HACK THIS!

24 INCREDIBLE HACKERSPACE PROJECTS FROM THE DIY MOVEMENT

JOHN BAICHTAL

que

Foreword by DALE DOUGHERTY, Founder of *MAKE* magazine

HACK THIS:

24 INCREDIBLE HACKERSPACE PROJECTS FROM THE DIY MOVEMENT

JOHN BAICHTAL

que®

800 East 96th Street
Indianapolis, Indiana 46240 USA

HACK THIS: 24 INCREDIBLE HACKERSPACE PROJECTS FROM THE DIY MOVEMENT

ISBN-13: 978-0-7897-4897-3

ISBN-10: 0-7897-4897-5

The Library of Congress Cataloging-in-Publication Data is on file.

Printed in the United States of America

First Printing: October 2011

TRADEMARKS

WARNING AND DISCLAIMER

BULK SALES

Que Publishing offers excellent discounts on this book when ordered in quantity for bulk purchases or special sales. For more information, please contact

U.S. Corporate and Government Sales

1-800-382-3419

corpsales@pearsontechgroup.com

For sales outside of the U.S., please contact

International Sales

international@pearson.com

EDITOR IN CHIEF
Greg Wiegand

ACQUISITIONS EDITOR
Rick Kughen

DEVELOPMENT EDITOR
Rick Kughen

TECHNICAL EDITOR
Mark Reddin

MANAGING EDITOR
Sandra Schroeder

PROJECT EDITOR
Mandie Frank

COPY EDITOR
Megan Wade

INDEXER
Lisa Stumpf

PROOFREADER
Leslie Joseph

PUBLISHING COORDINATOR
Cindy Teeters

DESIGNER
Anne Jones

COMPOSITOR
Studio Galou, LLC

CONTENTS AT A GLANCE

TABLE OF CONTENTS

ABOUT THE AUTHOR

John Baichtal is the founding member of Twin Cities Maker, a hackerspace organization that has been collaborating for almost two years. Twin Cities Maker has its own rented warehouse, the Hack Factory, complete with a welding station, a woodshop, a classroom, and an electronics area. John is currently writing *The Cult of Lego,* a book about adult Lego builders for No Starch Press. He has written dozens of articles for print, including pieces for *MAKE Magazine*, *Kobold Quarterly* (a D&D magazine), and *2600: The Hacker Quarterly*. He has blogged for Wired.com (*GeekDad* blog) for four years and *Make: Online* for a year, with more than 1,000 posts published during that time.

DEDICATION

To hackers everywhere, for expanding the realm of the possible;

to Eileen Arden, Rosie, and Jack, for their limitless interest in the mysteries of the world; and to Elise, for making it all worth it.

ACKNOWLEDGMENTS

I want to thank Gareth Branwyn for his assistance and encouragement in this project, and to all the hackerspace members who contributed projects and photos to this book.

WE WANT TO HEAR FROM YOU!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

As an editor in chief for Que Publishing, I welcome your comments. You can email or write me directly to let me know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that I cannot help you with technical problems related to the topic of this book. We do have a User Services group, however, where I will forward specific technical questions related to the book.

When you write, please be sure to include this book's title and author as well as your name, email address, and phone number. I will carefully review your comments and share them with the author and editors who worked on the book.

Email: feedback@quepublishing.com

Mail: Greg Wiegand
Editor in Chief
Que Publishing
800 East 96th Street
Indianapolis, IN 46240 USA

READER SERVICES

Visit our website and register this book at informit.com/register for convenient access to any updates, downloads, or errata that might be available for this book.

PROJECT 6

MILKYMIST VJ CONSOLE

After years of using ordinary PCs for interactive VJing, the team at Paris hackerspace /tmp/lab decided to build their own, creating Milkymist, a custom board that generates visualizations based on sensor input and musical rhythms.

