

Sharing the fruits of science

Patents and licences have served the scientific community for generations, but an emerging movement called "open science" says we need to broaden our thinking about intellectual property for the good of humanity – and the good of science | ***by Gerry Toomey***

"If I have seen further, it is by standing on the shoulders of giants," wrote Sir Isaac Newton, borrowing a metaphor from earlier thinkers. But what if those giants hadn't been so keen to freely share their insights, methods and knowledge? In what state would we find science, technology and scholarship today had the intellectual giants, Newton included, been more inclined to sell their findings to the highest bidder?

We'll never know the answers to such speculation. But we do know that science is a process of accretion and integration of knowledge. It depends on multiple contributors and is punctuated by the occasional exclamation of "eureka" – the breakthroughs and the paradigm shifts.

We also know that the social behaviour of modern science, and of the broader domain of innovation, is marked by a continual tug-of-war. At one end of the rope we find the forces of collaboration and sharing. At the other end are the instincts to compete and to protect one's hard-earned intellectual property. While both kinds of behaviour lubricate scientific discovery and technological innovation, IP protection via patenting, with a view to future profits, has become a dominant trend in recent decades, particularly in the life sciences.

But now an international scientific counterculture is emerging. Often referred to as "open science," this growing movement proposes that we err on the side of



Josée Masse

collaboration and sharing. That's especially true when it comes to creating and using the basic scientific tools needed both for downstream innovation and for solving broader human problems.

Open science proposes changing the culture without destroying the creative tension between the two ends of the science-for-innovation rope. And it predicts that the payoff – to human knowledge and to the economies of knowledge-intensive countries like Canada – will be much greater than any loss, by leveraging knowledge to everyone's benefit.

"You can't get rid of competition in science, nor do you want to because it feeds innovation," says Bartha Maria Knoppers, Canada Research Chair in Law and Medicine and a law professor at Université de Montréal. Open science isn't about throwing out the patent system, she insists. Rather, says open science, we need to distinguish between the research tools and basic knowledge that scientists need to do their work, and those ideas that are truly inventive and novel, with industrial application, that the patent system was designed to protect.

Covenants of behaviour

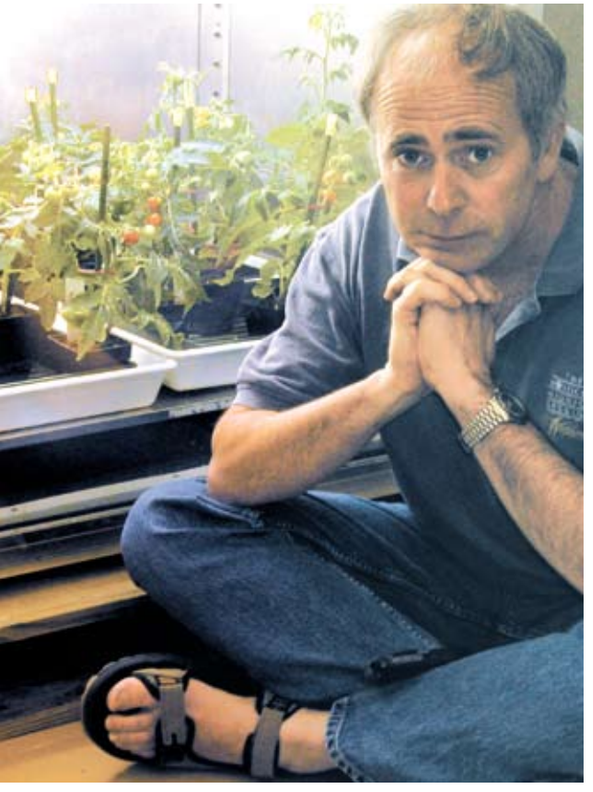
Like Newton, the advocates of open science have borrowed a metaphor: the "open source" approach to software development.

"The reason we talk about open source," explains Richard Jefferson, a California-born biotechnologist now living in Australia, "is because it was the first movement to embed in the creative process, in this instance software engineering, the permission not just to inspect inventions but to use them to create economic value. Open source imposes covenants of behaviour rather than financial agreements. Unrestricted use and the right to make a profit don't usually get in bed together. In open source, they've done so quite productively."

