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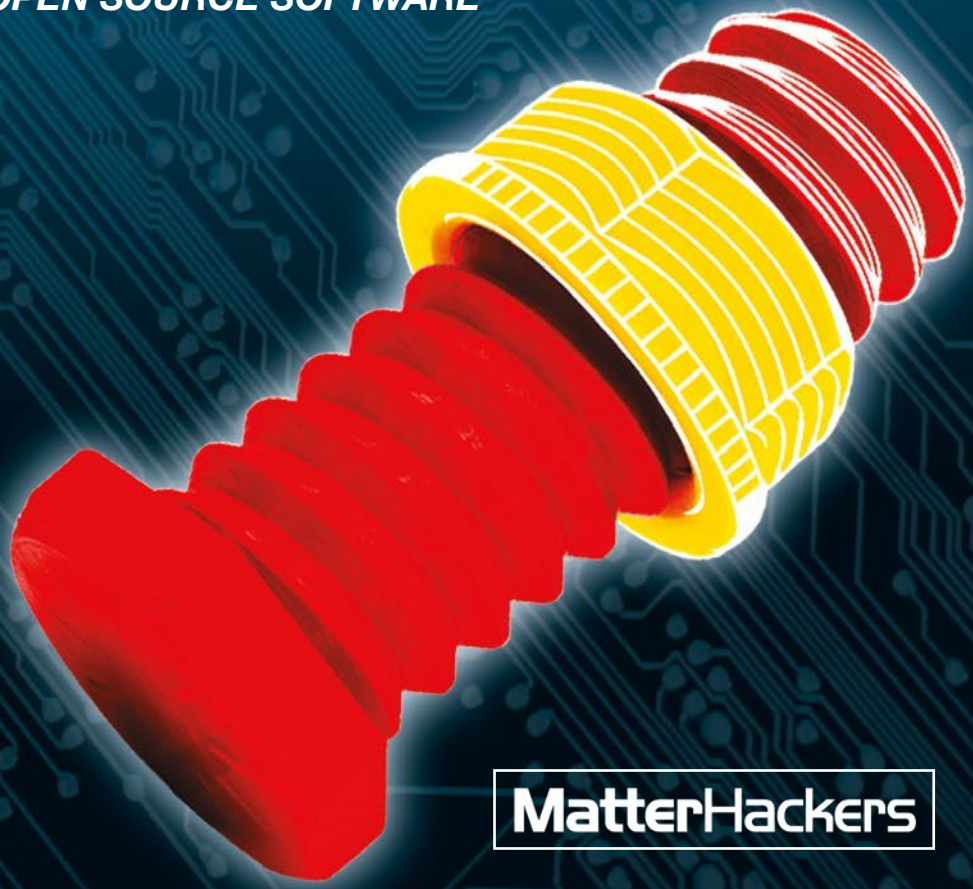
3D Printing with MatterControl

STREAMLINE THE 3D PRINTING PROCESS WITH OPEN SOURCE SOFTWARE



MatterHackers

Joan Horvath and Rich Cameron

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Apress®

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To the MatterHackers team, for believing in open source software

Contents at a Glance

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About the Authors

Joan Horvath and Rich Cameron (known online as "Whosawhatsis") are the cofounders of Nonscriptum LLC based in Pasadena, California. Nonscriptum consults for educational and scientific users in the areas of 3D printing and maker technologies. This book is their latest collaboration, following their earlier works *Mastering 3D Printing* (Apress, 2015) and *The New Shop Class: Getting Started with 3D Printing, Arduino*, and *Wearable Tech* (Apress, 2015). Starting in January 2016, they will also be teaching online classes in 3D printing for LERN Network's U Got Class continuing education program. Links for all of the above are on their website, www.nonscriptum.com.

In addition work with Rich, Joan also has an appointment as Core Adjunct faculty for National University's College of Letters and Sciences. She has taught at the university level in a variety of institutions, both in Southern California and online. Before she and Rich started Nonscriptum, she held a variety of entrepreneurial positions, including VP of Business Development at a Kickstarter-funded 3D-printer company. Joan started her career with 16 years at the NASA/Caltech Jet Propulsion Laboratory, where she worked in programs including the technology transfer office, the Magellan spacecraft to Venus, and the TOPEX/Poseidon oceanography spacecraft. She holds an undergraduate degree from MIT in Aeronautics and Astronautics and a master's degree in Engineering from UCLA.

Rich is an experienced open source developer who has been a key member of the RepRap 3D-printer development community for many years. His designs include the original spring/lever extruder mechanism, the RepRap Wallace, and the Deezmaker Bukito portable 3D printer. By building and modifying several of the early open source 3D printers to wrestle unprecedented performance out of them, he has become an expert at maximizing the print quality of filament-based printers. When he's not busy making every aspect of his own 3D printers better, from slicing software to firmware and hardware, he likes to share that knowledge and experience online so that he can help make everyone else's printers better too.

