Of guerillas and cafés

Scientists are experimenting with new initiatives to talk to the people

Howard Wolinsky

Last Halloween, a group of film lovers in London held an event in an abandoned car park and its adjacent buildings, all of which had been transformed into alien spacecraft. The group, Secret Cinema London, screened *Alien* and in keeping with the film's gory science fiction theme, a material scientist demonstrated the properties of 'frozen smoke'—a low-density solid called aerogel in which the liquid components are replaced with gas—and a couple of biologists dissected animal hearts and livers near a 'cabinet of curiosities' containing jars of specimens.

The scientists were from Guerilla Science (London, UK; www.guerillascience.co.uk), an organization that promotes science at arts festivals. Guerilla Science is just one example of how scientists are exploring new ways to bring science to the public in a variety of venues, including events at cafés and festivals. Indeed, Guerilla Science shuns the more traditional science festivals and tries instead to attract people in unconventional, unexpected environments: typically at musical festivals that include the Secret Garden Festival and Latitude. At these events, the group stages talks, performances and interactive laboratories in canvas tents, with attendees sitting on sofas or bales of hay (Fig 1).

Jenny Wong, co-founder and creative director of Guerilla Science—who also holds a master's degree in biological sciences and the history and philosophy of science from the University of Cambridge, UK—explained the thinking behind the group's activities at the Secret Cinema London event: "We were just conducting our live dissection more as a kind of spectacle, so the actual engagement with the scientist came from visitors speaking to the scientists located in the room next to us."

Fig 1 | The Guerilla Science 'Beatbox Laboratory' by performance scientist Aaron Williamon and biomedical engineer Evan Morgan at the Latitude festival's Literary Salon in 2009. © Zoe Cormier.

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Richard Bowdler, another co-founder of Guerilla Science, who has an MSc in chemistry from the University of Oxford in the UK, had been involved with outrageous 'science' games even before the inception of Guerilla Science. For example, at the Secret Garden Party—an arts and music festival launched in 2004 in an estate near Cambridge, UK—he came up with the idea to roll pianos down a hill to demonstrate basic laws of motion. Then, in 2007, he

started the Science Tent at the Party. "People effectively stumble upon our area, or our tent, or whatever event we're doing and ask or are drawn to it almost inadvertently and then are kind of caught out to realize, 'Oh, this is science. I always thought science was boring, yet what this person is talking about is rather interesting. Maybe I should review my perspective on the scientific community and the value of science in society,'" Bowdler explained. The Science Tent eventually developed further and led to the founding of Guerilla Science in 2008.

Members of the public who attend these events for their non-scientific appeal are inadvertently exposed to science in an entertaining way. The Guerilla Science roster includes people such as physicist Martin White, who

Fig 2 | The Science Igloo at the 2009 BergamoScienza, which houses talks and exhibitions.

discusses his work on the ATLAS experiment—head-on collisions of protons—at the Large Hadron Collider at CERN (Geneva, Switzerland); David Spiegelhalter, a professor of the public understanding of risk at the University of Cambridge, UK, who predicts when audience members will die; and University of London physicist Jon Butterworth, who discusses the hunt for the Higgs boson. Nearby are sideshows, where festival-goers can learn about the basic laws of science while making a cloud in a glass bottle, body armour out of cornstarch, or simulating an earthquake with a Slinky®, the helical spring toy.

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Bowdler said more than 1,000 music festival-goers each year stop off at the group’s events. “There is an element of outreach in people being exposed to science who otherwise wouldn’t put themselves in the way of it,” he said, but noted that the group is not a public relations agency for science *per se*. “We want people to engage with other real people who just happen to be scientists. And we want them to kind of think about the world in which they are, in a different way. So science is very relevant to the most basic activities that we do and

often people just don’t realize that because they don’t have head space to think about it and we want them to have the chance to do that and kind of be amazed at the world.”

Science can certainly draw large crowds—even to the extent of requiring the police to restore order. Such was the case at the 2004 BergamoScienza (www.bergamoscienza.it), a non-profit event to showcase science held in Bergamo, a medieval town 40 miles from Milan in Italy. “[The crowds] were not fighting, but they were pushing each other, so we had to call the police,” commented Roberto Sitia, one of the organizers of the event and professor of molecular biology at the Università Vita-Salute San Raffaele (Milan, Italy). “If you are the organizer for the show, you’re happy; it means that your show is welcome.”

The ‘stars of science’ appearing at the show, drawing the crowds, were the two grand dames of Italian science: Rita Levi-Montalcini, an Italian neurologist who received the 1986 Nobel Prize in Physiology or Medicine for the discovery of nerve growth factor; and Margherita Hack, an Italian astrophysicist and popular science writer. Levi-Montalcini celebrated her hundredth birthday last year and Hack is almost 90.

