

Create, Share, and Save Money Using Open-Source Projects

About the Author

Joshua M. Pearce is the Richard Witte Professor of Materials Science and Engineering and is cross-appointed in the Department of Electrical and Computer Engineering at the Michigan Technological University, where he directs the Michigan Tech Open Sustainability Technology (MOST) Lab (www.appropedia.org/MOST). He is a Fulbright–Aalto University Distinguished Chair alumnus and is also currently a visiting professor of photovoltaics and nanoengineering at Aalto University in Finland, as well as a visiting professor with the Research Team on Innovative Processes (ERPI) at the University of Lorraine in France. Pearce's research concentrates on the use of open-source-appropriate technology to find collaborative solutions to problems in sustainability and poverty reduction. It also encompasses areas of electronic device physics and materials engineering of solar photovoltaic cells and RepRap 3D printing, and includes applied sustainability and energy policy. His research group is well-known for releasing innovations with open-source licenses that eviscerate the cost of science. Pearce's work is regularly covered by the international and national press and is continually ranked in the top 0.1 percent on Academia.edu (mtu.academia.edu/JoshuaPearce). He is also the faculty advisor for the Michigan Tech Open Source Hardware Enterprise. In addition, he is founding co-editor-in-chief of *HardwareX*, a journal dedicated to open-source scientific hardware, and author of *Open-Source Lab: How to Build Your Own Hardware and Reduce Research Costs* (www.appropedia.org/Open-source_Lab).



Create, Share, and Save Money Using Open-Source Projects

Joshua M. Pearce



New York Chicago San Francisco Athens London Madrid
Mexico City Milan New Delhi Singapore Sydney Toronto

Library of Congress Control Number: 2020943744

McGraw Hill books are available at special quantity discounts to use as premiums and sales promotions or for use in corporate training programs. To contact a representative, please visit the Contact Us page at www.mhprofessional.com.

Create, Share, and Save Money Using Open-Source Projects

Copyright © 2021 by McGraw Hill. All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

McGraw Hill, the McGraw Hill logo, TAB, and related trade dress are trademarks or registered trademarks of McGraw Hill and/or its affiliates in the United States and other countries and may not be used without written permission. All other trademarks are the property of their respective owners. McGraw Hill is not associated with any product or vendor mentioned in this book.

1 2 3 4 5 6 7 8 9 LOV 25 24 23 22 21 20

ISBN 978-1-260-46176-3
MHID 1-260-46176-9

This book is printed on acid-free paper.

Sponsoring Editor

Lara Zoble

Editorial Supervisor

Stephen M. Smith

Production Supervisor

Lynn M. Messina

Acquisitions Coordinator

Elizabeth M. Houde

Project Manager

Patricia Wallenburg, TypeWriting

Copy Editor

James Madru

Proofreader

Michael McGee

Indexer

Karin Arrigoni

Art Director, Cover

Jeff Weeks

Composition

TypeWriting

Information contained in this work has been obtained by McGraw Hill from sources believed to be reliable. However, neither McGraw Hill nor its authors guarantee the accuracy or completeness of any information published herein, and neither McGraw Hill nor its authors shall be responsible for any errors, omissions, or damages arising out of use of this information. This work is published with the understanding that McGraw Hill and its authors are supplying information but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought.

Contents

Acknowledgments	ix
Disclaimer	x
1 Introduction to the Open-Source Philosophy and the Benefits of Sharing	1
Why We Share Aggressively	1
The Theory of Nice	9
Meet the Makers	11
Concluding Thoughts	12
References	13
2 Making and Sharing Recipes, Life Hacks, and Household Tricks	15
Sharing Recipes	15
Sharing Life Hacks and Home-Improvement Tricks	16
Open-Source Ad Blockers	18
References	20
3 Making and Sharing Digital Photographs and Open-Source Cameras	21
Taking and Sharing Digital Photographs	21
Free Software for Photo Lovers	24
Open-Source Cameras	25
Open-Source Software for Photogrammetry and Machine Vision	25
4 Making and Sharing Art	29
5 Making and Sharing Music, Software, and Instruments	35
Great Places to Share Your Music	35
Open-Source Music Software	36
Making Musical Instruments	36
Open Theremin	39
References	40
6 Scanning, Making Paper and Audio Books, and Sharing Books	41
Open-Source Book Scanning	41
Making Books	42
Making Audio Books	43
Reading and Sharing Books	43
Cory Doctorow Makers	45
References	46