Acknowledgments

The consumer 3D printing ecosystem would not exist in its current form without the open source 3D printing hardware and software community, and in particular this book is a result of the efforts of many developers of the MatterControl software. We are grateful for the support of the MatterHackers team, particular Lars Brubaker, Kevin Pope, and Taylor Landry for their support during the writing of this book. We would also like to acknowledge Marius Kintel, the main developer and maintainer of OpenSCAD software and his collaborators for their software which was used to develop many of the objects in this book. The maker community as a whole has also been very supportive. The picture of Joan and Rich in the "About the Authors" section was taken at San Mateo Makerfaire by Ethan Etnyre; we appreciate all the inspiration we have gotten by looking at projects made by everyone at maker events large and small.

The Apress production team made this process seamless for the most part, and were there with virtual needle and thread for the occasions where it was not. We dealt most directly with Kevin Shea, Michelle Lowman, James Markham, Corbin Collins and Dhanish Kumar, but we also appreciate the many we did not see.

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Finally, we are grateful to our families for putting up with our endless brainstorming on the best way to explain some concept or the other. In the same vein, thanks to all of our maker community colleagues who helped us think about a problem, or posed unanswered questions at some point that we have tried to answer here.

Introduction

The consumer 3D-printing landscape has changed a lot in the past year. Initially in the realm of crowdfunded startups, the printers are now starting to look more and more like consumer electronics devices than hobbyist kits. As with any maturing industry, unfortunately along the way there has been a fracturing of standards. Many one-off proprietary systems are coming on to the market. The open source community has been standing against that trend. This book focuses on MatterControl, a program for using any one of the many printers that conform to open source standards.

3D printing can be defined pretty simply: creating an object by building it up layer by layer—rather than by machining it away the way you would by making something from a block of wood or by squirting something into a mold as you would for injection-molded plastic parts. Making 3D printing work, though, is far from simple. 3D-printer designers can take one of two fundamental approaches. Either they can make their system proprietary (using software and hardware available only to them) and tightly control their ecosystem so that the user does not have to (and, often, cannot) make many changes; or they can accept the complexity, requiring that the user be more sophisticated.

This book is aimed primarily at the latter audience. MatterControl hides some of the complexity from users, but also allows flexibility for the printers that support it. MatterControl comes preloaded with settings for some printers, which makes getting started with those printers particulary simple.

This book is meant to be a self-contained tutorial on consumer 3D printers that run open source software. More specifically, it is a "manual plus" for MatterControl and the ecosystem of open source 3D-printing hardware and software surrounding it. We draw on some of the material from the earlier book *Mastering 3D Printing* (Apress, 2014). That book for the most part avoided screenshots and step-by-step instructions because when it was written (about a year before this book), most software interfaces were too much in flux to include in a traditional book. With the maturing of the industry and its software, it is now possible to create more of a step-by-step guide to using particular software. Details may change and features may be added, of course. By the time you read this, MatterControl may have evolved a little, but the fundamentals are now in place. This book is mostly software-focused; if you are more interested in the hardware too and post-processing, you might consider also investing in *Mastering 3D Printing*.

This book can be used as a textbook for a semester-length class or university extension certificate series covering 3D printing and its applications, particularly one focusing on K–12 educators. It might be paired with an in-depth class on 3D computer-aided design (CAD) software for students interested in engineering and industrial or product design, or a group planning on starting with an open source RepRap printer that they plan to modify for specialized applications. Similarly, this book might be paired with a text covering one of the sculptural 3D-modeling programs for students developing skills in 3D animation or fine art.

Part 1 (Chapters 1–3) of the book gives background on the history of these printers, talks about how the hardware works, and introduces the MatterControl software, including downloading and configuring it for a particular printer. Part 2 (Chapters 4–8) is the nitty-gritty tutorial on the workflow of using a 3D printer: developing a 3D model, slicing it into layers that the printer will create one at a time, and controlling the printer in real time. This part concludes with a discussion of special cases, such as printing something hollow. Part 3 (Chapters 9–12) talks about how to put your 3D printer to work, with some case studies,

a discussion of classroom lessons learned, and ways of post-processing your 3D print to improve the surface finish. This part reviews creating larger projects and troubleshooting, too. To round out the book, we have two appendices. Appendix A lists the 3D printers currently supported by MatterControl, and Appendix B gathers up all the links referenced in the book so that you can have them in one place.

We hope you enjoy this book and that it launches you on many adventures in 3D printing. As the software and hardware begin slowly mature, we know you will be able to invent and prototype as never before, and we hope in some small way that we can speed you along that road.

PART I

The 3D-Printing Ecosystem

Chapter 1 introduces you to desktop 3D printers. Then we move on to talking you through what the MatterControl program is in Chapter 2. Finally, in Chapter 3, we walk you through setting up and installing MatterControl so that you are ready for the 3D printing-workflow in the chapters that follow.