

# #the makerspace\_ librarian's sourcebook {

// edited by **ellyssa kroski**



An imprint of the American Library Association  
Chicago | 2017

[www.alastore.ala.org](http://www.alastore.ala.org)

**Ellyssa Kroski** is Director of Information Technology at the New York Law Institute, as well as an award-winning editor and author of thirty-five books including *Law Librarianship in the Digital Age*, for which she won the AALL's 2014 Joseph L. Andrews Legal Literature Award. Her ten-book technology series *The Tech Set* won ALA's Best Book in Library Literature Award in 2011. She is a librarian, an adjunct faculty member at Drexel and San Jose State Universities, and an international conference speaker. Her professional portfolio is located at [www.ellysakroski.com](http://www.ellysakroski.com).

---

© 2017 by the American Library Association

Extensive effort has gone into ensuring the reliability of the information in this book; however, the publisher makes no warranty, express or implied, with respect to the material contained herein.

ISBN: 978-0-8389-1504-2 (paper)

**Library of Congress Cataloging-in-Publication Data**

Names: Kroski, Ellyssa, editor.

Title: The makerspace librarian's sourcebook / edited by Ellyssa Kroski.

Description: Chicago : ALA Editions, an imprint of the American Library Association, 2017. | Includes bibliographical references and index.

Identifiers: LCCN 2016037887 | ISBN 9780838915042 (pbk. : alk. paper)

Subjects: LCSH: Makerspaces in libraries. | Makerspaces—Equipment and supplies. | Maker movement.

Classification: LCC Z716.37 .M35 2017 | DDC 025.5—dc23 LC record available at <https://lcn.loc.gov/2016037887>

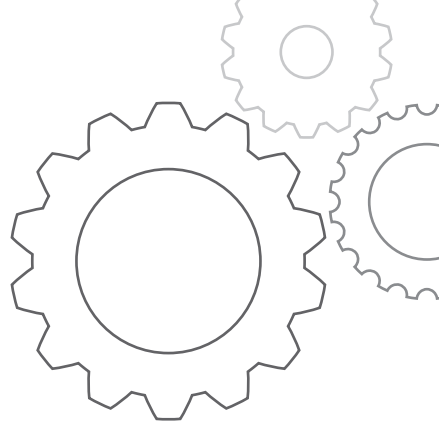
Cover design by Kim Thornton. LilyPad Arduino: photo by Leah Buechley.

All others: © Shutterstock, Inc. Text composition by Alejandra Diaz in the Adobe Caslon Pro and Helvetica typefaces.

© This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

Printed in the United States of America

21 20 19 18 17      5 4 3 2 1



# contents

*List of Figures and Tables*     *vii*  
*Preface*     *ix*  
*Acknowledgments*     *xi*

---

## **Part One // Creating the Library Makerspace**

Ch 1    How to Start a Library Makerspace ..... 3  
          CHERIE BRONKAR

Ch 2    Pedagogy and Prototyping in Library Makerspaces.....29  
          LAURA COSTELLO, MEREDITH POWERS, AND DANA HAUGH

Ch 3    Encouraging a Diverse Maker Culture.....51  
          AMY VECCHIONE, DEANA BROWN, GREGORY BRASIER, AND ANN DELANEY

Ch 4    Safety and Guidelines in the Library Makerspace.....73  
          KEVIN DELECKI

---

## **Part Two // Makerspace Materials, Tools, and Technologies**

Ch 5    A Librarian's Guide to 3D Printing.....87  
          BOHYUN KIM

Ch 6    Raspberry Pi for Librarians..... 113  
          STEPHEN M. TAFOYA

Ch 7    Arduino for Librarians..... 135  
          JONATHAN M. SMITH

Ch 8    LilyPad, Adafruit, and More: Wearable Electronics for Libraries... 157  
          MEGAN EGBERT

Ch 9	Google Cardboard for Librarians.....	175
	TOM BRUNO	
Ch 10	Legos in the Library.....	193
	MEGAN LOTTS	
Ch 11	littleBits, Makey Makey, Chibitronics, and More:.....	213
	Circuitry Projects for Libraries	
	WENDY HARROP	
Ch 12	Computer Numerical Control in the Library with.....	229
	Cutting and Milling Machines	
	ROB DUMAS	
Ch 13	Robotics in Libraries.....	245
	ANTONIA KRUPICKA-SMITH	
Ch 14	Drones in the Library.....	263
	CHAD MAIRN AND KRISTI SEFERI	
Ch 15	Library Hackerspace Programs.....	287
	CHAD CLARK	

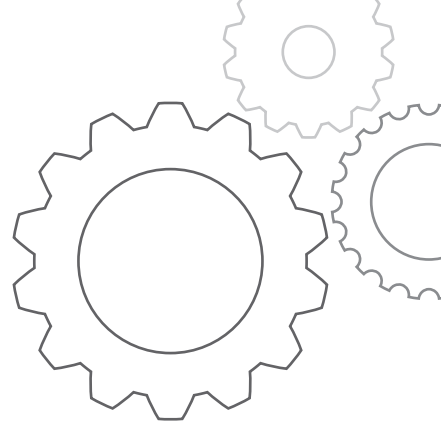
---

## Part Three // Looking Ahead

Ch 16	Mobile Makerspaces.....	307
	KIM MARTIN, MARY COMPTON, AND RYAN HUNT	
Ch 17	Sustainability: Keeping the Library Makerspace Alive.....	325
	SHARONA GINSBERG	
Ch 18	The Future of Library Makerspaces.....	345
	ERIC JOHNSON	

*Index*    369

# figures and tables



## Figures

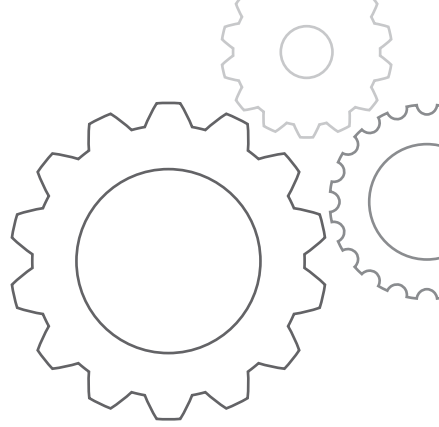
- 5.1 Elements of Polygonal Mesh Modeling 90
- 5.2 3D Model of the Left Shark Loaded in the MakerBot Desktop Application with the Rotate Control Option Selected (Note That Part of the Model Is below the Build Platform) 97
- 5.3 Settings Section of the MakerBot Desktop Application Connected to Replicator 2X with the Quick Tab Displayed 98
- 5.4 3D Model of the Stanford Bunny with Non-Manifold Geometry Issues, Opened in NetFabb Basic 101
- 5.5 3D Printed Gears Using MakerBot Replicator 2X, Displayed with Information about Material Type, Printing Time, and Cost 105
- 5.6 3D Model of a Keyring Displayed in Tinkercad 108
- 6.1 Raspberry Pi Model B, with Its Many Ports and Connections 114
- 6.2 If You Have a 3D Printer, You Can Create Some Cool Pi Cases 119
- 6.3 You Can Have Your Pi and Make Music with It, Too 121
- 6.4 By Diagramming the Pi, Users Learn the Parts of a Computer and How It Works 123
- 6.5 You Can Code Games, Apps, and Even Music on Raspberry Pi 126
- 6.6 Raspberry Pi Goes Hand-in-Hand with Minecraft 129
- 7.1 Breadboard View of a Circuit Diagram Illustrates the Connections for This Three-LED Project (See Step Two for Details) 147
- 7.2 Note the Connection between ANALOG Pin A0 of the Arduino and the OUT (or Analog Voltage Out) Leg of the TMP36 Sensor 149
- 7.3 Wiring May Look a Bit Different Depending on the Arrangement of the Pins on the PIR Sensor 151

10.1	Mason Gross Printmaking Class	206
10.2	Image from #LeGOMAKE Tour Workshop	208
11.1	Makey Makey Kit by JoyLabz	214
11.2	littleBits Magnetic Circuit Components	216
11.3	Snap Circuits by Elenco	217
11.4	Students Snap Pieces Together to Complete Circuits	218
11.5	Chibitronics LED Sticker Circuits	219
11.6	Basic Conductive Materials to Help Students Explore Circuitry in the Library Makerspace	220
14.1	Soldering Motor Wires to Drone Frame	269
14.2	Turnigy Radio Transmitter	273
14.3	Complete Drone Parts	275
14.4	Completed Drone	275
14.5	Indoor Heli Sim 3D Simulator	276
16.1	Young Makers Using littleBits to Create Circuits	315
16.2	The MakerBus Readies for an Event	319

---

## Tables

Table 8.1	LilyPad Specs	159
Table 8.2	Flora Specs	160
Table 8.3	Gemma Specs	161



## preface

**T**he *Makerspace Librarian's Sourcebook* is an essential all-in-one guidebook to the maker realm written specifically for librarians. This practical volume is an invaluable resource for librarians seeking to learn about the major topics, tools, and technologies relevant to makerspaces today. Jam-packed with instruction and advice from the field's most tech-savvy innovators, this one-stop handbook will inspire readers through practical projects that they can implement in their libraries right now.

Part I leads librarians through how to start their own makerspaces from the ground up, reviewing strategic planning, funding sources, starter equipment lists, space design, and safety guidelines. It also discusses the transformative teaching and learning opportunities that makerspaces offer, as well as how to empower and encourage a diverse maker culture within the library.

Part II provides hands-on, practical discussions of the eleven essential technologies and tools that are most commonly found in makerspaces of all types. This section serves as a primer on all the major maker tools and technologies ranging from 3D printers, Raspberry Pi, Arduino, wearable electronics, to CNC, Legos, drones, and circuitry kits. It covers what they are, how to use them, how different libraries are using them, and offers project suggestions that are specifically geared toward libraries.

Part III looks ahead to topics such as making your makerspace mobile, sustaining your makerspace once initial grants and funding sources are gone, and the future of makerspaces in libraries.

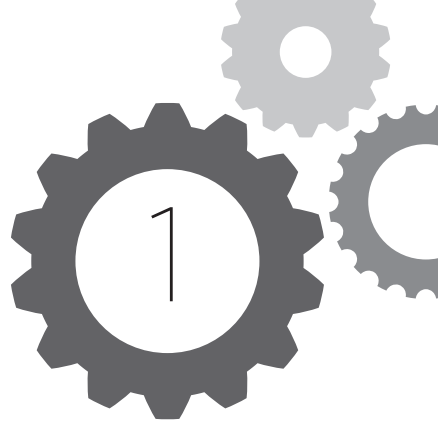
Authored by knowledgeable maker librarians, this comprehensive resource will guide librarians through all they need to know to make the most of their library makerspace.

—**ELLYSSA KROSKI**  
The New York Law Institute

## **Part I**

# Creating the Library Makerspace





# How to Start a Library Makerspace

CHERIE BRONKAR

---

## What Is a Makerspace?

You may have heard the term “makerspace” and wondered what it meant. Makerspaces are, simply put, places where people gather to make things. Although that may sound like a simplistic definition, the things that can be created in a makerspace vary a great deal. Makerspaces can be high tech, low tech, and everything in between. A makerspace’s offerings revolve around the needs of the community it serves, but the one thing all have in common is that they bring people together to share ideas.

Typically, the first thing that comes to mind when thinking about makerspaces is 3D printing, but when it comes to what’s going on in makerspaces around the world, that’s just the tip of the iceberg. Makers create things, ideas, and concepts. Makers work in metal, wood, plastic, fabric, paper, and digital forms. From robotics to crocheting, there are no limits to your makerspace. Let your imagination run wild.

---

*Cherie Bronkar is Director-Regional Library at Kent State University Tuscarawas.*

In this chapter, we'll provide the information and ideas to get your makerspaces up and running based on your unique populations and budgets. You'll find a myriad of ways to create your makerspace. You'll also discover ways to ensure your makerspace is fun and functional.

## **Know Your Makerspace Culture**

Makerspace culture developed from hackathons, which were rooted in software and brought together groups with an interest in creating new apps and software. Such ventures nourished the makerspace culture.

The makerspace culture brings together multiple groups with multiple interests, sometimes putting together unlikely pairings to encourage new ways to think and create. What the members of these groups have in common is a love of tinkering, building, and sharing ideas. The makerspace provides space, resources, training, and technology that all enhance the culture.

Because it isn't limited by age or experience, makerspace culture is unique. Often, groups are comprised of those who just have an interest in creating new products and information. The focus is on sharing and learning in a synergetic environment. The key is that whether these groups are solving a problem or simply creating a fun piece of 3D art, they are doing it in a collaborative environment where makers can bounce their ideas off others with similar interests.

How does the maker culture fit a library? Makers create information as well as physical objects. In the past, the librarian's traditional role was to house information. Libraries now take an active part in the production process as well as in developing new information, all the while passing along valuable STEM skills to library patrons through instruction and by providing the tools of production such as 3D printers, 3D modeling software, and more. The maker culture has found a new home in our libraries. We need makers and they need us.

