

Bridges II: The Law–STEM Alliance & Next Generation Innovation

A MEETING OF INNOVATION MINDS

Andrew W. Torrance & Eric von Hippel†*

Eric von Hippel and Andrew W. Torrance are two scholars who might never have met, let alone become close colleagues and collaborators.¹ In 2008, these two scholars began discussing, exchanging, and sometimes debating ideas with each other. They quickly found common ground and soon began a close and productive collaboration. Each has helped the other understand new aspects of innovation. The result has been a synthesis of ideas that has benefited both of them. In 2013, they coauthored an article entitled “The Right to Innovate”² and in 2017 von Hippel reported upon their joint insights in a chapter in his book, *Free Innovation*.³ Torrance plans to publish a book on what he calls “innovation hypercycles” in 2018 that will also include some of their joint ideas. This somewhat unorthodox Essay, written jointly by von Hippel and Torrance at the request of the *Northwestern University Law Review*, relates how their collegial collaboration began and expanded to enrich their understandings of innovation, in the hopes of encouraging more researchers to pursue cross-disciplinary collaboration. Collaboration between scholars with expertise from disparate fields of scholarship has long been an effective method of intellectual cross-fertilization. Although not every interdisciplinary collaboration is successful, this Essay illustrates the promise of one that, at least in the minds of the authors, succeeded, and exhorts scholars across any fields to consider collaborating with scholars whose research is potentially complementary. The result can be meaningful, and sometimes surprising, insights for both fields.

* Earl B. Shurtz Research Professor at the University of Kansas School of Law.

† Professor of Technological Innovation, MIT Sloan School of Management, and Professor in MIT’s Engineering Systems Division.

¹ We use the third-person voice throughout this Essay to avoid the need constantly to specify whose voice is being expressed because, like the relationship described, this Essay is the result of a close collaboration.

² Andrew W. Torrance & Eric von Hippel, *The Right to Innovate*, 2015 MICH. ST. L. REV. 793 (2015).

³ ERIC VON HIPPEL, *FREE INNOVATION* (2017).

Von Hippel is the T. Wilson (1953) Professor in Management and Professor of Management of Innovation and Engineering Systems at the Massachusetts Institute of Technology Sloan School of Management. Von Hippel has been working on innovation research topics for many years, and is the originator of lead user theory and other concepts central to the field of open, user, collaborative, and free innovation. His perspective on innovation invariably favors openness, collaboration, and attention to innovative contributions from people outside traditional corporate and institutional settings. Prior to his career as a scholar, von Hippel was an engineer and cofounder of Graphic Sciences Corporation. During his work at that company he obtained four United States patents claiming foundational aspects of electromechanical inventions related to facsimile transceivers.

Torrance is Earl B. Shurtz Research Professor of Law at the University of Kansas School of Law, and a Visiting Scholar at the MIT Sloan School of Management. In 1997, he received his Ph.D. in biology from Harvard University, studying the evolutionary genetics of Australasian mice. Instead of becoming a postdoctoral fellow in biology, he decided to attend Harvard Law School, receiving his J.D. from there in 2000. Immediately upon graduation, Torrance began practicing biotechnology patent law in Boston at the international law firm, Fish & Richardson P.C.. In 2004, he joined Inverness Medical Innovations, based in Waltham, Massachusetts, as in-house counsel. Then, in 2005, he accepted an Associate Professorship at the University of Kansas School of Law, and was promoted to Full Professor with tenure in 2011.

In April 2008, Torrance participated at a conference hosted by the Washington University School of Law called Open-Source and Proprietary Models of Innovation: Beyond Ideology. His presentation suggested that open source biology was beginning to follow the trajectory of open source software. The open source framework encourages the development of software available to all who wish to use and modify it, endeavors to maintain the openness of such software to subsequent users and modifiers, and seeks to harness the skill and enthusiasm of software engineers around the world who are willing to contribute and improve software available to all. While traditional proprietary development and ownership of software tends to be characterized by closely-guarded or inaccessible source code, open source frameworks make source code freely accessible, and encourage or require contributors to keep their own code open to the world. Despite feeling strongly that the available evidence compelled him to conclude that biology was becoming more like open source software, Torrance was nervous about suggesting this proposition to an audience of impressive innovation scholars.

While most of those present appeared to agree with Torrance's conclusions, one hand in the audience rocketed upwards as soon as he finished his remarks. Karim Lakhani, a pioneering open source software scholar and professor at Harvard Business School, agreed with Torrance's conclusions, but considered his proposed timeline far too conservative, remarking, "There will be kids doing genetic engineering in their garages in the very near future. It's going to happen quickly, not over decades."⁴ When Torrance sought out Lakhani after his talk, he found the open source scholar friendly, supportive, and enthusiastic about Torrance's research. His only suggestion was to be bolder. He explained that open source software, a field of innovation he had studied closely, had also developed far more rapidly than its skeptics had predicted. In fact, he explained how open source code had not only increased in prevalence and importance, but had come to dominate entire fields of software, in some cases thoroughly outcompeting existing software whose authors had tried to protect it with patents and copyrights. Lakhani was emphatic: open biology would do the same, and very rapidly. He then invited Torrance to present his research at the next meeting of the Open and User Innovation ("OUI") Conference.