Credit: Sébastien Bourdeauducq

/tmp/lab

HACKERSPACE PROFILE: /TMP/LAB

Location:

/tmp/lab
6bis rue Lé]on Geffroy
94400 Vitry-sur-Seine
Paris, France
http://www.tmplab.org/

Organizational type: Nonprofit

Founding date: September 2007

Number of members: 30

Dues: 30€/year

Size of the space: 100 square meters

Officers/Leaders:

- Stephanie "Ursula", president
- Dermiste, treasurer

Notable equipment:

Ikos Pegasus ASIC emulator, chemicals (for chip decapsulation), microscope, DIY biodiesel reactor, kiln, shower, washing machine, RepRap, OLPCs, and a Siemens BS11 base transceiver station

SPACE DETAILS

"Rent is hard in Paris, expensive," co-founder Sébastien Bourdeauducq described. "We got an offer from an artist collective to have an artist space outside of Paris in the industrial suburb of Vitry-sur-Seine. The building owner temporarily gave us the space for no rent." The space's name comes from the temporary nature of this arrangement.

"The goal was to provide an infrastructure first," Bourdeauducq explained, "and let 1,000 beautiful projects blossom in this fertile environment: open Source, hardware, cultural and artistic events, activism, etc. We wanted everyone to see the /tmp/lab and say 'Oh… it's simple, let's build one with my friends in my town.'"

Credit: Paula Vélez

▲ *The door to /tmp/lab lays out members' politics for visitors.*

Credit: Paula Vélez

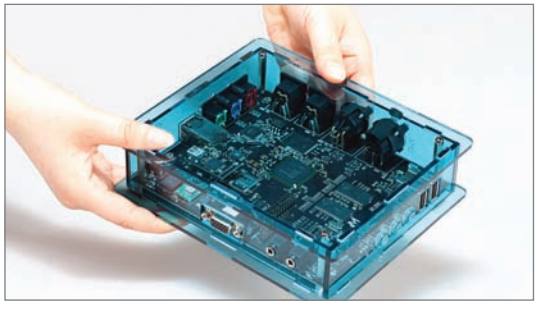
▲ *A /tmp/lab member hacks in the main work area.*

Credit: Girard Alexandre

▲ *Comfort in the tight confines of /tmp/lab can be a rare commodity.*

Credit: Paula Vélez

▲ *A sign at /tmp/lab touts Phack (phack.fr), an organization that supports Parisian hackerspaces.*



Credit: Sébastien Bourdeauducq (CC-BY-SA)

▲ *A beauty shot of the finished Milkymist One, showing off its laser-cut case.*

THE PROJECT

Participants: Sébastien Bourdeauducq, Yann Sionneau, Joachim Steiger, Lars-Peter Clausen, Takeshi Matsuya, Wolfgang Spraul, Adam Wang, and Michael Walle.

Sébastien Bourdeauducq of /tmp/lab used to do interactive VJing, where a club deejay uses a PC to generate video effects to go along with the music, with patterns and colors generated by the audio like a music program's visualizer. He discovered that he really didn't like using PCs—they were heavy, took a long time to set up, and if they lost power everyone in the club would watch as the computer painstakingly rebooted. Bourdeauducq wanted a dedicated system that could run his whole show from a small box.

Credit: Gerard Braad (CC-BY-SA)

▲ *Milkymist being demonstrated; the VJ runs music off his laptop while Milkymist handles the visualization.*

While Bourdeauducq was already very technically savvy—he ultimately used Milkymist for his master's thesis—he still needed help with the project and began looking for partners. "Geeks often disregard this project because they think it is too expensive and/or too complex," he explained. "It is exacerbated by the fact that DIY blogs adopt a similar attitude and largely overlook the project, making it even harder to reach out for people."

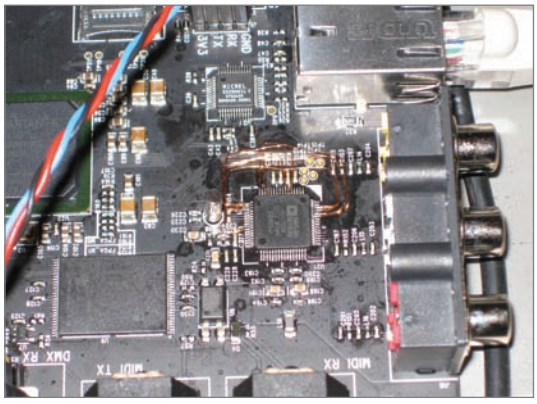
Ultimately, he found a team by directly approaching people he thought might be interested and by giving presentations at hacker conventions such as the CCC Congress and Notacon. They come from all over—for instance, Joachim Steiger hails from the Raumfahrtagentur hackerspace in Berlin and Lars-Peter Clausen is a member of Chaos Computer Club Hamburg. Bourdeauducq, along with Spraul and Wang, focused on laying out and producing the Milkymist board, while Sionneau, Clausen, Matsuya, and Walle developed the software. Meanwhile, Steiger designed and laser-cut the case.