Dr. Jefferson is founder of an international research institute in Canberra called CAMBIA. He and his centre are among the most outspoken and active proponents of open science.

Their lobbying efforts are complemented by practical services and tools. CAMBIA's Patent Lens information service, for example, helps innovators navigate through the huge and often frustrating labyrinth of existing patents. It does this by collating and harmonizing data from several national and international patent offices. Another practical service offered by CAMBIA is a technology licence, similar to an open source licence, through its Biological Open Source (BiOS) Initiative. Under this legally binding agreement, the originators of new technology make it available royalty-free for further research or to create new products. A licensee agrees to freely share any improvement to the technology with other licensees, even if the improvement has been patented.

Dr. Jefferson and other open-science supporters don't see their activities or views as an attack on the intellectual



Richard Jefferson and his research centre CAMBIA are among the strongest proponents of open science.

property rights guaranteed by copyright, patents and other laws; he himself holds the patent on a DNA-based molecular tool (the GUS reporter) widely used in biotechnology. Rather, open-science advocates say the contentious issues are, first, the *kinds* of scientific products that qualify for protection and, second, the way that the pervasive exercise of IP rights ends up blocking the access of other scientists and entrepreneurs to the tools needed for innovation.

Yann Joly, a lawyer and research colleague of Dr. Knoppers at U de M's Centre de recherche en droit public, says the patent system is not under attack by open-science supporters. "It would be a mistake to look at open-source approaches to science as a 'solution' to the patent system. That system has been around for [hundreds of] years and is still really popular." Mr. Joly believes any attempt to wholly replace the patent system with open-source approaches would be attractive to neither industry nor policy makers. "A combination of open-source approaches and patenting would be easier to sell."

Opening the human genome

By now there are several examples of how the collaboration envisaged by open science is delivering scientific benefits to the world – advantages that wouldn't be available from competition and sales of IP. Dr. Knoppers lists a few of them.

During the 1990s, she recalls, the Human Genome Project and later the Single Nucleotide Polymorphism (or SNP) Consortium, took on two monumental tasks. The first was to sequence the full complement of human DNA – a jumble of three billion molecules known as nucleotides. Although it started as a race between public and private groups, it ended as a joint effort. Then, from the newly available DNA sequences, the international SNP Consortium picked several million small but highly informative genetic variations. These are recorded for unrestricted scientific use in a regularly updated database, which has been running since 1998 (www.dbsnp.org). The ambitious, overriding aim of these efforts was to give researchers basic tools and data to conquer a multitude of genetically influenced diseases, through prevention, diagnosis and treatment.

More recently, the International HapMap Project (www.hapmap.org) has pushed these publicly accessible quantum leaps in knowledge a step further. It exploited SNP addresses to create an international map of genetic differences and similarities in human beings, across four populations of African, Asian and European ancestry. While all information from the project remains in the public domain, this didn't happen solely because of participants' enthusiastic respect for the common heritage of mankind. As Dr. Knoppers points out, "click-wrap" licences – where researchers agree to open-access conditions by the act of using the information – were a big help, preventing parasitic patenting of results.

The Public Population Project in Genomics (P^3G), chaired by Dr. Knoppers, is another example of open science at work. The project helps researchers around the world to coordinate their work, share new analytical technologies and set methodological norms so that results of population studies are comparable across projects and countries. The ultimate aims of this multi-country project are disease prevention and better health-care strategies.

But there's also efficiency in sharing data openly. "If various genomics projects collaborate on the questions they ask," explains Dr. Knoppers, "they can effectively increase the sample size at no extra cost." A bigger sample can lead to big time savings. In the U.K., half a million people are being enrolled in a long-term genomics study. With that population size, it would take 18 years to identify 10,000 cases of people with Alzheimer's disease. But by linking with other P^3G data banks (including Quebec's CARTaGENE, which tracks adults aged 40 to 69), the time needed to find 10,000 cases is slashed in half.

Broad licensing

In instances where basic tools of science have already been patented, the key issue is licensing. Open source licensing of materials, as a way to ensure wide distribution of technology, is still in its infancy. Here, Dr. Jefferson's international research centre CAMBIA is at the forefront by offering its royalty-free BiOS license.