## **Discover the Major Types of Makerspaces**

Makerspaces come in many forms, from low tech to high tech. Each library approaches its vision of a makerspace in its own unique way, often relying on the interests of the local community and potential users. Any library, including specialty libraries, can operate a successful makerspace, but they are more commonly seen in public, academic, and K–12 libraries. Makerspaces offer opportunities for collaboration in our communities and institutions. Offerings and key players vary greatly depending on the type and the size of the library.

## Public Libraries

Public libraries offer amazing opportunities to create makerspaces of all kinds. Where else do you get the chance to use fun activities to bring together so many diverse groups? Public libraries come in many shapes and sizes that allow for an array of creative makerspaces. Public libraries are on the forefront of the makerspace movement. They have a broader spectrum of users and an ability to create spaces that meet the needs of their communities. These spaces range from large to small, from high tech to low tech and all provide training to the public. This includes both one-on-one training and public workshops.

The Charlotte Mecklenburg Public Library's Idea Box is a great example of what a larger public library can achieve. The Idea Box ([www.cmlibrary.org/idea-box](http://www.cmlibrary.org/idea-box)) features 3D printers, laser engravers, vinyl cutters, sewing machines, Raspberry Pi, and more. It offers programs on everything from circuitry to sewing to meditation. The facility is a fully staffed space that's open at specific hours during the week, and it offers programs based not only on technology and available equipment, but also includes an array of creative and crafty pursuits.

Public libraries large and small throughout the United States are eager to embrace the maker explosion. Smaller libraries can easily incorporate fun and exciting programming. Crafting with recycled materials to make jewelry, duct tape crafts, Legos and erector set competitions, and small electronics projects with littleBits, Makey Makey, and Raspberry Pi are filling our libraries with eager learners.

## Academic Libraries

Academic libraries operate a bit differently than public libraries. In an academic library makerspace, much of the equipment will be aligned so that it can be applied to the curriculum. Although academic libraries are typically available to enrolled students, some are also open to the public. Training is provided in much the same way as in a public library, but academic libraries also work closely with faculty to develop project-based training.

A typical academic makerspace would include 3D printers, programmable electronics, digital microscopes, video equipment, large format printers, and other items that add to the institution's curriculum.

Case Western Reserve University's Think Box (<http://thinkbox.case.edu/home>) is an amazing space with many resources. Its equipment is extensive and includes items such as a vacuum chamber, miter saws, digital multimeters, band saws, and milling machines. Its projects range from brain scans turned into 3D

puzzles to a human-powered cell phone charger. A space like this gives students endless possibilities to put their education into practice.

Kent State University at Tuscarawas (<http://libguides.tusc.kent.edu/makerspace>) is a regional campus that's turned a section of its Academic Learning Commons into a makerspace featuring 3D printers, an Oculus Rift station, a digital microscope, and LEGO MINDSTORMS to excite and inspire students. Its focus is on problem-solving projects, and it's used its makerspace to solve a problem in its science labs by creating a clip that allows students to attach any type of cell phone to a microscope and take photos and video of their findings. It's also used 3D printers to create prosthetics for animals in conjunction with the Veterinary Technology program.

## K-12 Libraries

Much like the academic library, the K-12 library is geared towards curriculum and exploration. The K-12 makerspace provides an environment for students to experience technology and its applications. Training in these libraries is provided to specific classes, often as project-based learning. These spaces are generally not open to the public and are closely monitored.

Equipment in these spaces is often tied to STEM initiatives and includes items like 3D printers (notice a theme here?), littleBits, Makey Makeys, and electronics-based learning materials. (See the chapters in part II on specific tools for more ideas.) K-12 makerspaces also make good use of apps and software to keep their students in touch with technology. 3D-compatible software such as Tinkercad, Google SketchUp, FreeCAD, and MeshLAB are just some of the options. Apps can be downloaded to school computers and made available to students for use. Some popular apps are Motion Café, Garage Band, iMovie, Kodable, ScratchJr, Stop Motion, and Easy Studio, to name just a few. There's literally an app for everything, so look around for one that will amaze students.

The staff of school library makerspace may find they have limited amounts of time to work with students. As a response to little time during the school day, Theodore Robinson Intermediate School established an after-school Maker Club, which takes on projects that experiment with stop-motion animation software and art bots.<sup>1</sup>

## Mobile Makerspaces

Your makerspace need not be stationary. Some innovative libraries are creating mobile makerspaces which, much like bookmobiles, deliver materials to remote

locations. Mobile makerspaces take the maker movement wherever it is needed. These spaces offer opportunities for collaboration between schools, public, and academic libraries.

Featuring the ever-popular 3D printer, the mobile makerspace offers many pieces of equipment that can travel, such as laser cutters, craft supplies, and even hammers and nails. Much like our bookmobiles, traveling makerspaces like the STEAM Truck (<http://community-guilds.org/>) bring makerspace innovations to communities that might not otherwise have access to them. What an amazing way to reduce the technology gap for those areas that do not have makerspaces in their libraries or their schools!

## Membership Based

Increasingly, makerspaces receive support from membership fees. These makerspaces can be for-profit or nonprofit. For a fee, members are offered access to equipment, training, and the space. This model has also been adopted by a few academic libraries to allow their spaces to be shared by the public.

The focus of membership-based makerspaces varies greatly. From the arts-inspired Artisan's Asylum's (<http://artisansasylum.com/>), with its huge creative spaces where artists can collaborate, to the TechShop's ([www.techshop.ws/](http://www.techshop.ws/)) multiple locations and tech focus, there's a wave of membership-based centers sweeping the country. The membership-based makerspace is supported by membership fees, and often funded by grants that support specific programs for youth.

## Determine Your Makerspace Focus

As librarians, we all know the importance of narrowing your focus to make information manageable. The same is true with makerspaces. As you research makerspaces, focus on those with populations that best match your demographics and budget. Ask what works for them and consider mirroring an approach that has already proven successful.

Budget, staffing, and community will be major influences on the focus of your makerspace. Costs can run high if your focus is technology-driven. If you have a low budget for starting your space, consider a mixture of a few higher-dollar items augmented with other low-cost but creative ideas.

The maker movement is not solely based in technology. Yes, it's a great way to bring technology to those who might not consider using it, but being a maker is about creativity, collaboration, and producing new ideas. Makers exist regardless of budget, so keep that in mind and develop spaces that your library can support and staff.

Your space doesn't even need to be a space. It can be a series of programs, if that's what fits your library. When funds are unavailable, the focus can be on creative workshops featuring low-cost materials and big ideas. Once you decide what resources you can commit, look for ways to develop programming that fits the demographics of your users.

There are so many directions you can take with your makerspace. A technology-based space is a big draw. Spaces with 3D printing, laser engravers, robotics, and electronics are very popular. These are the typical spaces libraries envision when planning a makerspace.

Crafting and art makerspaces can be created with a little less funding. These spaces can include sewing, quilting, knitting, painting, writing groups, and anything you think will be appealing to your users. Another plus with this type of makerspace is that it can be set up for users of all ages.

Media spaces include video and audio recording studios and go very well with libraries that lend musical instruments. These spaces are becoming more popular, but much like the technology spaces, they require a great deal of staffing, training, and funding.

The focus for your makerspace should reflect your users' interests and your library's ability to staff and fund the space. As with any large project, starting with a focus allows you to ensure you've covered all the bases. It is very easy for your makerspace vision to branch in multiple directions. Keeping a focus will prevent that from happening and allow you to design the best possible space.

Once your space is up and running and you know what you've gotten yourself into, you'll have a better idea of what you might need to add. Makerspaces are spaces of continuous change. Additions will be constant, but starting with a single focus will allow you to face changes and additions without becoming overwhelmed.

## **Establish Funding**

A major component to any new endeavor is funding, and a makerspace is no different. In fact, because of the potentially huge costs, funding them can be even more of a concern. Whether you are funding the space with your current budget or applying for grants, it's important to factor in everything you will need to make your space a success.

A makerspace requires a great deal of planning. Using the information from this book will help you lay out a solid plan, but, as with any large project, there will be things that you never saw coming. To start with, plan for the costs of equipment, repairs, maintenance contracts, supplies, staffing, training, and construction, and then add a contingency to be safe.

Once you've done that, you can determine if you'll need outside help to fund your space. Luckily, makerspaces are appealing to grantors, so the time to apply for grants is now.

## How to Win a Grant

Larger libraries and institutions will often have a person on staff to guide you through the grant process. Your grant officer knows what grants are available, and their requirements. This is often the case with schools and universities as well. Institutions that already receive federal funding may have restrictions on what grants they can pursue. Be sure to check with your administration before you seek funding.

Grants come in many sizes from many places. Some are highly competitive, some are not. Use your networking skills and talk to people. Talk to people in public office and your state library, and seek out information from others who've been successful in obtaining grants. Talk to other makerspace librarians, and ask them if they applied for grants and which ones they received.

Federal grants can be very competitive, but this is not always the case. Federal grants offer big rewards, but require detailed paperwork, stipulations, and reporting. When you're seeking grants, research past recipients. This will give you a better idea of what grantors want to fund. Federal grants require a great deal of paperwork, so be ready to have your ducks in a row if applying for a federal grant. The Institute of Museum and Library Services (IMLS) is the largest source of federal funding. IMLS grants serve initiatives outlined in the Library Science and Technology Act (LSTA) and are offered throughout all fifty states, with over 2,500 grants available.<sup>2</sup>

Local grants can be found at the state, county, and community level. These grants can be less competitive than federal grants. They also tend to be more specific and offer less funding. Local grants come from an array of sources, from trust fund distributions to local businesses.

Edutopia.org lists multiple funding sources, including company funding from PG&E Bright Ideas, Botball Robotics, ING Unsung Heroes, and Lowe's Toolbox for Education.<sup>3</sup> Another source for finding grants for libraries and schools is Scholastic's Activities and Programs web page ([www.scholastic.com/librarians/programs/grants.htm](http://www.scholastic.com/librarians/programs/grants.htm)), which features information on grants and their requirements from an array of sources, including the Paul G. Allen Family Foundation, the MBNA Foundation, RGK Foundation, the National Endowment for the Humanities, and the W. K. Kellogg Foundation.<sup>4</sup>

Crowdfunding is being used to raise money for everything under the sun, so why not for your makerspace? There are many options for setting up crowdfunding; some are open to anything you want to fund and others are specific to education. Give crowdfunding a try. GoFundMe, Kickstarter, Indiegogo, Patreon, and Crowdrise are just a few examples. Educators have found success using DonorsChoose.org, a crowdfunding source that is set up to allow donors to choose educational projects to fund. Some libraries simply share their makerspace-focused Amazon Wish List with patrons and businesses in their local communities.<sup>5</sup> There are many options available today that weren't available just a few years ago. Try them all out and see what sticks.

Grantors love to see collaborations. Makerspaces are perfect for collaborative ventures among schools, universities, businesses, and small-business development agencies. Seek out local agencies to build partnerships that benefit the community, schools, or local businesses.

Your makerspace is in a prime position to promote technology, small-business creation, and job growth. These are all selling points.

## **Get Started without Funding**

We'd love to think every makerspace will receive unlimited funding, but sad to say that will not always be the case. So, what do you do when you desperately want to start a makerspace but don't have the funds? You do what makers are meant to do: get creative.

You can have an inviting and appealing makerspace on a shoestring. There are many ideas out there for items that don't cost an arm and a leg (many of which are discussed in this book). Paper crafts are extremely cost-efficient. From origami to book art (using withdrawn books) to creating apps, you can make it happen on the smallest budget.

The makerspace movement does not rely solely on high-priced technology. Making through shared interests has always been a part of our libraries. We've done this through much of the programming we've always offered. With some adjustment, this same technique can be applied to your budget makerspace.

Making can be as simple as featuring a building contest with Legos or hosting something more technical like a hackathon. Your makerspace does not always have to provide equipment and materials; you can bring together groups to share what they've done and learn from each other.

If you work at a school library, consider hosting a space where students can make and display dioramas, science projects, crafts, and jewelry (something



along the line of friendship bracelets). After all, what you want is for students to come to your library and collaborate in fun ways with fellow students. These kinds of activities in your makerspace would also be a great way to get faculty and librarians working together.

Most of us have computers in our libraries. There are many free design websites. Host some training to help your students create videos on their phones and upload them to free video editing apps, run a contest for the best Vine, create a school YouTube site, encourage the English faculty to have students supplement their literature studies with things like funny video spoofs of a book their class has read.

A public library can offer many of the same activities, and with its larger demographic there are even more low-cost options. Public libraries can host local artists in their spaces. Offer a “bring your own supplies” art project that introduces your users to other budding artists who can continue to meet at your library. Crocheting, knitting, graphic design using free software downloads—there is no end to what you can offer on a no-cost or low budget.

Ask for the things you need. Donated items are a great way to build your makerspace. Let your users know what you need; they may have that item to donate. Conduct a tool drive in your community.<sup>6</sup> Local companies are a good place to look for donations of small machinery and used technology.

If you have a small budget, all the better. You can still build a great space. The most important part of your space is simply that it encourages collaboration. If you can include a few tools and inexpensive equipment and suggest project ideas, you have a makerspace. The tools and equipment do not need to be expensive. Equipment for jewelry-making and scrapbooking are inexpensive, yet are fun and creative ways to interest your users.