BergamoScienza, a free, two-week science festival started by academics and industry to attract young people to careers in science (Fig 2), has been growing rapidly

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since its inauguration in 2003. Last year, the programme, featuring Oliver Sacks, the best-selling author and neurologist, drew 84,000 attendees, up from 35,000 in the first year. “There is appreciation and interest for science and quality—fortunately—even in the country where Mr Berlusconi thinks mainly or rather only about sex,” Sitia commented. “I think it’s crucial for the survival of science. Personally what I also like to convey is the sense of adventure that science gives.”

Kishore Hari, a self-described science nerd, who holds a bachelor’s degree in chemistry from the University of California, Berkeley, USA, has been running a science café in a restaurant in San Francisco’s Mission District over the past three years. The District is a gentrified area, mixing rich and poor, hipsters and Hispanics, and is also miles away from main science centres in the city. “Science isn’t well understood by the general public, isn’t well appreciated. We have an obligation to change that. Science

needs to be part of a daily discussion,” Hari explained.

Typically, Hari plays a video clip on the topic at hand from the San Francisco public TV station KQED’s *Quest* science programme. An invited scientist then speaks for another five minutes. A discussion ensues. Café sessions have covered diverse topics as challenging as cranial stimulation to treat Parkinson disease, treating infertility, restoration of a bobcat population in an area known as Coyote Valley and synthetic biology.

While BergamoScienza and other large-scale festivals are science writ large aiming for tens of thousands of participants, small is beautiful in the science café world

The Café Scientifique movement (www.cafescientifique.org) was inspired by the Café Philosophique, which was started in the early 1990s in Paris by philosopher Marc Sautet (1947–1998). Ann Grand, who runs a website for the Café Scientifique movement, started her own science café in Bristol, UK in 2003. She was moved to do so after her ex-husband, a scientist, gave a talk in one of the first science cafés in Leeds, UK, founded by Duncan Dallas, a retired British producer of science television series.

“It’s a place where anyone can come to have a conversation about science. It’s somewhat relaxed and informal and egalitarian where people meet as equals to have a conversation that just happens to be about science rather than about soap operas or football or whatever else it is that people usually talk about in bars,” Grand explained. She estimates that there are now 500 independently run cafés worldwide: “I don’t think there’s a continent that’s untouched by cafés.”

While BergamoScienza and other large-scale festivals are science writ large aiming for tens of thousands of participants, small is beautiful in the science café world. Grand feels that 75 attendees are already too many. “It’s really impossible to have a conversation if there are too many people in the room,” she said. She and Hari also ban PowerPoint presentations at their science cafés. “PowerPoint gets in the way of the scientist connecting with the audience,” Hari said.

Science cafés have also begun to attract the interest of professional and commercial enterprises. Julie C. Benyo, director of educational outreach for Boston’s public TV station WGBH, which produces the highly rated *NOVA* science TV series, said her station became involved in promoting science cafés to get younger people—the sort who hang out in cafés—interested in *NOVA* and science in general. In any case, the science cafés seem to work: Benyo noted that a WGBH-sponsored survey in 2007 found that attendees believed the café had been effective at increasing their interest in science, and more than three-quarters have recommended cafés to other people. She added that about 100 US science cafés held 1,000 programmes last year, reaching around 45,000 people.

Grand, who is working on a doctorate in open science and public engagement at the University of the West of England in Bristol, UK, explained that most scientists typically enjoy sharing their enthusiasm and interest in their work with a public audience. At the same time, funding agencies increasingly require scientists to engage with the public, which, after all, is ultimately financing the research. Grand said Café Scientifique talks therefore provide scientists with a way to meet those requirements: “When it comes to filling in the annual reports or whatever, they can talk about how they’ve done x science cafés and not only that, but it works the other way around. The UK government now recognizes café science as a valid model of science engagements.”

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Grand also observed that the café idea is spreading from its grassroots origins to science festivals and even scientific meetings. “It’s not uncommon for there to be a science café at a big science conference these days. The American Psychological Association had them and the AAAS have them at their big conferences,” she said. “Scientists are members of the public, too. It’s a way for the scientists to get together and have a conversation about something that they like talking about.”

While the science café idea has been exported from the USA to Europe and beyond, the USA in return has imported the European science festival. John Durant had been involved in presenting science to the public in his native Britain, including the Edinburgh International Science Festival, before he became director of the Massachusetts Institute of Technology Museum (Cambridge, MA, USA) in 2005. Durant, who has an MA in natural science and a PhD in the history and philosophy of science, then helped to start the Cambridge Science Festival, America’s first (<http://cambridgesciencefestival.org>).

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While Guerilla Science adds science to arts and music festivals, the Cambridge Festival aims to fully merge science and the arts. The 2010 Cambridge Festival features programmes, most of which are free, such as making science toys from trash, making plaster casts of dinosaur footprints found in the nearby Connecticut Valley and songs about astronomy. There typically is an arts festival-style play, including Berthold Brecht’s *Galileo* and Alan Lightman’s *Einstein’s Dreams*.

Moreover, the Cambridge Festival enables visitors to meet and talk to prominent scientists. “We’ve got five Nobel Laureates lined up for the 2010 science festival, Monday to Friday,” Durant said. “It’s not every day that everybody gets a chance to ask their favourite question of a Nobel Prize winner.” Typically, about 250 events are held over 9 days and attendance of the festival has doubled to 30,000 over the past 3 years.