The important consideration, says Dr. Knoppers, is to ensure broad licensing – that is, to multiple users – at an affordable price. This is one of the measures that can "mitigate the kind of immediate reaction where people say, 'Oh, you can't have patents on genes.'"

One example of this is home grown. More than 20 years ago, renowned Canadian genetics researcher Ronald Worton identified the defective gene responsible for Duchenne muscular dystrophy, or DMD. In that instance, the DNA probes

What's in a name

In the world of software development, "source" denotes a computer program's source code. In a nutshell, open source operates on the principle that you create more benefits from software when you have many people debugging it and freely adapting it for diverse applications than when you try to restrict use through copyright and commercial licences. The main restriction under most open source licenses – there are more than a dozen such "copyleft" schemes – is that you yourself may not restrict others from using or adapting either the original software or your own adaptations. This is the birthright of Linux, Apache, MySQL, Perl, Python and Firefox, among the best known product names associated with open source.

Click to **consent**

A click-wrap is a pop-up agreement that requires a person downloading software or other information from a website to agree, with a simple click of the mouse, to the stated conditions of use. No click, no download. The "wrap" in click-wrap refers to the plastic shrink-wrap of a software package. Software companies often used to state that removal of the wrap constituted buyer consent to the conditions of product use.

to detect mutations in patients were given immediately to anyone in the world for research purposes.

"We only sought licence agreements in the case of commercial use of the probes," says Dr. Worton, now retired in Ottawa. That contrasts sharply with many recent cases of patent holders trying to block the use of their technology. Among the most controversial was a test for susceptibility to hereditary breast cancer. Myriad Genetics used its patent on the gene mutation linked to the disease (held jointly with the University of Utah) to establish a monopoly on testing. To the dismay of public health communities around the world, Myriad required DNA samples to be analyzed on its premises, with its equipment. Myriad challenged groups that had used the gene sequence to develop their own cheaper tests, among them the Ontario Ministry of Health.

Like Dr. Knoppers, CAMBIA's Dr. Jefferson distinguishes between the development of basic scientific tools and the application of those tools, between "discovery and invention." He sees scientific discovery as a social enterprise – not only serving as midwife to marketable inventions, but also delivering publicly valuable products for which markets or profit margins may be small. That includes alleviating poverty and hunger, especially in the developing countries, preventing or curing the diseases of the disadvantaged, and improving human stewardship of natural resources. So, while open science is described as a pragmatic way of doing research, it also has a social and ethical backbone. Terms like global public goods, common heritage of humankind and human rights recur in the literature on open science.

Since biotechnology is largely about the development of tools, the term biotech industry is a misnomer, according to Dr. Jefferson. "We shouldn't care about the 'biotech industry' as such, any more than we should be concerned specifically with the 'power tool industry.' We should be talking about mature sectors like food and agricultural production, natural resource management and public health."

He complains of an increasing tendency to privatize the platforms and tools of science. "Patents, many of which have been granted in the public sector, including to universities, are then used as leverage for financial gain instead of for creating social value. The real value is created in the aggregation of this capability, through the freedom to innovate."

This commercialization of the social enterprise, particularly in the biosciences, has taken place mostly over the past quarter-century. The explosion of patenting by both the public and private sectors, what Dr. Jefferson calls a "filing frenzy," has coincided with the new era of biotechnology and genomics.

From the outset of the biotech revolution, privatization of public research results was stimulated in the U.S. by the Bayh-Dole Act. This 1980 law allowed the products of U.S. government-funded research, including results from university labs, to be taken from the public domain and sold to corporations, with the goal of stimulating private-sector use

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APPOINTMENT NOTICE
Vice-President (Academic) & Provost



Dr. Andrew Hakin

The University of Lethbridge is pleased to announce the appointment of Dr. Andrew Hakin to the position of Vice-President (Academic) and Provost effective July 1, 2007.

Hakin has held the position of Associate Vice-President (Academic) at the U of L since 2005.

He is a graduate and member of the Royal Society of Chemistry who earned a BSc (Honours) in chemistry from the University of Leicester in 1984 and was awarded a PhD in physical chemistry from the same university in 1987. He joined the University of Lethbridge as an Assistant Professor of Chemistry in 1989, and he was promoted to Associate Professor in 1994 and Full Professor in 2003. Hakin has served as Chair of the Department of Chemistry and Biochemistry and was President of the U of L Faculty Association in 2001.

