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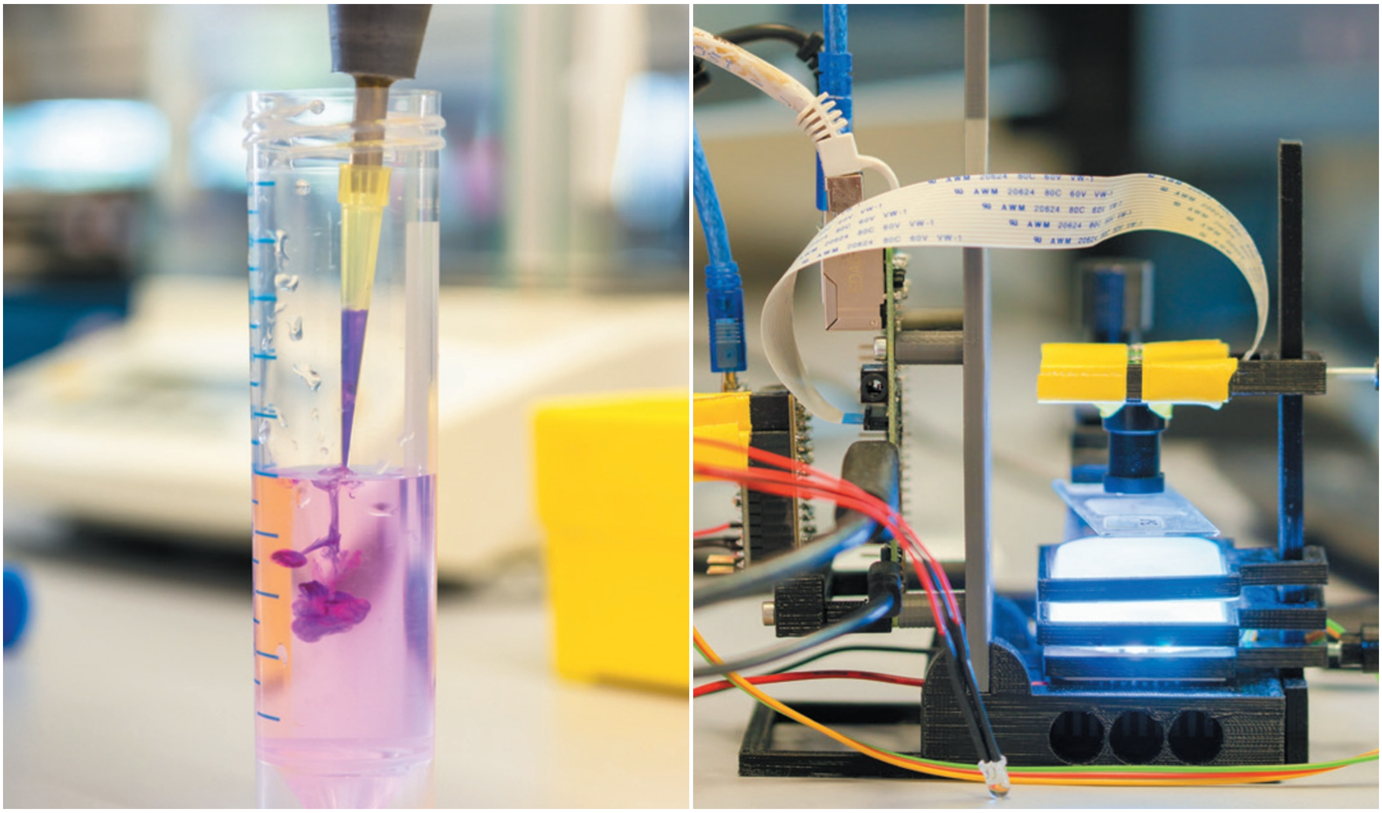

DIY labware: a 3D printable micropipette (left) and FlyPi, a 3D printable open-source platform for optical microscopy (right).

LABORATORY MANAGEMENT

‘Open-hardware’ pioneers push for low-cost lab kit

Conference aims to raise awareness of shared resources for building lab equipment.

BY ELIZABETH GIBNEY

Few scientists know that, instead of buying their lab equipment, they can often build it much more cheaply — and customize their creations — by following ‘open-hardware’ instructions that are freely available online.

Fifty enthusiasts who gathered last week at CERN, Europe’s particle-physics laboratory near Geneva, Switzerland, are hoping to remedy researchers’ lack of awareness about open science hardware. At the first conference dedicated to the field, they met to compare creations — and to thrash out a road map to promote the widespread manufacturing and sharing of labware. “We want open hardware to become a normal part of the scientific process,” says Shannon Dosemagen, a co-organizer of the conference who is executive director of the non-profit citizen-science community Public Lab.