You can still add an electronics component to your space without incurring huge costs. Edutopia has featured many ideas for what it refers to as “unmaking.”<sup>7</sup> Who hasn’t wanted to take apart a piece of electronic equipment to discover what’s inside? Unmaking uses recycled electronics to allow users to learn about electronics by taking them apart and putting them back together.<sup>8</sup>

## Evaluate Your Space Design

There are many aspects to take into consideration when designing your makerspace. The equipment you install in your makerspace will be very different from what’s found in a traditional library. The way this space is used will be different than any other library space. The library of the past was based around quiet study.

Although we still need quiet spaces, the makerspace will be noisy. Even if you don't have noisy equipment, a successful space is a collaborative space, and collaboration means people must talk to each other. Excited users are not quiet; nor should they be. Locate your space in an area where talking won't be disruptive to quiet study areas.

Some libraries will be repurposing a current space to house a makerspace. Be prepared to call the electrician. The maxim "you can't have too many outlets" has never been more true than it will be in your makerspace. Because many pieces of equipment will be required to support technology and computers, data ports have become the new electrical outlets. Add more than you need, and then add a couple more.

Some equipment will need proper ventilation, which is a bit easier to address in a new space. If you are repurposing an older space, you'll need to check with an architect to see if ventilation is possible. Heat and moisture can wreak havoc on technology and even some of your supplies. 3D printer filament is temperamental once opened, so a moisture-proof container is a must. Equipment can easily overheat in any environment. Electronics fans are usually inexpensive and can save costly repairs due to overheating.

Supplies can take up much more space than anticipated. If your tools break, you'll need more tools to fix them. These things quickly collect; and having a space already planned for all the extras will ensure you have a clean area and your supplies are organized for easy access.

Dealing with makerspace waste material is sometimes an afterthought. Much of your makerspace waste is recyclable. Having a place to store recyclable materials is a must. In addition to scraps from filament, paper projects, and metal, you may have waste from batteries or that requires specific disposal and recycling precautions. Research your local outlets to learn where you can safely recycle or dispose of these materials.

If it's possible to add plumbing to your space, this can be a real plus. Although not essential, a sink in your space can be quite helpful. Makers make messes too, and a convenient way to clean up is quite handy.

Whether your space is large or small, creating a diagram of the way you will lay out your equipment, work areas, electrical outlets, and data ports is essential. Take measurements of equipment before you order it and allow enough space for the equipment to be used properly. For instance, a large-format poster printer takes up more space than a regular printer. Posters need to be laid flat, and professional large-poster cutters need to be mounted to a table, which can take up a huge amount of space. Although you can easily determine how big the printer

will be and plan for its footprint, the space needed to create with printing posters and banners may be a surprise. Legos, Erector Sets, and electronics kits can easily be stored in small areas, but do you have a space designated for users to spread out and use them? If not just improvise, as Diana Rendina did for her Lego Wall at Stewart Middle Magnet School in Tampa, Florida. Diana created space on a wall for building with Legos to optimize her small space.<sup>9</sup>

Computers will take up a lot of space if you are using equipment that needs specific software to operate. 3D printers, vinyl cutters, and data-driven equipment will need space for the computers that support them.

When planning your space, there are many considerations that won't come to mind. Besides planning for electrical, bandwidth, and the size and layout of your equipment, you will need to envision and design a plan that includes space for all the extras. Keep in mind that workspace and supplies storage will be just as essential to your space as the equipment.

Although there are many considerations when creating your makerspace, the main thing is to create a space that fits the needs of your community. Once you determine what kind of makerspace you want to establish, look at the budget you have available and make a plan. Don't be deterred by the cost—there are always ways to create an effective makerspace on any budget.

## Getting Started—Equipment Lists

Here are some sample starter equipment lists for you to consider, depending on the type of makerspace you'll be building as well as your library's budget.

### Technology-Focused Makerspace Starter Kit

(Estimated Cost \$3,300)<sup>10</sup>

- Makey Makey (\$50)
- Squishy Circuits (\$25)
- Minecraft EDU (\$25)
- LEDs (\$30)
- LED batteries (\$14)
- copper tape (\$20)
- Scratch (free)
- Tackk (Free documentation website)
- paper/vinyl cutter (\$350)
- 3D printer (\$2,500)
- Arduino Adventures parts kit (\$60)
- Raspberry Pi kit (\$90)
- Legos (\$50)
- Snap Circuits kit (\$60)

## **Bigger Budget Technology-Focused Makerspace Starter Kit**

(Estimated Cost \$21,000)<sup>11</sup>

- OWI Robotic Arm Edge robot arm (\$50)
- LEGO MINDSTORMS Education NXT Base Set (\$500)
- GCC Expert 24 Vinyl Cutting Plotter with stand and heat transfer vinyl pack (\$820)
- 3Doodler pen (\$99)
- Anthrotab 20SSPW multi-charging unit (\$614)
- Zotac ZBOX-ID90-P Intel Core i7 3770T,4GB RAM,500G HDD, Intel HD4000 Graphics integrated by CPU, Mini PC, and 55-inch GVision large format touch screen display (for presentation room) (\$595)
- Logitech MK550 Black USB RF Wireless Ergonomic Wave Combo (\$80)
- Erector Set (\$81)
- Architect Lego set (\$160)
- FlipBooKit Moto (\$99)
- EL-Wire starter kit, 25 feet (\$40)
- Starter Pack for Arduino (includes Arduino Uno R3) (\$65)
- Flip video camera—White, 30 minutes (\$80)
- Parallax BOEBot Robot for Arduino Kit (\$124)
- Ultimaker PLA filament spools (assorted colors) (\$65 per spool)
- Microsoft Surface 2, 64 GB (\$449)
- Microsoft Surface Power Cover (\$199)
- Wakom Intuos Pro Pen & Touch Special Edition (\$379)
- Accucut Original Mark IV Super Starter Set—Early Childhood (\$1,999)
- Xyron 2500 Machine (\$1,480)
- Ultimaker 2 3D printer (\$2,500)
- LulzBot TAZ (\$2,200)
- Canon imagePROGRAF iPF750 36-inch large format printer (\$3,495)
- digital cameras (\$259 each)
- green screen and lighting kit (\$179)
- Cricut Scrapbooking vinyl/leather/paper cutting machine (\$250)
- Sprout 3D scanner/printer (\$3,000)
- Adobe Photoshop (\$179)

## Media—Video-Focused Makerspace Starter Kit

(Estimated Cost \$7,200)<sup>12</sup>

### Hardware

- Canon PowerShot A2300 digital camera (\$211)
- Canon Eos Rebel T3i digital camera (\$250)
- Sony Bloggie camcorder (\$175)
- Panasonic camcorder (\$500)
- Kodak Play Touch video camera (\$200)
- flash drives, SD cards, and readers (\$5 each)
- HP Photosmart 5510 color scanner/printer (\$385)
- Digital Concepts tripod (\$20)
- 85-watt photo light (\$15)
- 10 x 9-foot green screen wall (\$75)
- two Shure SM28 microphones with stands (\$99 each)
- HP Compaq 6200 Pro SFF computer (\$215)
- HP Compaq 4000 Pro SFF computer (\$109)
- 27-inch iMac computer (\$2,000)

### Software

- Adobe CS 6 Production Premium—Photoshop, Illustrator, Premiere Pro, and more (\$2,600)
- iLife Suite—Garage Band, iMovie, and iPhoto (\$45)
- Audacity—for audio recording (free)
- Cyberlink Power Director 8—movie-making software (\$25)
- Microsoft Office (\$90)

## Media—Sound-Focused Makerspace Starter Kit

(Estimated Cost \$7,500)<sup>13</sup>

- ProTools (\$299)
- Sibelius (\$280)
- Audacity (free)
- Garage Band (\$45)

### Video

- Final Cut Pro (\$300)
- Adobe Creative Suite (\$1,500)
- iMovie. (\$15)

### Audio

- iMac with software and 27-inch monitor (\$1,763)
- Eleven Rack guitar rack (\$699)
- Scarlett 2i4 USB audio interface (\$169)
- Novation LaunchKey 49 MIDI board with drum pads (\$150)
- Shure SM57 dynamic microphone (\$99)
- Blue Yeti Pro USB condenser microphone (\$150)
- condenser shotgun microphone (\$80)
- Sennheiser headphones (\$90)
- handheld boom poles (\$125)

### Video/Film

- Canon XA10 HD camcorder (\$800)
- camera tripod with revolving head (\$25)
- three stand-up lights with softbox/diffuser kits (\$175)
- green room (green walls/floor) (\$100)
- portable green screen (\$75)
- Canon Rebel T5i (\$600)

## Low Budget, Elementary School-Focused Makerspace Starter Kit (Estimated Cost \$500–\$1,000)<sup>14</sup>

- sewing supplies (needles, thread, scissors, fabric) (\$100)
- ribbon, yarn, string (\$30)
- Legos, K'NEX, building blocks (\$50)
- all types of paper (wrapping paper, card stock, construction paper, printer paper, scrapbook) (\$200)
- Post-it Notes (\$50)
- markers, pens, crayons, etc. (\$50)
- cardboard of any kind, from food packaging to large appliances (free; flattened please)
- cardboard tubes from wrapping paper, toilet paper, paper towel, etc. (free)
- Play-Doh (\$20)
- circuitry kits (can be purchased online) (\$20–100)
- craft supplies (cotton balls, popsicle sticks, paint, tape, low temperature hot glue gun, glue gun sticks, glue and glue sticks, toothpicks) (\$100)
- canvas, art supplies (\$100 and up)
- cameras, photography equipment (\$50 and up)

- things to take apart, such as old or broken electronics and small devices (donations)
- hammers, screwdrivers, pliers (\$100)
- nails, screws, bolts (\$50)
- storage containers—tubs, baskets (\$50)
- dominos, marbles (\$50)
- playing cards (used for building items) (\$20)
- batteries (various sizes) (\$50)

### **Dream Budget—Milling/Power Equipment Focused Makerspace Equipment List** (Estimated Cost \$30,000—\$50,000)<sup>15</sup>

- large Matsuura RA-1F Vertical CNC milling station (Red Dragon) (\$2,000)
- tabletop gear lathe (Central Machinery) (\$4,000)
- drill press (Speedway) (\$100)
- metal lathe (South Bend Lathe Works) (\$4,000)
- bandsaw, vertical (Do-All) (\$2,000)
- drill presses and table (Rockwell) (\$600)
- hydraulic press (\$300)
- disc sander (\$200)
- bench grinder (Farm & Fleet) (\$40)
- cut-off/chop saw (Milwaukee) (\$200)
- 7 x 12-inch bandsaw, vertical/horizontal with coolant tank (Wilton) (\$2,000)
- bench top lathe (Delta) (\$500)
- hand grinder (Skil) (\$50)
- drill bits, taps, etc. (\$50)
- nuts, bolts, etc. (\$50)
- large vise (\$30)
- forge (\$1,265)
- casting furnace (\$55)
- centrifugal spin caster (\$500)
- anvil (\$100)
- post vise (\$1,600)
- forging hammers (\$200)
- electric arc welder (Lincoln) (\$450)
- ESAB PCM-1125 plasma cutter (\$679)
- compound miter saw (Dewalt) (\$399)
- CNC router (\$2,000)

- router table (Craftsman) (\$200)
- scroll saw (Delta) (\$45)
- lathe tools (\$75)
- combination disc/belt sander (Craftsman) (\$89)
- laser cutter (\$3,499)
- MakerBot Replicator (\$2,500)

## **Identify Your New Roles**

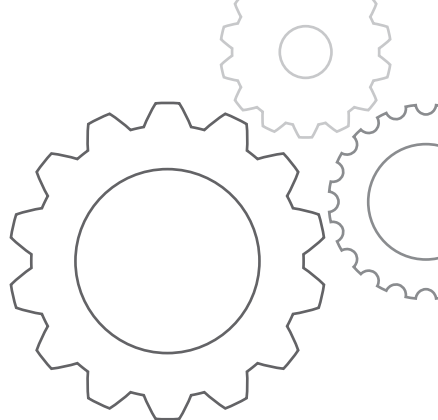
Librarians are no strangers to adapting to new technology and new environments. However, the pace at which we need to adapt is increasing. Librarians who embrace this world of constant change have easily moved into new roles, including the makerspace. Managers of makerspaces and technology-driven spaces must set clear expectations and provide professional development to adequately prepare staff for their new roles. We do a huge disservice to our users and our staff when we roll out new equipment without first providing the training needed to operate and troubleshoot the equipment.

## **Determine Expectations**

We all have lofty expectations for librarians who operate makerspaces. Realistically, we won't necessarily find a librarian who knows everything there is to know about each piece of equipment. In this case, as with any position in the library, we're looking for more than one specific skill set. Ideally, we'd love to fill these positions with librarians who've been trained in engineering and information technology, but that's not very realistic. As with any library position, we look for approachability, creativity, and the drive to be a lifelong learner. These qualities are essential for the makerspace librarian. There will always be users who need friendly, knowledgeable assistance to help them find opportunities to use makerspaces creatively. I've found that users relate well to librarians who've started as novices and learned through trial and error. It seems to introduce a certain comfort level, especially for curious new users who might be intimidated by the equipment.