“We’re trying to make science part of culture,” Durant said. “It’s significant, for example, that the festival format is best known in connection with many of the arts. It’s best known in connection with literature and music and the visual arts and so on. But now, what’s increasingly happening is people are saying, ‘Well science is a part of culture as well as those other good things, so why shouldn’t we have festivals to do with science?’”

Durant added that such festivals appeal to people who might not otherwise seek out science. “Why assume that people have to

come to us? Why not go to them?" he asked. "We try to do stuff in many different venues and in fact, out on the street sometimes, in street carnivals and street demonstrations and so on. And take the science to where the people are. So I think there is a practical impetus behind festivals. It's all part of trying to integrate science with the wider culture."

The idea quickly spread. When the organizers of a San Diego Science Festival (www.sdsiencefestival.com) sought help and assistance from the Cambridge Festival, it eventually led to the establishment of the Science Festival Alliance. The US National Science Foundation (Arlington, VA) has joined the bandwagon and provides a 3-year US\$3 million grant to promote the science programmes. Festivals in Cambridge, MA, and San Diego, CA, have already received help from the Alliance and two others in San Francisco and Philadelphia, PA, will be held in 2011. Alliance manager Ben Wiehe, who formerly promoted science cafés for WGH's *NOVA* and who has a master's degree in anthropology from the University of Chicago (IL, USA) noted, "The Alliance supports anyone interested in starting a science festival or otherwise getting involved in supporting a science festival and with an initial focus in the United States."

"We're trying to make science part of culture"...

Durant, who helped write the grant to create the Alliance, said he hopes that the festivals will open a dialogue between the public and scientists: "I'm hoping we can encourage more people to see science as having something for them [...] The best events for me in festivals are where scientists and members of the community just end up having a conversation with each other either in the course of a larger event or off to one side of an event. We're trying to break down the barriers."

He added: "Many scientists have their work funded from the taxpayer in one way or another and many feel, I think genuinely, that it's part of their responsibility to pay back a little bit by participating in these events."

Howard Wolinsky is a freelance journalist in Chicago, IL, USA.

EMBO reports (2010) 11, 263–266.
doi:10.1038/embo.2010.41

Can bacteria save the planet?

New developments in systems biology and biotechnology to harness bacteria for renewable energy and environmental regeneration

Philip Hunter

Ever since the German physician Robert Koch (1843–1910) demonstrated in 1877 for the first time that a microorganism, *Bacillus anthracis*, could cause sickness, bacteria have gained notoriety as agents of disease and contamination with few saving graces. If anything, the approval rating of microorganisms has deteriorated even further in recent years in the light of the role we now know they have in complex diseases—such as stomach ulcers, heart attacks and strokes—and the intractable problem of bacterial resistance to antibiotics.

Yet, the reputation of bacteria might begin to improve dramatically, as they are likely to have a crucial role in solving a range of problems facing humankind: they might be engineered to provide alternative sources of energy to replace fossil fuels, clean up pollution from heavy metals and toxic chemicals, manufacture new materials from renewable sources and power a new generation of nanoscale machines.

Although few of these developments are close to fruition and significant challenges remain, the underlying science is blooming. "Yes, I think bacteria will be applied in [the] future for many vital applications," said Sang Yup Lee, head of the Metabolic and Biomolecular Engineering National Research Laboratory at the Advanced Institute of Science and Technology in Daejeon, South Korea. "In fact, bacteria have been studied intensively and extensively for the production of valuable and bulk chemicals, materials, and energy from renewable resources by engineering their metabolism."

The greatest value of this work so far has been the knowledge and tools created for the manipulation of bacteria at the level of the whole genome. Indeed, according to Lee, genome-wide optimization is the key to successfully engineering any bacteria for industrial applications. In this context, industrial bacteriology can

be seen as a proving ground for the knowledge generated by the emerging field of systems biology.

In the early days, as Lee noted, the genetic engineering of bacteria for industrial applications emulated evolution: random mutations in key genes were introduced and strains that were better suited to the tasks required—such as synthesizing a new compound—were selected. After several rounds of random mutagenesis and selection, a point of diminishing returns would be reached where further improvement would be increasingly hard to make and the resulting bacterial strain would thus be adopted for the process.

...genome-wide optimization is the key to successfully engineering any bacteria for industrial applications

However, as mutations in even a single gene invariably have multiple consequences for several metabolic pathways, the process of mutagenesis and selection inevitably created undesirable results. This in turn led to the idea of metabolic engineering, whereby the expression of several genes that participate in a given metabolic network would be optimized as a whole, either through suppression or amplification of their expression. Even so, such a technique is still a rather primitive implementation of systems biology. "Despite being systematic, this approach to some extent limits the outcome of strain improvement because the scope for engineering the cell is often local rather than truly system-wide," Lee commented. "[C]onsideration of the overall bioprocess, from strain improvement to its actual cultivation, is often neglected."