The greatest challenge for the design team was making the Milkymist as small and handy as possible. That meant going with a system-on-a-chip (SoC) instead of merely using a PC. A SoC is essentially a big microcontroller, a low-powered computer with all the components like the microprocessor, memory, power management circuits, display controller, and so on integrated into a single chip.

"On the surface, Milkymist is promoted as a visual synthesizer," Bourdeauducq said. "But

Credit: Sébastien Bourdeauducq (CC-BY-SA)

▲ *A screen shot shows the interface VJs use to operate Milkymist.*

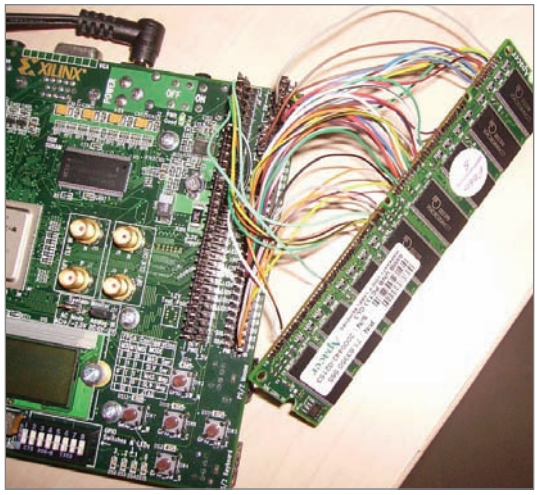


Credit: Michael Walle

▲ *The tininess of Milkymist's surface-mount components (see Project 16, "LED Matrix Gaming System") made testing wiring changes a particular challenge.*

it is also the leading open source system-on-chip design. It is today the fastest open source system-on-chip capable of running Linux, and it comes with an extensive set of features and graphics accelerators."

By using an FPGA for the central chip, advanced users can modify the design, either to customize the product for their own use or to contribute to the open source design. "This makes Milkymist the platform of choice for both anyone looking to build or use a fast open source processor and for the mobile VJ," Bourdeauducq said. FPGA, which stands for field programmable gate array, is the physical chip upon which the SoC is programmed. Unlike many integrated circuits that are configured in the factory, an FPGA can be reprogrammed in the field, hence the name. It is, nevertheless, the realm of the advanced programmer and probably too difficult for a neophyte to configure without a lot of study.



Credit: Sébastien Bourdeauducq (CC-BY-SA)

▲ *Milkymist's RAM presented a consistent problem early on and required a great deal of tinkering to get it working the way the team wanted.*