The OUI Conference was still relatively young in 2008, having been founded in 2001 by Eric von Hippel, who had served as Lakhani's Ph.D. advisor at the MIT Sloan School of Management, and several colleagues. Torrance and Bill Tomlinson, a professor at the University of California, Irvine, Donald Bren School of Information & Computer Sciences who studies real world phenomena using detailed online simulation games, decided to present a recent research project that explored innovation. Using *The Patent Game*, an online simulation game they designed to allow human users to invent, patent, open source, make, sell, license, assign, and sue for infringement, Tomlinson and Torrance ran a series of experiments that measured innovation under three protection treatments: (1) availability of only patents, (2) availability of patents and open sourcing, and (3) availability of only open sourcing. The results of their controlled experiments surprised them. They found that innovation, by multiple measures, was highest when no patent protection was available, lowest when inventions could be patented, and intermediate when inventors could either patent or open source their inventions. These results challenged the orthodox

⁴ Torrance is confident this quotation captures the essence of what Lakhani said. However, because it was reconstructed from memory, the precise words used by Lakhani may have differed somewhat. Interestingly, at a meeting of the MIT Innovation Laboratory held on November 28–29, 2017, at Harvard Business School, an impressive presentation by Dr. David S. Kong of the MIT Media Laboratory highlighted recent developments in open source synthetic biology. Both Torrance and Lakhani were in attendance, and, right after the presentation, Lakhani said to Torrance, "I told you so!"

view, then prevalent in the scholarly community, that patents were most effective at spurring innovation, and lack of patent protection inexorably led to a tragedy of the innovation commons.⁵ But these results were consistent with the growing abundance of high-quality open source software.

At the OUI Conference, Torrance approached Lakhani, who introduced him to several open and user innovation scholars. Based on conversations with these scholars, Torrance quickly realized that they all considered a particular audience member, sitting in the front row of the lecture hall, to be extremely influential in this community of scholars. At the OUI Conference, all scholars presenting their research were asked to participate in a “lightning round” at the beginning of the first day, in which they presented the essence of their project in two minutes. Time limits were strictly enforced. When his time to present arrived, Torrance narrated quickly through five PowerPoint slides. These introduced the experimental methods, showed bar graphs illustrating the unorthodox results he and Tomlinson had observed, and then summarized their findings and what they saw as their potential policy significance. Their slides indicated that, at least in these simulation experiments, an open source regime generated markedly more innovation than the regimes allowing patent protection. As soon as Torrance had finished his quick presentation, the influential audience member seated in the front row, whom he had never met, stood up and exclaimed to the whole audience, “This is what we’ve been waiting for!” and led the lecture hall in a loud round of applause. Happy his presentation had been well-received, Torrance took his seat. After the lightning round was finished, Torrance was introduced to the front-row scholar, Eric von Hippel, who promptly invited Torrance to drop by MIT to discuss innovation next time he was in Cambridge.

THE BEGINNING OF THE COLLABORATION

Later that year, Torrance was asked by the BioBricks Foundation, an organization dedicated to fostering democratization in the then-nascent field of synthetic biology, to help it with some legal issues. His involvement with the BioBricks Foundation deepened over the course of that fall, and he was invited to participate in the International Genetically Engineered Machines (iGEM) competition held in November in the MIT Stata building. One

⁵ Torrance and Tomlinson began this research project in 2007. It continues to this day. Thus far, it has resulted in three published articles: Andrew W. Torrance & Bill Tomlinson, *Patents and the Regress of Useful Arts*, 10 COLUM. SCI. & TECH. L. REV. 130 (2009); Andrew W. Torrance & Bill Tomlinson, *Patent Expertise and the Regress of Useful Arts*, 33 S. ILL. U. L.J. 130 (2010); Andrew W. Torrance & Bill Tomlinson, *Property Rules, Liability Rules, and Patents: One Experimental View of the Cathedral*, 14 YALE J.L. & TECH. 138 (2011).

afternoon, between presentation sessions, Torrance wandered over to the MIT Sloan School of Management, and, after navigating its warren of offices, found himself darkening von Hippel's doorway. Von Hippel, with characteristic enthusiasm, invited him in for a chat. They spoke for a long time about their own research interests. Von Hippel was very eager to learn more about how law and regulation might affect the freedom of innovators to operate within modern and distributed innovation projects. He found Torrance's work on open license design for the BioBricks Foundation especially interesting. As they chatted, they quickly realized a common interest in innovation, its origins, and the factors that fostered or hampered it. Each found the other able to offer insights into the field of innovation that were illuminating. As their chat drew to an end, von Hippel gave Torrance a copy of his then-new book, *Democratizing Innovation*, and asked Torrance to send him articles on innovation law topics that he should read. A productive and fun collegueship—and friendship—had begun.