In 2000, Hakin received the University of Lethbridge Distinguished Teaching Award, and he received the Stig Sunner Award for his outstanding research in the field of thermochemistry in 2003.

Hakin is one of an elite group of researchers who study calorimetry and the thermodynamics of aqueous systems.

Hakin follows Dr. Séamus O'Shea who served as the U of L's Vice-President (Academic) & Provost since 1991.

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Bernard Lambert

U de M's Bartha Knoppers says various genomics projects can effectively enlarge their sample size by sharing their data.

of research results. Universities seized the opportunity. In Canada the ownership of IP varies by institution, and in most cases it is shared between the university and the inventor.

Corporate power

A related problem, says Dr. Jefferson, is the concentration of IP rights for major biological innovations in the hands of just a few groups, mostly large multinational firms. In Canada, Agriculture and Agri-Food Canada is facing, he believes, a "virtual duopoly of nominal innovation" because service to the agricultural sector is dominated by two firms, Monsanto and DuPont Pioneer. With that kind of control, says Dr. Jefferson (who recently visited Agriculture Canada as an invited speaker), "AgCanada has been robbed of much of its potential – in spite of the fact they could be powerful and productive."

It's no longer just small pockets of public-minded scientists in industrialized countries who are advocating the principles and spirit of open science. In recent years, developing countries have argued that the World Intellectual Property Organization, or WIPO, a specialized UN agency, should recognize that IP policy, laws and enforcement must take greater account of the public interest and promote innovation for all. Their efforts began to pay off this year. Discussions held in February and June led to international agreement on 45 proposals in areas ranging from tech transfer to public policy.

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For universities in the technologically advanced countries, says Dr. Jefferson, the promise of getting fat cheques in the mail from patenting the fruits of their biosciences research projects has simply not materialized. He maintains that offices of technology transfer are "generally losing money" and that there's ample evidence that private biotechnology enterprises, as a commercial industry, have fallen flat as well.

So if not to make money, then what role for the biosciences, and for intellectual capability more generally? To their supporters, open source and open science are all about leverage. "There should be a total rethink of the role of intellectual property, as a powerful tool for creating social value," says Dr. Jefferson.

"Think of IP in a completely different way. A country as creative as Canada could use its own IP to leverage the rest of the world's IP, saying, 'We provided the platforms, we provided enabling knowledge. So now you share the improvements with us. We can both serve our missions.'

"It's like Tom Sawyer getting all the other kids to whitewash his fence. Canada needs to be that clever in getting other people's work into its arena of economic development."

Gerry Toomey is a science writer with Green Ink Publishing Services Ltd. (www.greenink.co.uk). He lives in Chelsea, Quebec. AU•UA

Open source, open access, **open science**

Although open science has taken its cue from open source, it also complements and, in a sense, expands on a third campaign, "open access."

The advocates of open access want fuller access to, and use of, published scientific articles and other scholarly information. Their core argument is that publicly funded universities and granting bodies have a moral duty to make academic scholarship available on the web at no charge. Two issues are of special concern. First, permission barriers imposed by copyright and other mechanisms curtail usage. Second, high subscription fees block access to research results, especially in developing countries.

These concerns haven't gone unnoticed by the commercial scientific press. Elsevier, a leading international publisher, now allows researchers from universities and research organizations in selected developing countries free access to its scientific journals. This past April, Elsevier said it would give journalists in developing countries free access to summaries of research papers from some 2,000 journals, including its prestigious *The Lancet*.

In recent years, open access e-journals, usually based on unconventional business models, have become increasingly popular. (See *University Affairs* online, March 2006, for "The bottom line on open access.") A 2006 study by health policy specialist Gunther Eysenbach at the University of Toronto suggests that scientific papers published in online, open-access journals have more impact and are cited more often than papers for which readers have to pay.

While open access focuses on scientific knowledge in published form, open science deals primarily with how scientists create, protect and share the actual methods and data sets of basic science. In this sense, it is more concerned with patents and licensing than with copyright and journal subscription fees.