Credit: Takeshi Matsuya

▲ *The Milkymist board runs a version of the GNU-Linux operating system.*

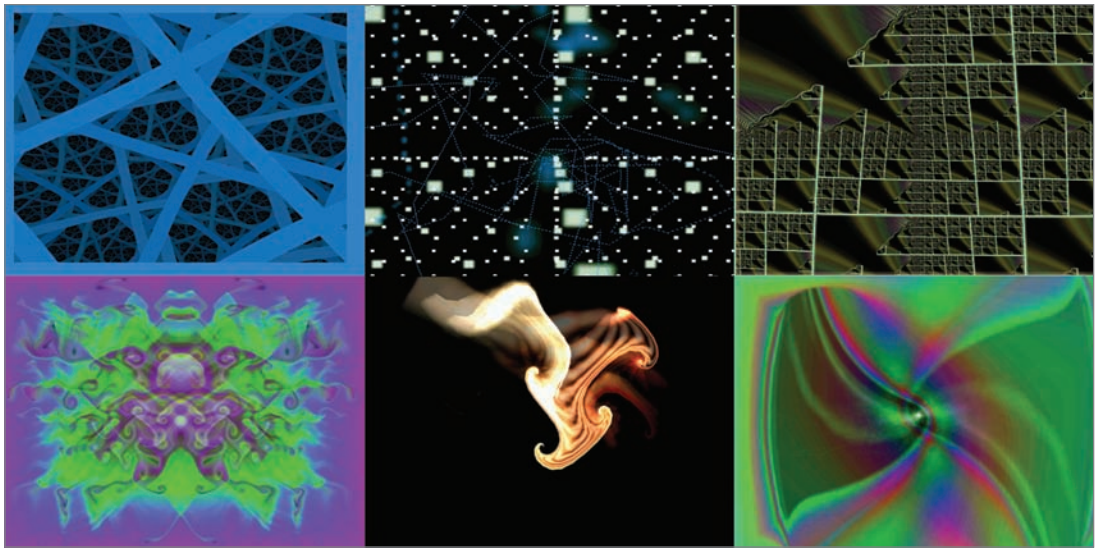
After designing the board, the team set about manufacturing it. Because of the space constraints of the small system, it made more sense to use surface-mount components, which are much smaller and solder directly to the PCB, rather than through-hole components, which attach by wire leads threaded through holes in the board. The downside to SMD is that the manufacture can be quite difficult to do by hand.

Bourdeauducq traveled to the Minbo electronics factory in Taiwan and observed the entire manufacturing process. The six-layer PCBs have solder paste silk-screened onto them; then a manufacturing machine called a pick-and-place adds the SMD components. Next, the whole thing goes through a reflow oven to melt the solder. After the assembly, boards go through an automated optical inspection machine to detect soldering problems early. If the boards pass inspection, they are flashed with their initial architecture. Finally, self-test software is run on them to verify that all peripherals work as expected.

For VJing software, the team created Flickernoise, an easy-to-use interface that allows for the creation of visuals that react to the music with the help of control interfaces like MIDI (digital music) signals, video-in, DMX512 (digital stage lighting controllers), and even infrared remote controls. Flickernoise, like Milkymist, is open source and can be downloaded for free.

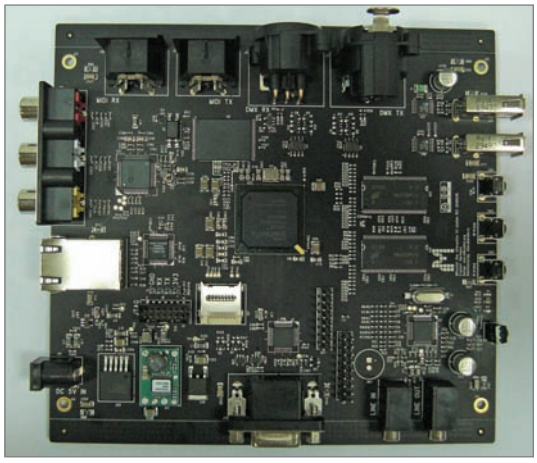
Unlike the software, however, the Milkymist team can't be given away for free. While Bourdeauducq initially intended Milkymist for his own use, it gradually became apparent that the team might have a commercial product on its hands. "As the technical problems gradually went away, I wanted to see 'how deep the rabbit hole goes' and make a fully fledged product out of it," Bourdeauducq recalled. "The project took a definitive turn in December 2009, when I met with Wolfgang Spraul, a former Openmoko employee, who offered to fund and take care of the production. This sped things up a lot."

The team sold about 35 Milkymists in the first four months, marketing the product as an "early developer kit" for hackers.



Credit: Sébastien Bourdeauducq (CC-BY-SA)

▲ *A sampling of the various video effects created by Milkymist.*



Credit: Sébastien Bourdeauducq (CC-BY-SA)

▲ *The Milkymist board serves as the brain of the system, similar to a computer's motherboard.*

"While this is great for building a community of open source developers, hackers are a minority." An additional hurdle is the fact that the Milkymist looks extremely complex, which Bourdeauducq calls a misconception. "Even people with moderate skills but the right mindset manage to carry out useful hacks on Milkymist."