# index



## A

- Abbas, J., 35
- ABS plastic
  - qualities of, 89
  - toxicity in, 81
- academic libraries
  - class visits to makerspace, 58
  - cross-disciplinary work encouraged by, 347
  - Lego projects, 203–204
  - makerspaces of, 5–6, 349
  - user visions for makerspace, 55
- access
  - library for access to information, 346
  - library makerspaces support, 34–35
- accessibility
  - of makerspace, 334
  - of mobile makerspace, 316
- acrylic, 234–236
- active learning
  - with Legos, 194, 209
  - overview of, 30–31
- Adafruit
  - for Arduino purchase, 137
  - Arduino Selection Guide, 136
  - Flora, 160, 291
  - Gemma, 161
  - Raspberry Pi purchase from, 116
  - wearable electronics tutorial, 162
- ADDIE (analyze, design, develop, implement, evaluate) model
  - instructional design models based on, 38
  - learning event, design of, 41
  - rapid prototyping and, 38
- advertising, 334
- Afinia H480 3D printer, 91
- Agency by Design, 62, 64
- agreement, 76
- Albertsons Library's MakerLab
  - See* Boise State University Albertsons Library's MakerLab
- All About Pi project, 123–125
- Allen County Public Library, 329
- ALSC (Association for Library Service to Children), 202
- “Alternative Drone Technologies for Aerial Photography and Videography” workshop, 282
- Amazon
  - Prime Air, 264, 278
  - Raspberry Pi purchase from, 116
- American Association of School Librarians, 353–354
- American Library Association
  - for 3D printer inquiries, 93
  - values of, 365
- analysis, 38
- Anderson, Chris, 351
- Android OS
  - Cardboard Virtual Tours project, 190
  - Google Cardboard smartphone requirements, 182–183
  - Google Cardboard workshop and, 188
  - Google Cardboard/VR games, 190–191
- anode, 165
- Anthony, Laura, 296
- applications
  - Google Cardboard app, 180–182
  - Google Cardboard workshop, 187–189
  - in K–12 library makerspaces, 6
  - MIT App Inventor 2 projects, 298–299
- AR (augmented reality), 357–358
- Arapahoe Library, 167
- ARC device, 103
- Arduino
  - board, tips for, 138–139
  - board, use of, 137–138
  - boards, major available, 136–137
  - description of, 135–136
  - electronic components, 140
  - Flora and, 160
  - Gemma and, 161
  - libraries' use of, 141
  - LilyPad's use of, 158–159
  - Multiwii upload to, 282

- Arduino (*continued*)
    - physical computing with, 290–291
    - projects, 142–155
    - wearable electronics, programming, 163
  - Arduino IDE
    - Arduino Blink project, 143–146
    - for Arduino Setup project, 142–143
    - description of, 135, 136
  - Arduino Setup project, 142–143
  - Arduino Uno
    - as most versatile board, 136
    - Room Occupancy Sensor project, 151–155
    - for Temperature Sensor project, 148–151
    - for Traffic Light project, 146–148
    - use of, 137–138
  - ArduPilot Flight Controller, 282
  - Aristotle, 33
  - art
    - Interactive Artwork with Paper Circuits project, 226–227
    - with Legos, 198
  - Art Bot project, 300
  - art makerspace
    - as low cost, 8
    - at public library, 11
  - The Art of the Brick* (Nathan Sawaya exhibition), 198
  - Artisan's Asylum's, 7
  - Arts and Scraps, 319
  - Asgarian, R., 167
  - Asimov, Isaac, 246
  - assessment
    - backward design oriented to, 40
    - of library makerspaces, 360–361
    - of makerspace cost/benefits, 333
  - Association for Library Service to Children (ALSC), 202
  - Association for Unmanned Vehicle Systems International, 264
  - Association of College and Research Libraries, 354
  - augmented reality (AR), 357–358
  - autism, 335
- B**
- backward design, 39–40
  - badging, digital, 336
  - Bare Conductive, 220
  - battery
    - circuitry kits, use of, 221
    - coin battery, 250
    - drone assembly, 267, 270, 273–274
    - troubleshooting circuitry project, 222, 223
  - battery holders, 166, 169
  - BeagleBone, 290
  - Beginner Robots with littleBits project, 227
  - behavior, 335
  - Best Library Contest, 206
  - Birch, L., 158
  - Blink project, 143–146
  - block parties, Lego, 201–202
  - blog
    - for keeping up with maker movement, 340–341
    - for makerspace user training, 22
  - BlueJ, 261
  - Bluetooth, 184
  - Boise Public Library, 55
  - Boise State University Albertsons Library's MakerLab
    - Creative Technologies Association, 66–67
    - diversity of users, 63
    - inclusive culture at, 60–61
  - bookmark, LED Fabric Bookmarks project, 168–169
  - bookmobile, 308
  - Booth, Char, 288
  - bracelet, LED Cuff Bracelets project, 169–170
  - Bradbury, Ray, 175
  - Branson, R. K., 38
  - Brasier, Gregory, 51–69
  - breadboard
    - solderless, 138
    - for Traffic Light project, 146–148
  - BRIC Arts | Media | Bklyn, 329
  - Brick Fanatics website, 195
  - Bristlebots project, 251–252
  - brochure, for makerspace, 27
  - Bronkar, Cherie, 3–27
  - Brooklyn Central Library, 296
  - Brooklyn Public Library, 329
  - Brown, Deana, 51–69
  - Brown, Tim, 355
  - Bruffee, K. A., 31
  - Bruning, Lynne, 164
  - Bruno, Tom, 175–191
  - Buck Institute of Education, 32
  - budget, 331–332
    - See also* funding
  - Buechley, L.
    - LilyPad Arduino, release of, 158
    - on *Make* cover images, 60
    - Sew Electric*, 162
  - build plate, 95
  - build platform
    - leveling, 95
    - of MakerBot Replicator 2X, 93–94
    - troubleshooting mechanical issues, 102
  - Build Your Own Cardboard Device project, 186–187

- building
  - drones, assembly of, 269–274
  - drones, skills/tools involved, 268–269
  - physical robot, 246, 248
- building permit, 78
- Business Hours Decal project, 238–239
- buzzers, 165–166
- C**
- Cabell Library at Virginia Commonwealth University, 203
- CAD software, 89
- California State University, San Bernardino, 141
- camera, 265
- Cardboard
  - See* Google Cardboard
- Cardboard Virtual Tours project, 190
- Carnegie, Andrew, 31
- Carnegie, Dale, 30
- Carnegie Library of Pittsburgh, 336
- case, for Raspberry Pi, 118, 119
- Case Western Reserve University, 5–6
- cathode, 165
- Certificate of Waiver or Authorization (COA), 265, 277–278
- change, 35–36
- Charlotte Mecklenburg Public Library, 5
- chat, 65
- Chattahoochee Valley Libraries, 297
- Chattanooga Public Library, 4th Floor at, 233
- chemical structure, 108–109
- Circuit Stickers, 218–219, 225–226
- Chibitronics, 218–219
- Chicago Public Library, Maker Lab at, 233
- children, usage policies for makerspace, 26
- Chinn, C. A., 32
- Chiolerio, A., 157
- Choregraphe, 260
- circuitry
  - Circuit Stickers, 218–219
  - circuitry kits, how to use, 221–222
  - circuitry kits, in general, 213–214
  - conductive materials, 220
  - Electrochromatic Circuits project, 171–172
  - libraries' use of, 223–224
  - littleBits, 215–216
  - Makey Makey, 214–215
  - projects, 224–228
  - Snap Circuits, 217–218
  - tips/troubleshooting, 222–223
  - Toy Hacking project, 300
  - wearable electronics, safety of, 162
  - wearable electronics, teaching about, 157
- circuitry kits
  - in general, 213–214
  - libraries' use of, 223–224
  - littleBits, 215–216
  - Makey Makey, 214–215
  - use of, 221–222
- CityScope (Lego model), 198
- Clark, Chad, 287–302
- class visits, 58
- cleaning
  - of Legos, 200
  - of makerspace/equipment, 80
- Cleveland Public Library, 336–337
- clothing, 76
  - See also* wearable electronics
- CNC
  - See* computer numerical control
- COA (Certificate of Waiver or Authorization), 265, 277–278
- coat rack, 79
- code, hacking with, 289
- Code Avengers, 261
- Code HS, 262
- code of conduct, 335
- Codecademy.com, 261
- Code.org, 261
- Coder Dojo, 296–297
- coding
  - Arduino programming tips, 138–139
  - circuitry kits and, 222
  - Coder Dojo, 296–297
  - drone flight computer, 268
  - Hour of Code event, 296
  - learning to code with robots, 257–260
  - Makey Makey with Scratch, 215
  - robots, 246, 247
  - See also* programming
- Cohen, Kris, 59
- coin battery, 250
- Colegrove, Tod, 347
- collaboration
  - for community of makers, 335–336
  - grant for makerspace and, 10
  - library makerspaces for, 347
  - makerspace encourages, 11
  - noise with, 12
  - with Raspberry Pi, 113
  - as twenty-first century skill, 353, 354
- collaborative learning, 31
- comments, in Arduino, 139
- commercial 3D printing services, 102
- communication
  - about mobile makerspaces, 317

- communication (*continued*)
  - in diverse maker culture, 65–66
  - as twenty-first century skill, 353
- community
  - creation of, 66–67
  - donations of mobile makerspace supplies, 314
  - embracing, 334–335
  - funding for makerspace from, 329
  - hackerspaces for building, 289, 302
  - libraries as community hubs, 347
  - of makers, building, 335–338
  - makerspace, creation of, 66–67
  - makerspace focus on, 51–52
  - mobile makerspace, engagement with, 310
  - mobile makerspace, reasons for, 309
  - outreach, 59–60
  - of practice, building, 45–46
  - Raspberry Pi community, interaction with, 119–120
  - understanding, 332–334
- competitions, 45
- Compton, Mary, 307–323
- computer
  - for CNC, 231
  - for coding/programming robotics project, 247
  - space for in makerspace design, 13
- computer numerical control (CNC)
  - description of, 229
  - fully enclosed, 81
  - libraries' use of, 233
  - projects with, 234–243
  - safety suggestions for, 82
  - software/hardware, 230–231
  - tips for, 231–233
- Computer Science Education Week, 296
- conductive ink, 226–227
- conductive materials, 220
- conductive tape, 218–219, 220
- conductive thread
  - Electrochromatic Circuits project, 171–172
  - insulation techniques for, 164
  - in LED Fabric Bookmarks project, 169
  - Plush Game Controllers project, 172–173
  - use of, 163–164
- conferences, 338
- Considine, Sue, 337–338
- construction kits, 158
- constructionism
  - overview of, 33
  - prototyping as pedagogy, 37
  - for safe makerspace environment, 59
- control software, of 3D printer, 91
- Cooper, Tyler, 165
- Copenhagen University Library, 203, 207
- copper tape
  - Circuit Stickers, 218–219
  - for circuitry projects, 220
  - for Interactive Artwork with Paper Circuits project, 226–227
  - for Light-Up Board Games project, 225–226
- Costello, Laura, 29–49
- costs
  - of drones, 266–267
  - fees, alternatives to, 328–331
  - fees for patrons to cover, 326–328
  - of makerspace, sustaining funding, 325–326
  - makerspace focus and, 7–8
  - makerspace policy and, 24–25
  - of mobile makerspace, 311–313
  - starting makerspace without funding, 10–11
- CR1220 PCB Mount Battery, 166
- crafting makerspace
  - as low cost, 8
  - Scrapmobile, 319
  - 3D printing for craft project, 103
- Craigslist, 199
- crash, 232
- Create a Virtual Magic 8-Ball project, 301
- Create Your Own Cardboard Content project, 189–190
- “Create Your Own Character” Coloring Contest, 205
- Creative Technologies Association (CTA), 66–67
- creativity
  - applied, 364
  - assessment of library makerspace and, 360
  - library makerspace programming and, 354–355
  - opportunities for with makerspaces, 363
  - as twenty-first century skill, 353, 354
- credentials, 336
- Cricut Design Space, 230
- Cricut Explore, 230
- critical thinking, 353
- crowdfunding
  - for makerspace funding, 330–331
  - for Oculus Rift, 176
  - options for setting up, 10
- CTA (Creative Technologies Association), 66–67
- Cubelets
  - link for purchasing, 246
  - project, 255–256
- culture
  - of creativity, Legos and, 209
  - hackerspace program and, 288
  - of makerspace, 4
  - of safety, creation of, 74