Proponents of open hardware — named by analogy to ‘open software’ in computer science — have already created free online designs for dozens of pieces of labware, taking advantage of manufacturing technologies such as 3D printers and laser-cutting machines. They argue that sharing designs for others to adapt can vastly accelerate the progress of science. But this share-all do-it-yourself (DIY) philosophy is yet to become mainstream. “The majority of scientists are still waiting to get involved,” says Joshua Pearce, an engineer at Michigan Technological ▶

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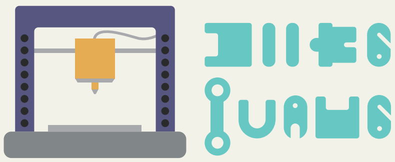
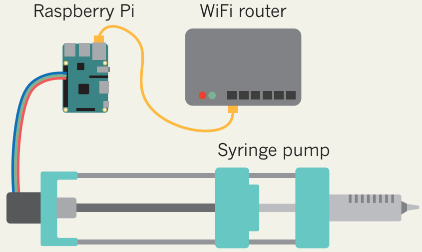
HOW TO MAKE A… DIGITALLY CONTROLLED SYRINGE PUMP

To deliver liquid at precise rates and volumes — whether for mixing reagents, pumping cells into culture or spinning polymers, every lab needs a syringe pump. Follow *Nature*'s guide to making your own.

1. Pick a recipe for a syringe pump online (go.nature.com/slzvlh).
2. Download 3D-printer files and print out plastic components.



3. Buy remaining parts, such as a Raspberry Pi controller, Ethernet cables, motor, bearing, rods and screws.
4. Allen key and drill bit at the ready: the syringe can be assembled in less than an hour.
5. Install software on Raspberry Pi, plug into syringe motor, and connect to computer via router to calibrate.



Open-source price: <US$100 for single; about $150 for a dual syringe pump

Proprietary price: $250–$1,500 for single; $1,800–$2,600 for dual pump

University in Houghton, who two years ago published a book for scientists on how to create a low-cost lab.

LOW-COST LAB KIT

The open-hardware movement can already point to much success in science, says conference co-organizer Jenny Molloy, who coordinates OpenPlant, a synthetic-biology centre at the University of Cambridge, UK. Citizen-science projects, schools and researchers who lack money to buy expensive equipment have been particularly quick to adopt it. In 2009, for example, Irfan Prijambada, a microbiologist at Gadjah Mada University in Yogyakarta, Indonesia, was able to equip his lab with tissue-culture hoods and microscopes for less than 10% of their commercial price, using designs posted by a life-sciences-community platform called Hackteria.

Online designs have been created for a wide range of labware, from DNA-amplifying PCR machines to fluorescence imaging microscopes. (Molloy says that the basic principles behind a lot of labware are not patented, so intellectual-property conflicts are rare.) For some kit — such as scanning tunnelling microscopes — the fabrication process is too complex to take place in the lab, but Pearce thinks that these, too, will eventually become open source. And because these blueprints are openly shared — allowing anyone to critique and improve them — the quality of equipment is often at least as good as or even better than what is available commercially, he says.

For researchers, this ability to tinker with equipment is the main advantage of open-source sharing. "If it's open source, I can adapt it and fix it. That's most important to me," says Tobias Wenzel, a biophysics PhD student at the University of Cambridge.

QUALITY ASSURANCE

But other scientists' reluctance to dive into DIY may stem from doubts about whether open hardware can faithfully produce the validated, standardized performance of commercial equipment. Too often, the documentation that accompanies designs — intended to calibrate the equipment's performance against known standards and describe its use — is unclear or incomplete, conference attendees heard. A community-standard or best-practice guide could use a checklist to ensure that designers cover all the necessary bases, says Wenzel. "It needs to be something that says: 'if you follow this procedure, this will work and you'll be able to get high precision, high accuracy and low error'," says Pearce.

The problem is that sharing work in enough detail for anyone else to follow takes time and effort, but provides little formal scientific credit. "It's one thing to build something for one's own research, but to make it so it's easy for others to replicate is much more difficult," says Ryan Fobel, an engineer at the University of Toronto, Canada, who helped to develop an open-source platform for doing biology and chemistry on a chip, known as DropBot.

To this end, at the Geneva conference researchers debated ways to assign credit to the designers of open hardware. Some would like to see a citation system for designs, or want journals to publish more research papers that outline designs. A central repository for open science hardware might help: CERN hosts a repository for electronics open hardware, and the US National Institutes of Health has a 3D-printing repository with a labware section. But no single repository collates everything.

Because many scientists won't want to build devices themselves, taking open hardware mainstream will need to involve non-profit organizations and companies that can supply the kit, notes Francois Grey, a physicist at the University of Geneva and conference co-organizer. Firms such as OpenTrons in Brooklyn, New York, which makes automated pipetting systems, already both design open-source lab equipment and sell ready-made kit built from open-source designs. But because such companies give away their designs, figuring out a solid business model is a challenge, adds Javier Serrano, an engineer at CERN who helped to pioneer the lab's Open Hardware Licence, which allows developers to ensure that all future modifications are documented and shared.

Companies might make money by providing support for open hardware, or by conducting quality-assurance checks and validation tests that allow them to offer warranty-like guarantees on products, Pearce suggests. And a collection of success stories might also help scientists to convince their institutions — which may be accustomed to patenting in-house inventions — of the value of forming open-hardware spin-offs, adds Molloy.

Pearce says that he dreams of a day when every published scientific article will instruct its readers not just on experimental methods, but also on how to build the equipment that the study requires. It's something that will need the cooperation of funders to become a reality. Existing large-scale equipment grants tend to pay for single instruments, but Pearce would like to see the money spent on open-source hardware, which he says could bring down prices and — over time — improve designs. ■

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