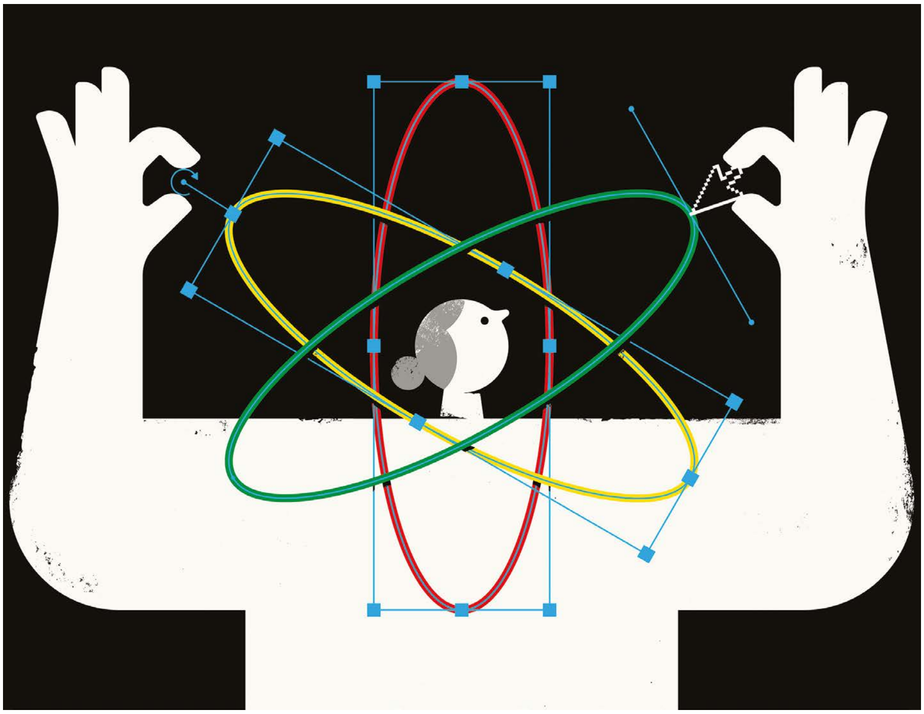

ILLUSTRATION BY THE PROJECT TWINS

GRAPHIC CONTENT: PICTURING SCIENCE

The web-based tool BioRender has become a staple of biomedical research drawings.

By Jeffrey M. Perkel

Like many researchers, Rita Sattler is trained to conduct science, not to draw it. But papers still need writing – and illustrating. So, when the time came to document what her team had done for a journal article, Sattler did what her colleagues frequently do: she fired up PowerPoint.

Microsoft's tool for creating and displaying slideshow presentations is one of two popular options for creating scientific illustrations; the other is Adobe Illustrator. But Illustrator is a professional-grade tool with a notoriously steep learning curve, and PowerPoint's strength is slide shows, not graphic design. "I'm not gonna give the adjective that I really want to say, but they were just really not nice," Sattler says of the resulting images.

In 2019, a graduate student working in Sattler's laboratory suggested an alternative. BioRender, a web-based tool designed for life-science and medical illustration, is like a feature-lite version of Illustrator. Developed in Toronto, Canada, by a start-up of the same name, and launched in 2017, it features an extensive library of scalable 'icons' from across the life sciences and medicine; researchers can drop these onto a canvas and manipulate them as if they were circles or polygons.

For Sattler, a neuroscientist at the Barrow Neurological Institute in Phoenix, Arizona, that made it possible to quickly illustrate cell-differentiation pathways without having to draw each cell from scratch. "Everybody was like, oh my God, this is awesome," Sattler says. "We jumped on this very, very quickly, and we've been using really nothing else since then."

Show, not tell

Scientific success requires an effective level of communication, whether with peer reviewers, funding agencies or colleagues. In a field in which the communication channels that count – journal articles and grant applications – often have page limits, an illustration can be worth far more than a thousand words. "If you want to communicate your findings, or in the case of a grant application if you just want to explain what you want to do, it's really important to use graphics," says Wilfried Rossoll, a cell biologist at Mayo Clinic in Jacksonville, Florida.