- skill development from, 61–65
  - See also* maker culture, diverse
- Cupertino Library, 297
- curriculum
  - incorporation of making into, 336
  - learning events and, 41
  - materials for library makerspaces, 43–44
- cutting machine
  - Business Hours Decal project, 238–239
  - overview of, 230
  - Personalized Cat Decal project, 239–241
  - T-Shirts I and II project, 241–243
- D**
- Danbury Hackerspace @ the Innovation Center, 297
- Darien Public Library, 282
- Dash and Dot robots
  - link for purchasing, 246
  - project for learning to code with, 257–258
- data, 183–184
- data ports, 12
- data visualization, 359
- DC Public Library, 297
- decal
  - Business Hours Decal project, 238–239
  - Personalized Cat Decal project, 239–241
  - T-Shirts I and II project, 241–243
- Delaney, Ann, 51–69
- Delecki, Kevin, 73–84
- Deloitte Consulting, 61
- Demco, 331
- Demmons, Chris, 279
- Denver Public Library (DPL)
  - “Open Code sessions with Coder Dojo,” 296–297
  - Raspberry Pi use at, 120–122
- design
  - ADDIE model, 38
  - instructional design, basics of, 37–38
  - instructional design models, 38–40
  - of makerspace, evaluation of, 11–13
  - of makerspace for safety, 78–79
- design challenge, 224
- design thinking
  - definition of, 62
  - library makerspace programming and, 355–356
- Dewey, John, 31
- digital badging, 336
- digital divide, 55–57
- Digital Harbor Foundation
  - FabSLAM competition, 45
  - Maker Camp programs, 103
  - resources of, 44
- digital light processing (DLP), 88
- digitally interfaced book, 301–302
- Digitally Interfaced Book: Paper, Graphite, Makey Makey, Scratch, and Imagination* (National Writing Project), 302
- Dimension* control, 97
- diorama, 224–225
- Disney, 177
- Dive City Rollercoaster, 188–189
- diversity
  - definition of, 52
  - of makers/makerspaces, 351–353
  - of makerspace users, 63
  - See also* maker culture, diverse
- DIY Cardboard kits
  - Build Your Own Cardboard Device project, 186–187
  - options for, 176–178
- DJI, 266
- DLP (digital light processing), 88
- documentation, 45
- dollar store, 294
- donations
  - of Legos, 199
  - for makerspace, 11, 329–330
  - of mobile makerspace supplies, 314
- DonorsChoose.org, 10, 330–331
- Doodle Fab, 106–107
- DPL
  - See* Denver Public Library
- driver, of mobile makerspace, 316
- “Drone Buying Guide” workshop, 282–283
- drone racing, 283
- drones
  - assembly of, 269–274
  - building, skills/tools involved in, 268–269
  - conclusion about, 283
  - drone part list, 283–285
  - flight skills, 274–276
  - future of library makerspaces and, 358–359
  - history of, 265
  - libraries’ use of, 277–279
  - overview of, 263–265
  - projects with, 279–283
  - regulations, 266
  - tips for, 276–277
  - types, brands, models of, 266–267
  - use of, 267
- Dumas, Rob, 229–243
- Dunbar-Hester, C., 62–63
- Duncan, R. G., 32
- Duncan, Suzette, 54
- DUPLO Lego brick, 195
- “dyna-micro,” 114

**E**

eBay, 199

education

- library as agent of change, 35–36
- maker education as learner-driven process, 36
- maker education of library staff, 361–362
- mobile makerspace and, 320

Edutopia

- funding sources listed by, 9
- for lesson plans, 43
- “unmaking” ideas, 11

Edwards, S. L., 64

Egbert, Megan, 157–173

Eight Learning Events model, 40

Einstein, Albert, 32

electricity, 317

*See also* circuitry

Electrochromatic Circuits project, 171–172

electronic components, of Arduino, 140

electronic cutting machine

*See* cutting machineElectronic Speed Controller (ESC), 270–271, 272  
electronics, 293–294*See also* wearable electronics

Elenco, Snap Circuits, 217

Eliasson, Olafur, 195, 198

empathy, 62

empowerment

- makerspace and, 52
- micro-empowerment, 60–61
- of users, mission of, 63–64
- of users in makerspace, 56

entrepreneurship

- argument about makerspaces and, 364
- business startup workshops for, 22

environment

- of library makerspaces, 37
- open/inclusive, 364–365
- welcoming, safe, low pressure makerspace, 337
- See also* design

equipment

- charging fees to patrons, 326–328
- costs of, 328
- costs of, policy for, 24–25
- diverse maker culture and, 51–53
- makerspace design and, 11–13
- makerspace equipment safety, 80–83
- manuals for, 19
- for mobile makerspace, 313–314
- policy for makerspace, 23–24
- staff training for, 20, 21
- supervision of makerspace, 75–76
- usage policies for, 25–26

user safety in makerspace, 76–77

workspace safety, design for, 78–80

equipment lists

- bigger budget technology-focused makerspace starter kit, 14
  - dream budget-milling/power equipment focused makerspace equipment list, 17–18
  - low budget, elementary school-focused makerspace starter kit, 16–17
  - for makerspace, 13–18
  - media-sound-focused makerspace starter kit, 15–16
  - media-video-focused makerspace starter kit, 15
  - technology-focused makerspace starter kit, 13
- ESC (Electronic Speed Controller), 270–271, 272

ETextile Lounge, 162

e-textiles

*See* wearable electronics

“eTextiles: How to Select Fabric” (Bruning), 164

ethics, hacker, 287

Etsy

- Lego creations on, 194
- rise of, 349, 350

evaluation

- ADDIE model, 39
- of makerspace program, 45
- See also* assessment

events

- charging patrons fee for, 327–328
- for creating community, 66–67

exhibitions, of hackerspace program, 292

expectations

- for CNC class, 231, 232
- for makerspace, 18

extruder

- filament, load/unload, 94–95
- of MakerBot Replicator 2X, 93
- printing of 3D model, 99
- troubleshooting mechanical issues, 101–102
- eye protection, 76

**F**

FAA

*See* Federal Aviation Administration

fabric

- LED Cuff Bracelets project, 169–170
- LED Fabric Bookmarks project, 168–169
- Light Locked Wallets project, 170–171
- Plush Game Controllers project, 172–173
- selection/care of, 164–165

FabSLAM competition, 45

face protection, 76

- Facebook
    - groups, list of, 338–339
    - Legos presence on, 195
    - for makerspace user training, 22
  - Farnham, S. D., 63
  - Fast, Grayson, 103–104
  - Fayetteville Free Library
    - budget for makerspace, 332
    - community-led makerspace of, 333
    - internal relationships in library, 337–338
    - volunteer program of, 336
  - FDTI breakout board, 159–160
  - Federal Aviation Administration (FAA)
    - COA from, 265
    - drone regulations, 266, 358
  - federal grants, 9
  - fee
    - alternatives to, 328–331
    - charging patrons, 326–328
    - for makerspace, 25
  - filament
    - loading/unloading, 94–95
    - troubleshooting mechanical issues, 101–102
  - file types, 96
  - filtration, 79, 82
  - Finals Stressbusters project, 203
  - Finch Robot, 246, 259–260
  - fire extinguisher, 79
  - First Person View (FPV)
    - description of, 264
    - drone buying workshop, 282–283
    - drone images displayed to, 263
  - first-aid kits, 79
  - Fisher, Erin
    - on guiding purpose of makerspace, 53
    - on makerspace equipment, 51
  - Fixit Clinic, 295–296
  - Fleischer, Corey, 103
  - flight computer, 272
  - flight controller, 267, 272
  - flight skills, drones, 274–276
  - flooring, of makerspace, 78
  - Flora, 160, 164–165
  - Florida State University, 38
  - focus, of makerspace, 7–8
  - focus group, 333
  - “Food for Fines” programs, 330
  - Forest, C., 69
  - Fourth Amendment, 264, 267
  - FPV
    - See First Person View
  - “Framework for 21st Century Learning” (P21), 353
  - Framework for Information Literacy for Higher Education* (ACRL), 354
  - free play, 196, 204
  - Fried, Limor, 160
  - Frimpong, Simon-Peter, 103–104
  - FryskLab, 318
  - Full Spectrum Hobby Laser, 231
  - Full Spectrum RetinaEngrave, 230
  - funding
    - fees, alternatives to, 328–331
    - fees for patrons, 326–328
    - getting started without, 10–11
    - grant, winning, 9–10
    - for makerspace, establishment of, 8–10
    - for makerspace, sustainability of, 325–326
    - makerspace focus and, 7–8
    - for mobile makerspace, preparation for, 310–311
  - furniture, 316
  - fused deposition modeling (FDM) 3D printer
    - description of, 88–89
    - MakerBot Replicator 2x, 3D printing with, 93–102
    - types of, 91–93
  - fused filament fabrication (FFF) printer, 81
  - future of library makerspaces
    - See library makerspaces, future of
- G**
- game controllers, 172–173
  - games, 190–191
  - Garfield County Libraries, 122
  - Gartner, Inc., 356, 357–358
  - gas, 311–312
  - G-code
    - in 3D printing process, 89
    - as CNC language, 230
    - control software and, 91
  - Geek Feminism, 335
  - Gemma, 161
  - gender
    - of Maker Faire attendees, 352
    - of makers, 59–60, 63
  - George Lucas Educational Foundation, 43
  - Georgia Tech Invention Studio, 68–69
  - GermBuster VR game, Realiteer, 184, 189, 190
  - Gershensfeld, Neil, 302
  - gesture sensors, 358
  - Getting Hands on with Soft Circuits: A Workshop Facilitator’s Guide* (Lovell), 166
  - Getting Started with Adafruit FLORA* (Stern & Cooper), 165
  - Gibson, William, 175
  - Ginsberg, Sharon, 325–341

- Global Positioning System (GPS), 263
  - GoFundMe, 330
  - Gomes, Patricia, 57
  - Google Cardboard
    - Create Your Own Cardboard Content project, 189–190
    - creating your own VR content, 181–182
    - development of, 176
    - DIY Cardboard kits, 176–178
    - downloading app, 180
    - libraries' use of, 185
    - locating VR applications, games, content, 181
    - projects, 186–191
    - Samsung VR Gear, 179
    - tips for, 182–185
    - View-Master Virtual Reality Viewer, 178–179
    - virtual reality, development of, 175–176
    - workshop, 187–189
  - Google Coder Cloud Server project, 131–132
  - Google Glass
    - at Arapahoe Library, 167
    - as augmented reality technology, 357
    - derision for, 176
    - Google Cardboard and, 185
  - Google Maps, 190
  - Google Project Loon, 279
  - Google+ communities, 339
  - GPS (Global Positioning System), 263
  - grant
    - how to win, 9–10
    - sustainability of makerspace, 331–332
  - GrantForward, 331
  - Grants.gov, 331
  - Graves, Colleen, 330, 333
  - greeting cards, 227–228
  - grounding, 118
  - Grumet, M., 37
  - guidelines, 76–77
- H**
- Hackasaurus project, 299
  - hackathons, 4, 297
  - hacker, 288
  - hacker ethics, 287
  - hackerspace
    - in libraries, examples of, 297–298
    - rise of, 287–288
  - hackerspace programs
    - Coder Dojo, 296–297
    - Fixit Clinics, 295–296
    - hackathons, library examples of, 297
    - hackerspace, rise of, 287–288
    - Hour of Code, 296
    - in libraries, examples of, 297–298
    - in library, reasons for, 288–289
    - planning for, 291–292
    - projects, 298–302
    - tips for, 292–295
    - types of, 289–291
  - Hackey Hack! 261
  - Hacking with Python project, 301
  - Hacking with Scratch project, 301–302
  - Hafner, Arthur Wayne, 346
  - Hale, Shannon, 334
  - HAM Radio to IP Gateway project, 122
  - hand protection, 76
  - hand tools, 83
  - hardware
    - computer numerical control, 230–231
    - hacking old hardware, 290
  - Harrop, Wendy, 213–228
  - Harvard Business Review*, 355
  - Haugh, Dana, 29–49
  - HELI-X, 276
  - Hello Purr, 298
  - Highland Park Public Library, 300
  - Hlubinka, M., 74
  - Hmelo-Silver, C. E., 32
  - Holman, Will, 348
  - Horizon Reports (New Media Consortium), 356
  - Hour of Code, 296
  - Houston Public Library, 202
  - “How to Build a Drone” workshop, 280–281
  - How to Make Snowflakes with Python Turtle
    - project, 301
  - HTC Vive, 185, 357
  - Hull, Charles, 87–88
  - Hume, Tim, 263
  - Hunt, Ryan, 307–323
  - “Hype Cycle for Emerging Technologies”
    - (Gartner, Inc.), 356, 357–358
- I**
- I Am Cardboard, 177, 186
  - Idea Box, 5
  - ideas, 62
  - Illuminated Greeting Cards project, 227–228
  - i.materialise, 102
  - IMLS (Institute of Museum and Library Services), 9
  - inclusion
    - at Albertsons Library's MakerLab, 60–61
    - community outreach for, 59–60
    - empowerment of users, 63–64
    - future of library makerspaces and, 364–365
    - in makerspace advertising, 334