Bourdeauducq ultimately hopes to make Milkymist an indispensable accessory for clubs, bands, and VJs. "We want to sell it in large quantities through retail chains, music shops, etc. In short, we are like a usual electronics device company, but one that applies (and benefits from) the open source principles everywhere possible. Only a self-determined minority of people and other companies would have a real interest in the open source aspects of our work. We believe this is the best way to make large-scale open source hardware happen."

ALT.PROJECT

TOXIC GAS SENSOR

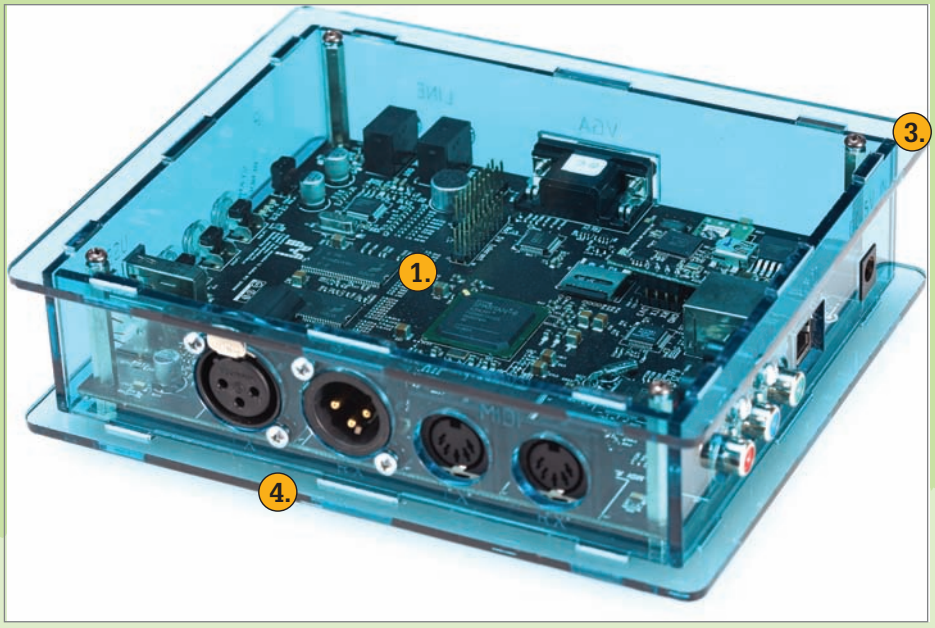
/tmp/lab is located in an industrial area in the suburbs of Paris, near a pharmaceutical factory. One side effect of this neighborhood is a terrible smell. "It smells like rotten eggs at times," hackerspace member Sébastien Bourdeauducq described. "We wanted to monitor the pollution from the factory, more for the fun of it than as a scientific experiment." Bourdeauducq attached Figaro toxic gas sensors to a Linux-based development board and an analog-to-digital converter and wrote a program that published the sensor readings on Twitter. Eventually, as is often the case, the project ran its course and the components were repurposed.

Credit: Sébastien Bourdeauducq (CC-BY-SA)

▲ *Faced with a potentially toxic environment outside the hackerspace, /tmp/lab members built sensors to track pollution.*

To learn more, visit:

http://www.tmplab.org/wiki/index.php/Toxic_Gas_Sensor



BUILD IT

Outwardly, the Milkymist seems too complicated and challenging to build, but as an open source project, every technical detail and schematic relating to Milkymist and Flickernoise are available for study and modification.

1. **Build the main Milkymist board**—Download the schematics from the project website and manufacture the board. Sending it out to an SMD shop might be the best tactic due to its complexity.
2. **Load Flickernoise software (not depicted here)**—The latest is version 0.4, indicating a beta release that may not be without obvious bugs. The software may be downloaded from milkymist.org.
3. **Assemble the case**—The vector files of the case the Milkymist team created are available from the project sites.
4. **Add the peripherals**—These could include MIDI-compatible synthesizers, cameras, and microphones, among other possibilities.
5. **Throw a party**—VJ the party with your new Milkymist!

FURTHER READING

- Explanation of the manufacturing process—http://en.qi-hardware.com/wiki/Milkymist_One_SMT/DIP_Process_Flow
- File dump—http://www.milkymist.org/mmone/
- Project wiki—http://milkymist.org/wiki/index.php?title=Main_Page

Index

SYMBOLS

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Z