Unlike data figures that detail primary research findings, these graphics are typically illustrated explainers of proposed models, experimental methods or biochemical pathways. More and more journals allow researchers to include graphical abstracts, for instance – illustrations intended to summarize the key conclusions of a paper.

Researchers typically create those illustrations using PowerPoint or Illustrator, or analogues thereof. But none of these was designed specifically for scientists, so they can be challenging to use. "I would have banged my head against the wall" trying to use Illustrator had it not been for BioRender, says Signe Elisabeth Åsberg, a sepsis researcher at the Norwegian University of Science and Technology in Trondheim, as she recalls the graphics she made for her thesis. Akiko Iwasaki, an immunobiologist at Yale University in New Haven, Connecticut, echoes that sentiment. Using Illustrator, she says, "it would take me days to create figures of tissues or cell types or vasculature. But with BioRender, within minutes I can draw what I need."

Fully equipped

That's thanks mostly to BioRender's library of around 30,000 life-science icons, which includes anatomical drawings and depictions of everything from SARS-CoV-2 virus particles to fruit flies. Users can resize, rotate and change the colour of those icons. But they cannot change their fundamental appearance, for instance to add or remove a protein domain. The library also includes icons for specific pieces of laboratory kit, making it possible to illustrate protocols with images of the actual equipment used.

Among the items depicted are the Orbitrap Fusion Tribrid mass spectrometer, made by Thermo Fisher Scientific in Waltham, Massachusetts, and the MinION DNA sequencer, from Oxford Nanopore Technologies in the United Kingdom. Beth Kenkel, an associate scientist at Bristol Myers Squibb in Seattle, says that this feature helps in her presentations to her team. "I can quickly make a graphic representation of how I plan to do an experiment. And then I can solicit feedback from my co-workers: is this how I should design it, or should I change something?"

Researchers can also create icons that represent specific structures in the Protein Data Bank, an open-access digital archive providing access to 3D structure data for proteins and nucleic acids. In March the company rolled out an enhanced Protein Data Bank interface that enables BioRender to produce "more painterly" renderings than its earlier iteration, says Shiz Aoki, a medical illustrator who co-founded BioRender. Users can also request custom icons from the BioRender team. Rossoll, for example, has ordered icons that represent two pieces of equipment used in tissue processing for immunohistochemical analysis. Created at no charge, those icons are now available to all BioRender users. "You're welcome," he quips.

All lined up

Fleshing out BioRender's toolbar are drawing tools specific to life-science research. There are pre-made lines and arrow styles for biochemical pathways, for instance; an arc tool for plasmid maps (graphical representations of small circular pieces of DNA commonly used in molecular biology research); and a new series of brushes for drawing plasmid membranes, vasculature and nucleic acids as if they were lines.

Andrew Deans, a protein chemist at St Vincent's Institute in Melbourne, Australia, published a paper (J. O'Rourke *et al. Nucleus* **10**, 221–230; 2019) in October that features four graphics created in BioRender. Deans is comfortable using Illustrator, but notes that it can be difficult to train new people to use it. As a result, he says, his students 'love' BioRender. But they still create data figures with Illustrator and Adobe Photoshop, he notes. And one member of his team, who is comfortable drawing freehand, creates illustrations using the Tayasui Sketches iPad app and an Apple Pencil.

And there are other options, although none is as bio-focused as BioRender. Kenkel, who also blogs for the reagent distribution service Addgene, says that she illustrates her posts mostly using Vectr, a general-purpose vector-graphics tool, and Canva, an online tool for creating social-media images. Both tools are free, web-based and easy to use, she says, and "basically tick all the boxes for me".