- makerspace focus on, 52
- radical, 54–55
- Indiana University, 185
- Indiegogo, 330
- Indoor Heli Sim 3D Simulator, 276
- information, 346
- information literacy, 354
- Inkscape
  - Business Hours Decal project, 238–239
  - for CNC, 230
  - Laser-Cut Name Tag project, 234–236
  - Milled Wooden Phone Stand project, 236–237
  - Personalized Cat Decal project, 239–241
  - T-Shirts I and II project, 241–243
- Innisfil Public Library, 295
- innovation
  - argument about makerspaces and, 364
  - in design thinking definition, 355
  - as twenty-first century skill, 353
- Innovation Lab, 278–279, 280
- inquiry-based learning, 31–32
- Institute for Healthcare Improvement, 74
- Institute of Museum and Library Services (IMLS), 9
- institutional objectives, 34–37
- Instructables website, 44, 108–109
- instructional design
  - basics of, 37–38
  - models, 38–40
- instructional materials, 248
- insulation techniques, 164
- insurance, 312
- Intel
  - definition of maker, 351–352
  - on gender of makers, 59–60
- Inter Library Loan (ILL), 278
- Interactive Artwork with Paper Circuits project, 226–227
- Interactive Design Institute, 158
- Interactive Models project, 224–225
- interest, 332
- International Society for Technology in Education, 353
- Internet, 338–341
- Internet of Things (IOT), 359–360
- “Introduction to Drone Flight” workshop, 281
- Inventables Easel, 230
- Invention Studio, Georgia Tech, 68–69
- iOS
  - Cardboard Virtual Tours project, 190
  - Google Cardboard, smartphone requirements for, 182–183
  - Google Cardboard workshop and, 188
  - Google Cardboard/VR games, 190–191
- iPad, 357
- iPhone, 182–183
- ISTE Standards for Students* (ISTE), 353
- J**
  - jetting, 88
  - jewelry, 169–170
  - Johnson, Eric, 345–365
  - JoyLabz, 214–215
  - junior makerspaces, 202
- K**
  - K–12 library, 6, 26
  - Kano OS, 129–131
  - Kelley, David, 355
  - Kent State University at Tuscarawas, 6
  - Kickstarter
    - for ARC device, 103
    - crowdfunding with, 330
    - for Oculus Rift, 176
  - Kim, Bohyun, 87–110
  - Klotz, Donny, 278–279
  - Koh, K., 35
  - Kristiansen, Ole Kirk, 194
  - Kroski, Ellyssa, ix
  - Krupicka-Smith, Antonia, 245–262
- L**
  - Lang, Jack, 115
  - Laramie County Library System, 122
  - laser cutter
    - with air filtration systems, 81
    - Laser-Cut Name Tag project, 234–236
    - safety suggestions for, 82
    - use of, 231
  - Laser-Cut Name Tag project, 234–236
  - learning
    - with hackerspace program, 292, 293
    - instructional design models, 38–40
    - with Legos, 194, 197–198
    - library as learning space, 29–30
    - maker education as learner-driven process, 36
    - makerspace support of, 33–34
    - team-based learning, 59
    - types of, 30–33
  - Learning and Information Commons (LINC), 332
  - learning event, 40–41
  - Learning to Code with Robots 1: Dash and Dot Robots project, 257–258
  - Learning to Code with Robots 2: Sphero Robots project, 258–259
  - Learning to Code with Robots 3: Finch Robots, 259–260

- Leclercq, Dieudonné, 40
- LED Cuff Bracelets project, 169–170
- LED Fabric Bookmarks project, 168–169
- LED lights
  - Arduino Blink project, 143–146
  - on Arduino board, 138
  - of Arduino board, 140
  - Circuit Stickers, 218–219
  - Illuminated Greeting Cards project, 227–228
  - LED Cuff Bracelets project, 169–170
  - LED Fabric Bookmarks project, 168–169
  - Light-Up Board Games project, 225–226
  - of LilyPad, 159
  - Room Occupancy Sensor project, 151–155
  - Traffic Light project, 146–148
  - wearable electronics, tips for, 165–166
- Leggette, Jacob, 103
- Lego BIONICLE, 195
- Lego block parties, 201–202
- LEGO Education, 197, 198
- LEGO Engineering website, 197
- LEGO Group
  - history of Legos, 194
  - Legos kits from, 199
  - number of Legos produced by, 193
- LEGO MINDSTORMS, 195, 197, 202
- LEGO MINDSTORMS EV3, 246, 256–257
- The Lego Movie* (film), 195
- The Lego Movie 2* (film), 195
- Lego Serious Play (LSP)
  - for Lego workshop, 207–208
  - team building with, 196–197
  - at University Campus Suffolk, 204
- LEGO Systems, 202
- Lego Technic, 195
- #LeGOMAKE study, 208
- Legos
  - art with, 198
  - conclusion about, 209
  - designing, prototyping, building, 197
  - free play, 196
  - history of, 194
  - Lego playing station, building, 204–205
  - libraries' use of, 201–204
  - in library, tips for, 199–201
  - physical computing with, 290–291
  - production of, 193
  - projects with, 204–208
  - teaching/learning with, 197–198
  - team building with, 196–197
  - types of Lego bricks, 195
  - use of, 194–195, 196
  - workshop, 207–208
- lesson plans
  - creating, 41
  - curricular materials, finding, 43–44
  - lesson plan worksheet, 42–43
- lessons learned, about mobile makerspaces, 321–322
- levels of engagement, 52
- Lewis, D., 73
- Lewis, J., 260
- librarian
  - expectations for makerspaces, 18
  - hackerspace programs, tips for, 292–295
  - library as agent of change, 35–36
  - library-wide maker culture with internal promotion, 337–338
  - maker education of library staff, 361–362
  - professional development, 22–23
  - roles, identifying new, 18
  - staff training for makerspace, 19–21
- libraries
  - in Arduino, 139
  - Arduino, use of, 141
  - circuitry projects, use of, 223–224
  - computer numerical control, use of, 233
  - drones, use of, 277–279
  - Google Cardboard, use of, 185
  - hackerspace programs, examples of, 295–298
  - hackerspace programs in, 297–298
  - hackerspace programs in, reasons for, 288–289
  - hackerspace programs, planning for, 291–292
  - hackerspace programs, tips for, 292–295
  - Legos, free play with, 196
  - Legos, team building with, 196–197
  - Legos, use of, 201–204
  - Legos in, tips for, 199–201
  - library makerspaces, present time, 346–347
  - library-wide maker culture, 337–338
  - makerspace culture in, 4
  - mobile makerspace, reasons for, 308–309
  - Raspberry Pi projects, 122–132
  - Raspberry Pi use in, 120–122
  - robotics in, 246–250
  - 3D printing in specific subject areas, 109–110
  - 3D printing projects, 104–109
  - 3D printing use cases, 102–104
  - wearable electronics, use of, 157–158, 167
- library makerspaces
  - community of practice, 45–46
  - curricular materials, finding, 43–44
  - environment of, 37
  - implementation/evaluation of programs in, 44–45
  - instructional design, 37–38
  - instructional design models, 38–40

- learning event, designing, 41
- lesson plans/activities, 41–43
- library as learning space, 29–30
- pedagogy, connecting theory to practice, 33–34
- pedagogy of, 30–33
- support of institutional/pedagogical objectives, 34–37
- types of, 4–7
- See also* makerspace; safety
- library makerspaces, future of
  - dark side of future, 363–364
  - diversity of makers/makerspaces, 351–353
  - emerging technologies and, 356–360
  - inclusive future, 364–365
  - maker education of library staff, 361–362
  - metrics/assessment, 360–361
  - present situation, 346–347
  - programming of, 354–357
  - prophecy, risks of, 345
  - short-term/long-term future, 350–351
  - staffing library makerspaces in future, 362
  - staying power of makerspaces, 347–350
  - twenty-first century skills and, 353–354
- Library Science and Technology Act (LSTA), 9
- library use cases, 102–104
- Light Locked Wallets project, 170–171
- Light-Up Board Games project, 225–226
- LilyPad
  - Arduino SimpleSnap, 159
  - Arduino USB, 159
  - overview of, 158–160
  - physical computing with, 291
  - ProtoSnap, 159
  - washing of fabric and, 164–165
- LilyTiny, 159
- LilyTwinkle, 159–160
- LINC (Learning and Information Commons), 332
- listservs, 341
- lithium polymer (LiPo) batteries
  - charging, 277
  - for drone assembly, 273–274
  - for drones, 267
- littleBits
  - Beginner Robots with littleBits project, 227
  - overview of, 215–216
- local grants, 9
- Lotts, Megan, 193–209
- Lovell, Emily, 166
- LSP
  - See* Lego Serious Play
- LSTA (Library Science and Technology Act), 9
- Lucky, Palmer, 176
- LulzBot Taz 5 printer, 91, 92
- Lynda.com, 262
- M**
- Mac OS X, 142–143
- Magic-8 Ball project, 301
- MagPi Magazine*, 119–120, 132
- mailing lists, 341
- maintenance
  - of makerspace equipment, 80
  - of mobile makerspace, cost of, 312–313
- Mairn, Chad, 263–285
- Make Magazine*
  - on gender of makers, 59–60
  - “Getting Started with Raspberry Pi” guide, 119
  - Maker Faires sponsored by, 349
  - readership of, 352
  - 3D printer recommendations, 92
- Make Music with Sonic Pi project, 125–127
- “make-a-thon,” 45
- maker culture, diverse
  - at Albertsons Library’s MakerLab, 60–61
  - community, creation of, 66–67
  - community outreach, 59–60
  - digital divide and, 55–57
  - makerspace communication, 65–66
  - meaning of, 51–53
  - other makerspace models, 68–69
  - partnerships, development of, 57–59
  - radical inclusion, 54–55
  - skill development from culture, 61–65
  - successful makerspace, characteristics of, 67–68
  - summary of, 69
- Maker Ed, 43–44, 352
- maker education, 36
- Maker Education Initiative (Maker Ed), 352
- Maker Faires
  - attendance at, 348–349
  - for building community of practice, 45
  - demographics of attendees of, 352
  - for marketing of makerspace, 27
  - for professional development, 23
- Maker Jawz, 297
- maker kits, 49
- Maker Media, 352
- Maker Mixers, 66
- maker movement
  - diversity of makers/makerspaces, 351–353
  - keeping up with, 338–341
  - makerspaces *vs.*, 349
- Maker Nights, 224
- maker organizations, 329
- MakerBot Desktop application, 96–99

- MakerBot Replicator 2x printer  
 assembly of, 93–94  
 build plate, preparation of, 95  
 build platform, leveling, 95  
 capabilities of, 89  
 filament, load/unload, 94–95  
 file types accepted by, 91  
 preview/print 3D model, 99  
 3D model file, downloading, 96  
 3D model file, opening/modifying, 96–99  
 3D printing with, 93–102  
 tips for successful 3D printing, 99–100  
 troubleshooting mechanical issues, 100–102
- MakerBot Replicator 2X User Manual and  
 Troubleshooting and Maintenance Guide,  
 102
- MakerBus  
 description of, 318–319  
 in driver's seat, 313  
 lessons learned from, 321–323  
 Paul, 310
- Makergear M2 printer, 92
- MakerLab, Boise State University Albertsons  
 Library, 60–61, 63, 66–67
- MakerMobile, 318
- makers  
 diversity of, 351–353  
 maker education of library staff, 361–362  
 for mobile makerspace, 320  
 Paul, 310
- Makers* (Anderson), 351
- Maker Shed, 137
- makerspace  
 costs of, 24–25  
 culture, 4  
 definition of, 3  
 equipment lists, 13–18  
 expectations for, determination of, 18  
 focus, determination of, 7–8  
 funding, getting started without, 10–11  
 funding for, 8–10  
 hackerspace, rise of, 287–288  
 hackerspace partnership with, 294  
 Lego Junior Makerspaces, 202  
 marketing of, 26–27  
 planning for, 26  
 policy development, 23–24  
 professional development, 22–23  
 roles, identifying new, 18  
 space design, evaluation of, 11–13  
 successful, characteristics of, 67–68  
 supervision of, 75–76  
 training plan, 19–22  
 types of makerspaces, 4–7  
 usage policies, development of, 25–26  
 workspace safety, 78–83  
*See also* library makerspaces; mobile makerspaces
- Makerspace (Facebook group), 22
- makerspace, sustainability of  
 charging patrons, 326–328  
 community, building, 335–338  
 community, embracing, 334–335  
 community, understanding of, 332–334  
 fees, alternatives to, 328–331  
 financial considerations, 325–326  
 grants/budgets, 331–332  
 interest/momentum, 332  
 keeping up with makerspace movement, 338–341
- Makerspace and Participatory Library (Facebook  
 group), 22, 93
- makerspace club, 329
- Makerspace Librarian's Sourcebook* (Kroski), ix
- "Makerspace Mondays," 22
- makerspace movement, 338–341
- Makey Makey  
 for Interactive Models project, 224–225  
 for math fact review, 224  
 overview of, 214–215  
 Piano program online, 221–222
- Making Simple Robots projects, 251–257
- manuals, for equipment, 19
- marketing, 26–27
- Martin, Kim, 307–323
- Massachusetts Institute of Technology (MIT), 198
- materials  
 cheap materials for experimentation/  
 prototyping, 47–48  
 conductive, 220  
*See also* supplies
- Mattel, 178–179
- Max-Villard, Maya, 103–104
- Mazzoni, S., 81
- McTighe, Jay, 39
- mechanical issues, 100–102
- media makerspace, 8
- media outlets, 26
- media-sound-focused makerspace starter kit, 15–16
- media-video-focused makerspace starter kit, 15
- membership-based makerspaces, 7
- membership fee, 328
- memory, 183–184
- Merlo, F., 81
- mesh modeling, 90, 100
- message board, 65
- metrics, 360–361
- Michigan State University, 233

