevan identify, in their recent paper "Making and Tinkering: A Review of the Literature" (2014), a point of caution about overemphasizing tools and activities in makerspaces, warning about the view "that deploying powerful new tools will lead to transformation in education" without taking into consideration the need for community development and care to nurture and grow positive maker mindsets. Steven Kurti et al., in their article on "The Philosophy of Educational Makerspaces" (2014), further the point with a focus on the individuals involved:

''It's all about the people and the 'spacemakers.' More than just tools, more than particular programs or projects, successful makerspaces are about the people and community.''

The dynamic between the spacemakers (those who run the spaces, including educators) and the participants, as well as the overall cultures of makerspaces, is as important as the types of physical products the makerspaces enable or the tools and programming that they provide. A common cultural goal of empowerment through learning and facilitating social connections can be supported by approaches that are youth-centered, employing inquiry, meaning, context, and personal interests, common in educational makerspaces (Martinez & Stager 2013), where "the line between learner and instructor becomes blurred" (Kurti et al. 2014).

Facilitation in these environments becomes a balance of skilled educator roles and the roles of students. Two primary goals are youth empowerment and community engagement. Youth are empowered by having a space where their voices are heard, their choices honored, and their contributions valued, which all lead to a sense of confidence in their abilities. The Agency by Design program of Harvard's Graduate School of Education recently released a white paper on making, noting:

''... the most important benefits of maker-centered learning are neither STEM skills nor technical preparation for the next industrial revolution. Though these benefits may accrue along the way, the most salient benefits of maker-centered learning for young people have to do with developing a sense of self and a sense of community that empower them to engage with and shape the designed dimension of their worlds'' (2015).

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This empowerment also stems from building critical thinking, problem solving, communication, and collaboration skills. Maker Ed's OPP *Research Brief Survey of Makerspaces, Part II* identifies a very high self-reported emphasis of these skills in the offerings of the makerspaces surveyed. While the brief acknowledges the limits of drawing too strong a conclusion from self-reported alignments, it does point to the desire and intentions of makerspaces to develop and foster these cognitive skills (2015).

Still, STEM, creative, and technical skills gained in makerspaces can also play vital roles in job development and entrepreneurialism, thus benefiting the wider community and economy. *Wired* magazine former editor Chris Anderson's book *Makers: The New Industrial Revolution* identifies makerspaces and the Maker Movement as key parts of a third industrial revolution, where a wide variety of technical and creative skills gained from experiences in makerspaces translate to job skills, create new jobs and industries, and fuel innovation (2012).

Makerspaces can play a vital role in providing these benefits and opportunities for diverse demographics and populations with special needs. Maker Ed's OPP *Research Brief Survey of Makerspaces, Part I* revealed that the surveyed sites collectively serve a population with a greater diversity than the U.S. population, based on 2010 census data. Data show that these sites also serve individuals with mental and physical disabilities, with some spaces identifying as high as 66 percent of their served population belonging to this demographic (2015).

For any population, cognitive skills, technical skills, social-emotional development, and youth agency and empowerment are salient outcomes well served by the potential of makerspaces. Increased access to making opportunities, as well as the need for increased cultural awareness, sensitivity, and accommodation, are necessary for even greater strides toward equity in education and communities (Vossoughi et al. 2013).

Photo: Steve Davee

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INTERDISCIPLINARY ROLES OF MAKERSPACES

In the interest of inclusivity and providing multiple paths of access for learning and connections between disciplines, makerspaces are positioned to enrich and expand learning, equitability, and access. Halverson and Sheridan reinforce this theme:

''Bringing the maker movement into the education conversation has the potential to transform how we understand 'what counts' as learning, as a learner, and as a learning environment. An expanded sense of what counts may legitimate a broader range of identities, practices, and environments—a bold step toward equity in education'' (2014).

In their review of literature, "Making and Tinkering," Vossoughi and Bevan note concerns about solely focusing on STEM fields and point out that many maker educators advocate for what Martin and Dixon call "a more holistic, youth-centered view" that integrates making in all subject areas (2013).

The focus on other academic areas well served through making, such as arts, humanities, design, and communications, only serves to increase connections to STEM if desired, through the multiple pathways and points of entry afforded by multidisciplinary approaches (Halverson & Sheridan 2014).

Makerspaces used in formal and informal educational contexts have been found to serve and align well with traditional subject matters and current standards. Maker Ed's OPP survey of 51 makerspaces paints a picture that "making connects across all areas of the curriculum," serving STEM and the arts particularly well. Martinez and Stager, in *Invent to Learn,* note the potential synergy of making with current Next Generation Science Standards, especially if the call by these standards for "meaningful assessment, interdisciplinary knowledge, inquiry, and engineering" is interpreted to honor imagination, child-centered approaches, and "real engineering that is playful and creative" (2013).

Makerspaces in academic settings have helped bridge the humanities, arts, and STEM fields. As one example, in order to create a diversity of makerspaces and bring together makers of all backgrounds, Christine Henseler, a professor of Spanish and Hispanic Studies and chair of the Department of Modern Languages at Union College in New York, in conjunction with her colleagues, staffed existing creative facilities to form a "distributed maker community" across the campus, including in libraries. Her findings state that the "key to integrating makerspaces into the Liberal Arts (and vice versa) lies in establishing both more organic and structured opportunities for these creative innovators to interact, reflect and learn, pool their resources, and share their skills and knowledge" (2014).

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Increasingly, schools are fully embracing making in a variety of forms and are integrating making in all subjects and classrooms. Many schools, including public schools district-wide in Virginia's Albemarle County, infuse making in diverse subject areas, in both a large range of in-school makerspaces and by using classrooms as makerspaces, supported by embedding making practices in teacher professional development. These initiatives are further extended through summer programs (Halverson & Sheridan 2014).

Makerspaces can be the physical embodiment of multidisciplinary approaches. Dale Dougherty, founder of *Make* magazine, Maker Faire, and Maker Ed, describes makerspaces as sharing "some aspects of the shop class, home economics class, the art studio, and science labs. In effect, a makerspace is a physical mash-up of different places that allows makers and projects to integrate these different kinds of skills" (2013).

The inspiration of the art studio model in particular is a trend recognized in recent literature, as Halverson and Sheridan note in "The Maker Movement in Education": "Many makerspaces resemble studio arts learning environments, where participants work independently or collaboratively with materials to design and make" (2014).

An extension of the art studio model is the atelier, a studio and laboratory for the shared construction of meaning and learning with children and educators. The model of the atelier is one that inspires comparison with the spirit of multidisciplinary, child-centered makerspaces. As educator Lella Gandini describes in the new edition of the book *In the Spirit of the Studio,* the atelier is "a workshop for children's ideas that manifest through the use of many materials" and a vital component to the educational approaches modeled by Reggio Emilia, an Italian city renowned for its early childhood educational approaches, which inspire many maker educators today (Martinez & Stager 2013). In the space of the atelier, materials and the process of exploring with them are emphasized as "vehicles for expressing and communicating and are part of the fabric of children's experiences and learning processes rather than as separate products" (Gandini et al. 2015).

Representing over 50 years of educational wisdom, this language resonates remarkably well with goals and potentials of present-day youth makerspaces. Ultimately, the interdisciplinary and empowering nature of these makerspaces can help prepare youth for a future we can't yet imagine, a goal of education voiced by John Dewey in the 1940s, which sounds every bit as relevant today:

''The world is moving at a tremendous rate. No one knows where. We must prepare our children not for the world of the past, not for our world, but for their world—the world of the future.''

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