Ken Hughes, an oceanography postdoc at Oregon State University in Corvallis, uses Inkscape, an open-source Illustrator analogue whose version 1.0 release came out on 1 May. And Zen Faulkes, who studies crustacean biology at the University of Texas Rio Grande Valley in Edinburg, favours CorelDRAW, a commercial tool that he supplements with images from the Noun Project, a collection of more than 2 million freely available icons. (Another option is the Servier Medical Art collection from the pharmaceutical company Servier in Suresnes, France; this includes some 3,000 free-to-use images.)

According to Aoki, BioRender now has some 200,000 users. It's free to use, but the resulting images are watermarked, and output-file resolution and format are limited. Figure publication requires a licence (US$35 per month, or $99 per month for 5 users). Users can start working from a blank canvas, but the company also provides hundreds of predesigned templates, including several related to SARS-CoV-2. One of these, detailing the coronavirus replication cycle, is currently the most-used template on the site, Aoki says.

Jeffrey M. Perkel is *Nature*'s technology editor.

AFRICAN SCIENTISTS LEVERAGE OPEN HARDWARE

A growing emphasis on do-it-yourself science is helping researchers to equip labs in resource-limited areas. **By Abdullahi Tsanni**

A 2018 article in the journal *HardwareX* details "an open source hardware setup to measure locomotor activity in rodents". It has a simple design. But for developer Victor Kumbol, then a neuroscience master's student at the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana, that device, called Actifield, has had an outsized impact.

Actifield is an actimeter, a device that quantifies animal activity (V. Wumbor-Apin Kumbol *et al. HardwareX* http://doi.org/ggb8hw; 2018). "I needed the actimeter to test for potential drug compounds that could modify behaviour in mice. But my department had only one actimeter available, and it was outdated," Kumbol says. "So I decided to build one for myself."

With colleagues Elikplim Ampofo and Mary Twumasi, Kumbol travelled to Cape Town, South Africa, to attend a two-week workshop run by the non-profit organization Teaching and Research in Natural Sciences for Development (TReND) in Africa, which promotes research and education on the African continent.

Founded in 2011 by Lucia Prieto-Godino, now at the Francis Crick Institute in London, Sadiq Yusuf at the Uganda Technology and Management University in Kampala and Tom Baden at the University of Sussex in Brighton, UK, TReND in Africa encourages do-it-yourself research with a focus on low-cost, open-source science. Courses cover such topics as fly genetics, neuroscience and hardware development.

In one example, TReND in Africa instructor and University of Sussex bioengineer André Maia Chagas joined a team including Prieto-Godino and Baden in 2017 to design a microscope. It was built using off-the-shelf and 3D-printed components, and dubbed the €100 lab (A. Maia Chagas *et al. PLoS Biol.* **15**, e2002702; 2017).

"Open-science hardware is not only important in Africa but all over the world," Chagas says. "If you have the blueprint for a piece of equipment, you can understand how it works. You can repair your equipment if it breaks down, and, even more importantly, adapt it to your local needs."

Kumbol's Actifield device is an array of infrared light emitters and detectors inside a box, run using a microcontroller made by the open-source developer Arduino. As rodents move around in the box, they disrupt the beams and the actimeter counts those events.

At US$122.91, the device is a fraction of the cost of commercial systems, which can amount to $6,000 or more. The resulting paper in *HardwareX* helped Kumbol to secure funding from the Mozilla Foundation to organize a follow-up workshop last July at the University of Health and Allied Sciences in Ho, Ghana. He has demonstrated Actifield at the Kwame Nkrumah University of Science and Technology, and has built actimeters for the science department there.

Now a PhD student at the Einstein Center for Neurosciences in Berlin, Kumbol has joined the editorial board of *HardwareX*. In February, he was invited to speak about using open-science tools to tackle equipment challenges in Africa at a VIB Core Management Workshop in Leuven, Belgium.

"It was a great experience for me," Kumbol says. "I received a lot of positive feedback on the potential for open hardware, which has really motivated me to start working on the next steps."

Says Chagas, "This is what we want: a new generation of African scientists that will train others on the continent."

Abdullahi Tsanni is a science writer based in Abuja, Nigeria.