- micro-empowerment, 60–61
  - Milled Wooden Phone Stand project, 236–237
  - milling machine, 231, 236–237
  - Minecraft Community Hack project, 300
  - Minecraft Hacking with Kano OS project, 129–131
  - mission
    - inclusive future and, 365
    - of library makerspace, 351
  - MIT (Massachusetts Institute of Technology), 198
  - MIT App Inventor 2, 298–299
  - mobile makerspaces
    - circuitry projects and, 224
    - conclusion about, 322–323
    - description of, 6–7, 307–308
    - examples of, 318–319
    - financial route, planning, 311–313
    - funding possibilities, 311
    - lessons learned, 321–322
    - for marketing of makerspace, 27
    - obstacles to, 316–317
    - people, importance of, 320–321
    - preparation for, 309–311
    - reasons for, 308–309
    - tools for, 313–314
    - use of, 315–316
  - Modular Robotics, 255–256
  - momentum, 332
  - money
    - costs of mobile makerspace, 311–313
    - planning for mobile makerspaces, 311–313
    - sustainability of makerspace, 325–326
    - See also* costs; funding
  - Morrison, T., 61
  - MOSS, 255–256
  - motor
    - for building drone, 270
    - drone assembly, 271
    - for robotics projects, 248, 250
  - Mozilla Foundation, Hackasaurus, 299
  - Mui, Peter, 295
  - Mullins, Rob, 115
  - Multiwii, 282
  - music, 125–127
  - Mycroft, Alan, 115
- N**
- name tag, 234–236
  - NAO robots, 260
  - National Science Foundation, 363
  - National Writing Project, 302
  - Nelson, H. G., 62
  - NetFabb Basic, 100, 101
  - NetFabb Cloud Service, 100
  - networking, 23
  - neurodiversity, 335
  - Neuromancer* (Gibson), 175
  - New Media Consortium, 356
  - The New York Times*, 177
  - newspaper, 26
  - NFC (Near Field Communications) tag, 177–178
  - Nguyen, L. C., 64
  - niche, 294, 333–334
  - NMC Horizon Report: 2015 Library Edition* (New Media Consortium), 349
  - noise, 12, 199
  - NOOBS (New Out of Box Software), 117
  - North Carolina State University, 233, 326
- O**
- Oakland Public Library, 295
  - obstacles, to mobile makerspaces, 316–317
  - Occupation Safety and Health Administrations' Personal Protective Equipment Booklet, 76–77
  - Oculus Rift
    - development of, 176
    - features of, 357
    - smartphone and, 185
  - Olexa, R, 229
  - "On the Road, Playing with LEGO, and Learning about the Library, Part Two" (Lotts), 208
  - online training
    - for staff, 19–21
    - for users, 21–22
  - Open Educational Resources (OER) Commons, 44
  - "Open Hack Nights" event, 294
  - open house, 66
  - Open Source Media Center (OSMC), 117
  - operating system
    - See* Android OS; iOS
  - Oregon State University (OSU), 103
  - Orlando Public Library, 122
  - outreach
    - for building community of practice, 45–46
    - community, 59–60
  - Overly, N. V., 35
  - Ozobot, 246
- P**
- P21, 353
  - paper circuits, 226–227
  - paper prototyping, 38
  - parking, for mobile makerspace, 317
  - participatory library
    - concepts of, 63
    - user engagement in, 64–65

- partnerships
  - access to resources with, 68
  - for building community of makers, 335–336
  - for building community of practice, 45–46
  - development of, 57–59
  - funding for makerspace from, 329
  - with groups with similar missions, 69
  - for hackerspace program, 294–295
  - of MakerLab team, 61
- Partridge, H., 64
- Passas, Jennifer, 264
- patrons
  - charging makerspace fee to, 326–328
  - community, embracing, 334–335
  - community, knowledge of, 332–334
  - secondary promotion by, 337
  - See also* students; users
- PBS, 265
- PC Magazine*, 92
- PDB (Power Distribution Board), 270–271
- pedagogy
  - active learning, 30–31
  - collaborative learning, 31
  - constructionism, 33
  - inquiry-based learning, 31–32
  - learning, how makerspaces support, 33–34
  - makerspace support of institutional/ pedagogical objectives, 34–37
  - project-based learning, 32
  - prototyping as, 36–37
- peers
  - peer-to-peer learning, 59
  - radical inclusion in makerspace and, 54–55
- people
  - inside mobile makerspace, 315–316
  - mobile makerspace and, 320–321
  - mobile makerspace, reasons for, 308, 309
  - for mobile makerspace team, 309–310
  - See also* patrons; users
- Pepper robots, 260
- personal safety, 76–77
- Personalized Cat Decal project, 239–241
- Phantom 2 Vision + drone, 278–279
- phone stand, 236–237
- photography, 282
- physical computing
  - description of, 290
  - kits for, 291
  - Trinkets, 293
- Pi from Scratch project, 127–129
- Pima County library system, Arizona, 64
- pins, 137–138
- Pinterest, 194
- PIR sensor, 151–155
- PLA plastic
  - qualities of, 89
  - toxicity in, 81
- Places Journal*, 348
- planning
  - for costs of makerspace, 8
  - diverse maker culture and, 53
  - for hackerspace programs, 291–292
  - lesson plans, 41–43
  - for makerspace, 26
  - for mobile makerspace costs, 311–313
  - training plan, 19–22
- plated thread, 163
- Plischke, Carsten, 197
- Plush Game Controllers project, 172–173
- polarized components, 140
- policy
  - cost considerations, 24–25
  - for makerspace, establishment of, 23–24
  - for makerspace safety, 75–76
  - in staff training, 21
  - usage policies, 25–26
- polygonal mesh modeling, 90
- Ponoko, 102
- Pool, Tim, 279
- pop-up play, 204
- Popular Science*, 348
- poster printer, 12–13
- Poumay, Marianne, 40
- power
  - Google Cardboard, smartphone requirements for, 184
  - for mobile makerspace, 317
  - socket, 137
- Power Distribution Board (PDB), 270–271
- power tools, 81, 83
- Powers, Meredith, 29–49
- preview, of 3D model, 99
- printing
  - See* 3D printers; 3D printing
- print-to-digital shift, 29
- problem-solving
  - library makerspace programming and, 354–355
  - in maker environment, 62
  - as twenty-first century skill, 353, 354
- product development, 364
- professional development, 22–23
- programmable robots, 260
- programming
  - drone flight computer, 268
  - hacking with code, 289

- learning to code with robots, projects for, 257–260
- of library makerspaces, 354–356
- Makey Makey with Scratch, 215
- platforms for robotics, 261–262
- robots, 246, 247
- tips for Arduino, 138–139
- wearable electronics, 163
- See also* coding
- project-based learning, 32
- projects
  - academic library Lego projects, 203–204
  - with Arduino, 142–155
  - building physical robots project, 248
  - circuitry, 224–228
  - coding/programming robotics project, 247
  - with computer numerical control, 234–243
  - with drones, 279–283
  - with Google Cardboard, 186–191
  - hackerspace programs, 298–302
  - with Legos, 204–208
  - public library Legos projects, 201–202
  - with Raspberry Pi, 122–132
  - robotics, 251–260
  - 3D printing, 104–109
  - with wearable electronics, 168–173
- promotion
  - of hackerspace program, 294
  - library-wide maker culture with internal promotion, 337–338
  - of makerspace, 26–27, 334–335
  - secondary promotion, 336–337
- propeller, 271
- Proton Pulse game, 191
- prototyping
  - cheap materials for, 47–48
  - as pedagogy, 36–37
  - rapid, 39
  - 3D printing, library use cases, 102–103
- public libraries
  - growth in makerspaces, 349
  - Legos projects, 201–202
  - makerspace focus for, 26
  - makerspaces of, 5
  - starting makerspace without funding, 11
  - user visions for makerspace, 55
- Python, 289, 301
- Python Turtle, 301

**Q**

- Qiu, Kanjun, 162

**R**

- radical inclusion
  - description of, 52
  - in diverse maker culture, 54–55
  - for positive balance of makers, 69
  - skill development and, 61
- radio frequency, 272
- radio-controlled transmitters, 267
- Radnor Memorial Library, 202
- Raft* option, 98
- rapid prototyping, 39
- Raspberry Pi
  - conclusion about, 132–133
  - description of, 113–114
  - getting started with, 116–118
  - introduction to, 114–116
  - in library, examples of use, 120–122
  - physical computing with, 290–291
  - projects with, 122–132
  - tips for, 118–120
- Raspberry Pi Foundation, 115, 119
- Raspberry Pi, projects with
  - All About Pi, 123–125
  - Google Coder Cloud Server, 131–132
  - Make Music with Sonic Pi, 125–127
  - Minecraft Hacking with Kano OS, 129–131
  - Pi from Scratch, 127–129
  - time for, 122–123
- Raspberry Pi Zero, 115–116
- Raspbian OS, 117
- receiver, 272–273
- registration
  - of drone, 266, 267, 277
  - drone workshop and, 281
- regulations
  - for drone operation, 277
  - for drones, 266, 267, 358
- relationships, 337–338
- Rendina, Diana, 13, 331
- report, of accidents/injuries, 79
- resin, 88
- resources
  - for coding/programming robotics project, 247
  - for curricular materials, 43–44
  - for emerging technologies information, 356–357
  - for Google Cardboard, 181
  - for grants, 331
  - for keeping up with maker movement, 338–341
  - library makerspaces for providing access to, 347
  - maker education of library staff, 361–362
  - materials for experimentation/prototyping, 47–48
  - ready-made maker kits for time-limited librarians, 49

- resources (*continued*)
- for robotics, 250, 261–262
  - robotics kits, links for, 246
  - for safety, 84
  - tech tools, inexpensive, 48–49
- RetinaEngrave, 234–236
- retrofit, of mobile makerspace, 312
- Rhode Island School of Design (RISD), 198
- risks
- of makerspace, 73–74
  - supervision of makerspace and, 75
- robot kits, 246, 291
- robotics
- Art Bot project, 300
  - Beginner Robots with littleBits project, 227
  - building physical robots, 248
  - coding/programming robots, 247
  - conclusion about, 260
  - definition of, 246
  - Lego robots, 202
  - libraries' use of, 250
  - overview of chapter on, 245
  - physical computing with, 290–291
  - projects, 251–260
  - resources for, 261–262
  - tips for, 249–250
  - types available, 246
- Rochester Public Library, 335–336
- Roldan, Roberto, 278
- roles, 18
- Romeo, 260
- Room Occupancy Sensor project, 151–155
- Rotate* control, 97
- Royal Society for the Encouragement of Arts,  
Manufactures and Commerce, 348
- Ruby, 289
- RubyMonk, 261
- Rutgers University Art Library
- Best Library Contest, 206
  - Lego Playing Station, 193
  - Lego Serious Play at, 204
- S**
- safe environment, 59
- safety
- for CNC class, 233
  - crash of machine, 232
  - culture of safety, creation of, 74
  - hackerspace program and, 292–293
  - plans, 76
  - resources for, 84
  - risks of makerspace, 73–74
  - supervision of makerspace, 75–76
  - user safety in makerspace, 76–77
  - for wearable electronics, 162
  - workspace safety, 78–83
- Samsung VR Gear, 179, 185
- San Diego Central Library, 295–296
- San Diego Public Library, 141
- Sawaya, Nathan, 195, 198
- SBC (single-board computer), 114
- Scalable Vector Graphic (SVG) format
- for CNC, 230
  - for Laser-Cut Name Tag project, 235, 236
- scaling, 3D model file, 96–97
- schematics, for building drones, 268–269
- Schiller, Nicholas, 288
- Schmidt, Eno, 297
- Scholastic, 9
- school library
- makerspace focus for, 26
  - makerspaces of, 6
  - starting makerspace without funding, 10–11
- School Library Journal*, 349
- school visits, 27
- schools
- incorporation of making into curriculum, 336
  - mobile makerspace and, 310
- Schubert, W. H., 41
- Science Buddies, 300
- Scrapmobile, 319
- Scratch
- for hacking, 289
  - Hacking with Scratch project, 301–302
  - for Interactive Models project, 225
  - Makey Makey with, 215, 224
  - Pi from Scratch project, 127–129
  - for robotics, 261
- Sculpteo, 102
- SD card, 116, 117
- secondary promotion, 336–337
- Section 333 exemption, 266
- SeeMeCNC Rostock MAX v2 printer, 92
- Seferi, Kristi, 263–285
- selective laser sintering (SLS), 88
- sensor
- with e-textiles, 166
  - Room Occupancy Sensor project, 151–155
- sergers, 83
- Settings* section, 98
- Sew Electric* (Buechley & Qiu), 162
- sewing, 164–165
- See also* wearable electronics
- sewing machine, 83, 163–164
- Shapeways, 102
- Shirokobrod, Gene, 103