7	Making, Editing, and Sharing Videos	49
	Open-Source Movie Cameras	49
	Open-Source Video Editing	50
	Open-Source B-Roll and Sharing Your Videos	52
	Reference	53
8	Making and Sharing Maps and GIS Data	55
	Open-Source Maps	55
	Open-Source Drones	57
	Open-Source GPS	59
	Open-Source GIS Information	60
	Open-Source GIS Software	60
	References	64
9	Making and Sharing Clothing	65
	Free Patterns for Clothes	66
	Open-Source Software for Automated Sewing	69
	Open Hardware for Clothes Making	69
	Do-It-Yourself (DIY) Clothing and the Future	70
	References	70
10	Making and Sharing Woodworking and Other Old-School Skills	71
	References	76
11	Making and Sharing Electronics	77
	Arduino	77
	Finding and Sharing Open-Source Electronics	80
	Open-Source Software for Electronics Design	81
	Ordering Boards	81
	PCB Making	82
	References	85
12	Making and Sharing Digital At-Home Manufacturing	87
	RepRap 3D Printer	87
	Open-Source Mills	95
	Applications	97
	References	102
13	Making and Sharing Scientific Equipment	103
	Poor Scientists, Rich Open-Source Science	103
	Next Steps	109
	References	109
14	Making and Sharing Data as a Citizen Scientist	113
	Introduction to Citizen Science	113
	Easy First Steps into Citizen Science	113

How Companies Can Harness Open Source to Support Citizen Scientists . . .	120
References	122
15 Making and Sharing Waste Recycling: Recyclebots	125
Recycling Waste for 3D-Printer Feedstock	125
Sheets, Blocks, and Bulk Extrusions	130
References	131
16 Making and Sharing Big Free Stuff	133
Introduction to Free Big Stuff	133
Open-Source Cars	133
Free Electricity	134
Open Building Institute	136
Open Source Ecology	138
References	139
17 How to Make a Million Dollars of Value	141
A Wee Bit of Math	141
Case Studies	142
References	148
18 Making the Future of Sharing	151
The Past: Great Minds Agree That Cooperating Builds Great Societies	151
The Future	155
References	158
Index	159

Acknowledgments

First and foremost, on a personal note, I thank my wonderful wife, Jen, for putting up with the long hours of my writing this text and all the craziness that comes with it. In addition, I also thank Jen for driving as I write this now in the car, for turning various parts of our house into mini-makerspaces to work on projects, and for her support and her reading and critiquing of this manuscript. She is my most beloved and harshest critic—if you ever think your creation is good enough, you have not met her.

I also thank my children, Emily, Jerome, Vincent, and Dominic, who actually helped me make my first 3D printer and create some of the examples in this book, as well as various “epic makes” throughout the years.

Thanks also goes to the rest of my family for their support and encouragement: Mom and Dad, as well as siblings Solomon, Mary Rachel, and Elijah, who independently invented new ways to kill room lights late at night after reading for hours and getting too tired to get out of bed. Special thanks go to Mary Rachel for giving me a copy of *Makers* by Cory Doctorow, whose fiction inspired me to try to make some of the better parts real in this book.

In addition, I thank McGraw Hill for having the foresight to publish this book, and I especially thank Lara Zoble for making the book a reality.

This book was truly a massive international and asynchronous collaboration that goes back years and contains the ingenious and incredibly useful and beautiful contributions (from art to computer code) of people with whom I have

worked closely, and of many whom I have never met (or may only know of through their esoteric internet handles that you will find scattered throughout these pages).

I also thank the past and present members of my own research group, the Michigan Tech Open Sustainability Technology (MOST) Lab, for their fruitful collaboration and the fun of creating new things to help people.

For their ongoing support, I thank the Appropedia community. A giant thank you also goes to the entire GNU/Linux community for really showing us what is possible when we all work together and providing us with the free software on which we rely. In addition, I'd like to thank Arduino founders Massimo Banzi and David Cuartielles and all their collaborators for making the control of any type of equipment easy and fun. The entire world owes a great deal of thanks to Adrian Bowyer and his many collaborators for making the RepRap project into the incredible success it is. I thank all the fantastic open-source software and hardware individuals, groups, and companies that keep enabling us to reach higher; the Open Source Hardware Association and all its members; and all those who have shared their brilliance with the world and helped make so many items easy to create because of their contributions in all the varied fields discussed in this book. Special thanks also go to everyone who provided examples that are cited or shown in these pages. Finally, I thank the growing number of makers in the burgeoning maker community who inspire and teach us all.

Disclaimer

Although many brilliant sharing people from all over the world contributed to the contents of this book, all errors and omissions are mine alone. The technologies described in this book are constantly changing, and while every effort has been made to ensure accuracy, it is always best to go directly to the sources for the most up-to-date information on the various open-

source hardware projects described. Wherever possible, hyperlinks are shown in the references and will be enabled on the Appropedia splash page for the book at www.appropedia.org/Create.

Finally, if any of the hardware or software is not good enough for you, remember, it's free, so quit whining and make it better!