- signage, 201
- Silhouette Cameo
  - Business Hours Decal project, 238–239
  - description of, 230
  - Personalized Cat Decal project, 239–241
  - T-Shirts I and II project, 241–243
- Silhouette Studio
  - Business Hours Decal project, 238–239
  - hardware specific, 230
  - Personalized Cat Decal project, 239–241
  - T-Shirts I and II project, 241–243
- Simple Robot 1: Bristlebots project, 251–252
- Simple Robot 2: Wobblebots/Wigglebots project, 252–254
- Simple Robot 3: Design Your Own Robot! project, 254–255
- Simple Robots 4: Premade Buildable Robots project, 255–257
- single-board computer (SBC), 114
- Sisters app, 189, 190
- sketch
  - Arduino Blink project, 143–146
  - Temperature Sensor project, 148–151
- skills
  - development of with diverse maker culture, 61–65
  - twenty-first century skills, 353–354
  - users' development of, 55–57
- SLA (stereolithography), 87–88
- Slack channel, 60, 65
- SLS (selective laser sintering), 88
- smart textiles, 157–158
  - See also* wearable electronics
- smartphone
  - Cardboard viewer, screen size and, 178
  - drones, control of with, 263
  - Google Cardboard and, 176, 182–185
  - for Google Cardboard workshop, 187–189
  - MIT App Inventor 2 projects, 298–299
  - NFC tags for VR, 177–178
  - Samsung VR Gear and, 179
  - View-Master Virtual Reality Viewer and, 178–179
- Smith, Jonathan M., 135–155
- Snap Circuits, 217–218
- social media
  - for keeping up with maker movement, 338–340
  - for Lego event publicizing, 204
  - Legos presence on, 194–195
  - for makerspace user training, 22
  - for secondary promotion by patrons, 337
- soft circuits
  - See* wearable electronics
- software
  - CNC, 230
  - for physical computing, 290–291
- soldering
  - Arduino board, 138
  - for building drones, 268, 269
  - in hackerspace program, 292
- soldering iron, 83
- solderless breadboard, 138
- Somerson, Rosanne, 198
- Sonic Pi, 120, 125–127
- Spalding, E., 35
- SparkFun
  - Arduino Comparison Guide, 136
  - for Arduino purchase, 137
  - LED tutorial, 165
  - Raspberry Pi purchase from, 116
  - RedBoard, 136
  - wearable electronics tutorial, 162
- SparkTruck, 318
- speaking engagements, 26–27
- Sphero robots, 246, 258–259
- sponsors, 330
- SQLZoo, 261
- St. Petersburg College
  - Innovation Lab, 264, 280
  - Innovation Lab, use of Arduino, 141
  - Seminole Community Library at, 278–279
  - Workforce Institute, 265
- staff
  - culture of safety, 74
  - library-wide maker culture with internal promotion, 337–338
  - maker education of library staff, 361–362
  - makerspace professional development, 22–23
  - mobile makerspace team, 309
  - staffing library makerspaces in future, 362
  - supervision of makerspace, 75
  - training for building physical robots project, 248, 249
  - training plan for, 19–21
  - user assistance from, 57
  - user safety in makerspace and, 76–77
- stainless steel thread, 163
- Standards for the 21st-Century Learner* (American Association of School Librarians), 353–354
- Stanford Bunny
  - downloading, 96
  - in NetFabb Basic, 100, 101
- Stanford University
  - FabLearn Fellows program, 44
  - SparkTruck, 318
- Stars Wars: The Force Awakens* (film), 177

starter kit, Arduino, 136  
 starter projects, 44–45  
 staying power, 347–350  
 STEAM (Science, Technology, Engineering, Arts, Math), 310  
 STEAM Truck, 7  
 Steiner, Lewis H., 34  
 STEM education
 

- argument that makerspaces are only for, 363
- 3D printing for, 103–104
- with wearable electronics, 157

 STEM skills
 

- makerspace culture in library, 4
- makerspaces in K–12 libraries and, 6

 stereolithography (SLA), 87–88  
 stereopticon, 187  
 Stern, Becky, 165  
 Stewart Middle Magnet School, 13  
 .stl file type, 89, 91  
 Stolterman, E., 62  
 stop-motion film, 203, 207  
 Stoppa, M., 157  
 storage
 

- of Legos in library, 200
- for makerspace supplies, 12, 13
- in mobile makerspace, 308

 Stratasys' PolyJet 3D printer model J750, 89  
 stressbusters, 203, 204  
 students
 

- learning, types of, 30–33
- maker education as learner-driven process, 36
- makerspace support of learning, 33–34
- mobile makerspace and, 320–321
- See also* users

 The Studio at Anythink, 233  
 subtractive manufacturing, 87  
 supervision, of makerspace, 75–76  
 supplies
 

- for CNC class, 231
- crowdfunding for, 330–331
- donations for makerspace, 329–330
- for makerspace, fees for, 326–328
- See also* materials

 Support option, 98  
 SVG format
 

- See* Scalable Vector Graphic (SVG) format

 Swivel Gun! VR Log Ride, 191

## T

Tafoya, Stephen M., 113–133  
 tape, 250
 

- See also* conductive tape; copper tape

teaching
 

- by kids in hackerspace program, 293
- with Legos, 197–198
- pedagogical approaches, 30–33
- See also* pedagogy

 team
 

- collaborative learning, 31
- for mobile makerspace, 309
- mobile makerspace, time investment, 322
- team-based learning, 59
- team building with Legos, 196–197

 tech companies, 310  
 technology
 

- access to, library makerspaces support, 34–35
- community development and, 66–67
- costs of, policy for, 24–25
- diverse maker culture and, 51–53
- future of library makerspaces and, 350, 356–360
- library makerspace programming and, 356
- library makerspaces, role in present time, 346–347
- maker education of library staff, 361–362
- makerspace focus and, 7–8
- makerspaces defined by argument, 364
- skill development from culture, 62–63
- tech tools, inexpensive, 48–49
- as twenty-first century skill, 353–354

 technology literacy, 34  
 technology-focused makerspace starter kit, 13  
 TechShop, 7, 348  
 TekVenture, 329  
 Temperature Sensor project, 148–151  
 Tesla, Nikola, 265  
 The Possible Project (TPP), 331  
 theft, 201  
 Theodore Robinson Intermediate School, 6  
 Think Box, 5–6  
 360° photos
 

- Cardboard Virtual Tours project, 190
- Create Your Own Cardboard Content project, 189–190
- with drone cameras, 265

 3D Hubs, 91–92  
 3D model file
 

- downloading, 96
- opening/modifying, 96–99

 3D model repositories, 96  
 3D modeling workshop with Tinkercad, 107–108  
 3D printer
 

- with CNC, 231
- future of library makerspaces and, 350
- MakerBot Replicator 2x, 93–102
- overview of, 89–90
- popular brands/models, 90–93

- safety suggestions for, 81
  - in types of makerspaces, 5, 6, 7
  - usage policies for, 25
  - 3D Printer Buyer's Guide (*Make Magazine*), 92
  - 3D printing
    - application of in specific subject areas, 109–110
    - commercial 3D printing services, 102
    - definition of, 87
    - demo and petting zoo event, 104–106
    - fee for, 326, 327
    - library makerspace programming and, 354–355
    - library use cases, 102–104
    - with MakerBot Replicator 2X, 93–102
    - policy for makerspace, 23
    - process of, 89
    - projects, 104–109
    - resources for lesson plans, 44
    - 3D printers, overview of, 89–90
    - 3D printers, popular brands/models, 90–93
    - 3D printers/materials, 88–89
    - types of printing technologies, 87–88
    - user engagement with, 53, 64–65
  - 3D Systems' ProX950 3D printer, 89
  - Thrills, Chills, and Spills project, 190–191
  - time
    - for CNC class, 231
    - for coding/programming robotics project, 247
    - for mobile makerspace, 322
    - for wearable electronics project, 166–167
  - time line, for training, 19
  - Tinkercad, 107–108
  - tools
    - makerspaces defined by argument, 364
    - for mobile makerspaces, 313–314
    - See also* equipment
  - tours, of makerspace, 22
  - Toy Hacking project, 300
  - TPP (The Possible Project), 331
  - Traffic Light project, 146–148
  - training
    - brief/empowering, 64
    - Legos training sessions, 204
    - materials, creation of while learning, 20
    - for robotics projects, 248, 249
    - staffing library makerspaces in future, 362
    - for user safety in makerspace, 77
    - of users, levels of, 55–57
  - training plan
    - construction of, 19
    - for makerspace, 19–22
    - for staff, 19–21
    - supervision of makerspace and, 75
    - for users, 21–22
  - Tran, Uyen, 141
  - transdisciplinarity, 53
  - transmitter, 272–273
  - Treehouse, 262
  - Trinkets, 293
  - troubleshooting
    - circuitry projects, 222–223
    - 3D printer mechanical issues, 100–102
  - T-Shirts I and II project, 241–243
  - Tuck, K., 66–67
  - Tucker, Fred, 265
  - “Turn your doodle into a 3D model” event, 106–107
  - Tuscany Dive, 188
  - tutorials
    - for Google Cardboard app, 180
    - for LEDs, 165
    - for wearable electronics, 162, 163
  - Twain, Mark, 345
  - twenty-first century skills, 353–354
  - Twitter
    - hashtags, 339
    - Legos presence on, 195
    - lists, 339–340
    - for makerspace user training, 22
  - “2016 Best 3D Printer Guide” (3D Hubs), 91–92
- ## U
- Ubuntu Mate, 117
  - underage/minor policies, 76
  - Understanding by Design* (Wiggins & McTighe), 39
  - UNICEF, 197
  - University Campus Suffolk, 204
  - University of Cambridge, 114–115
  - University of Leeds, 264
  - University of Ottawa, MakerMobile, 316, 318
  - University of South Florida Libraries, 277–278
  - unmaking, 11
  - unmanned aerial vehicles (UAVs)
    - See* drones
  - upcycling, 329–330
  - Upton, Eben, 115
  - U.S. military, 265
  - usage policies, 25–26
  - USB
    - Flora support for, 160
    - LilyPad and, 159–160
    - port for Arduino Uno, 137
  - user engagement
    - importance of, 52
    - in participatory library, 64–65
  - user group, 102
  - user input, 184

user safety, 76–77

users

- culture of safety and, 74
- digital divide/participatory maker culture and, 55–57
- diversity of makers/makerspaces, 351–353
- makerspace fee for, 326–328
- partnerships, development of, 57–59
- radical inclusion, 54–55
- skill development from culture, 61–65
- supervision of makerspace, 75–76
- training for makerspace, 21–22
- visions for makerspace, 55
- workspace safety and, 78–83
- See also* patrons; students

## V

values

- of ALA, 365
- hackerspaces and, 302
- of library/hacker, 288

Varma, Maya, 103–104

Vecchione, Amy, 51–69

“The Veldt” (Bradbury), 175

ventilation

- for hackerspace program area, 293
- for makerspace equipment, 12, 78–79

Verizon, 177

video

- “Alternative Drone Technologies for Aerial Photography and Videography” workshop, 282
- drone buying workshop, 282–283
- from drones, 264–265, 272
- library makerspace focused on, 11
- for 3D printer assembly, 93

*View* control, 97

View-Master Virtual Reality Viewer, 178–179

vinyl cutter, 241–243

virtual reality (VR)

- development of, 175–176
- Google Cardboard app, 181–182
- overview of, 357–358
- See also* Google Cardboard

visual literacy, 359

volatile organic compounds (VOCs), 79, 81

volunteers, 321, 336

VR Crossover Road, 190

## W

wallet, 170–171

Walter Library at University of Minnesota, 203

waste, 12

wearable electronics

- Flora, 160
- Gemma, 161
- libraries' use of, 167
- LilyPad/LilyTwinkle, 158–160
- overview of, 157–158
- physical computing with, 290–291
- programming, 163
- projects with, 168–173
- safety of, 162
- tips for, 163–167
- tutorials for, 162

“Wearable Electronics and Smart Textiles: A Critical Review” (Stoppa & Chiolerio), 157

wearable electronics, projects

- Electrochromatic Circuits, 171–172
- LED Cuff Bracelets, 169–170
- LED Fabric Bookmarks, 168–169
- Light Locked Wallets, 170–171
- Plush Game Controllers, 172–173

websites

- about Legos, 195
- for keeping up with maker movement, 338–341
- See also* resources

Weiwei, Ai, 195

Welch, Chris, 278

West, Dean, 198

Westport Library, 185, 260

White House Science Fair, 103–104

WiFi, 184

Wiggins, Grant, 39

Wigglebots project, 252–254

Willard, Nancy, 31

Windows 10 IOT Core, 117

wire stripper, 250

Wobblebots project, 252–254

women, 59–60

Wonder Workshop, 257–258

workshop

- charging patrons fee for, 327–328
- for user training, 22

workspace safety, 78–83

## Y

YouTube, 182

## Z

Zehm, Ryan, 55

Zookal (textbook company), 278

Zotrax M200 printer, 92