Von Hippel invited Torrance to attend the next meeting of his MIT Innovation Laboratory. An innovation itself, the Innovation Lab meets three times per year, with each meeting focused on a particular innovation issue of current interest. A number of prominent corporations are subscribing members of the Innovation Lab, and send representatives to each meeting to learn about the bleeding-edge of innovation. Top experts, both academic and corporate, from around the world present cutting edge research and practices on user, open, and collaborative innovation. Each meeting offers a mixture of challenging new ideas, and provides opportunities for attendees to meet, ask questions, and challenge assertions, all in a congenial setting, complete with excellent food and drink. After attending his first Innovation Lab, Torrance was hooked, and von Hippel invited him to present his own innovation research at the next meeting. Since then, Torrance has never missed an Innovation Lab meeting. At these meetings, von Hippel often teasingly refers to Torrance as “the resident lawyer.”

Over the ensuing years, von Hippel and Torrance have engaged in an ever-deeper dialogue about innovation, intellectual property, and other forms of relevant law. This dialogue has required Torrance to immerse von Hippel in important complexities of intellectual property, food and drug, tort, criminal, and constitutional law, including current trends in those fields. At the outset of these discussions, Torrance and von Hippel often found their views on intellectual property, in particular, to be starkly different. Torrance was comfortably-familiar with the conventional account of intellectual property law, including how legal incentives might encourage invention and innovation. He brought to the relationship a generally positive view of the benefits afforded by patents, copyrights, trademarks, and trade secrets.

Furthermore, his experience as an attorney at Fish & Richardson P.C., one of the leading intellectual property law firms in the world, and as in-house counsel at Inverness Medical Innovations, had reinforced his view that intellectual property could be a valuable policy tool for promoting innovation.

Von Hippel had also seen the effects of patents firsthand, having acquired several for inventions in the early facsimile machine industry. Yet, his research into innovation, and, in particular, the sources of innovation, had revealed a vast pool of innovative behavior that operated outside the corporate and institutional sphere. In his own articles and books, von Hippel had woven an intricate and well-evidenced account of how users (including “lead users”) often created key inventions, how open (rather than proprietary) innovation regimes often thrived, and how collaboration among users and open innovators could accelerate rates of innovation. Despite his own successful past as a patentee, he expressed strong skepticism that intellectual property was the only, let alone the most important, mode by which innovation could thrive.

Early discussions between von Hippel and Torrance explored the actual roles that intellectual property played, and how important its influence was on innovation. This was a heady time for both of them, as they began to entertain the notion that what they “knew” about the other’s field might not be the complete story. Torrance was introduced to entire branches of innovation studies, such as those that explored innovation by individuals with non-financial motives, such as solving their own personal problems, enhancing their reputations within innovation communities, or simply innovating for amusement, to satisfy curiosity, or for personal satisfaction. He realized that a broad array of scholars outside law, such as those in economics, philosophy, sociology, policy studies, public health, and technology studies, were also engaged in studying fundamental questions about innovation, offering perspectives that were often useful complements to the legal scholarship with which he was already most familiar. Von Hippel discovered that the law often worked in a more complicated fashion than he had imagined, and, perhaps more importantly, that changing existing law was dauntingly difficult. In addition, von Hippel developed a richer view of how laws beyond intellectual property could also have decisive impacts on innovation. For example, an area of particular research interest for Torrance, legal regulation of drugs and medical devices, turned out to be even more influential than intellectual property law on certain areas of innovation, and has figured prominently in their joint research.

EXTENDING THE COLLEAGUESHIP TO OTHERS

To this point, the story of productive intellectual sharing across fields by Torrance and von Hippel is, in a way, quite conventional. One of the deep joys of academic learning and research is participation in such research pairings. What happened next, however, was unusual: Torrance and von Hippel's early work together persuaded them both to try to bring interested individuals in their respective academic fields together to help build this emerging interdisciplinary area of intellectual property law and the economics of modern open and distributed innovation processes. Along with several colleagues, including Carliss Baldwin of Harvard Business School, Katherine Strandburg of NYU Law School, and Pamela Samuelson of Berkeley Law School, they attempted to do this via two conferences. The first took place at the MIT Sloan School of Management in 2010. Prominent academics from the fields of intellectual property and user and open innovation gave presentations of their research, offered their views of how to harmonize the two disparate fields, and knitted together research questions that might provide valuable evidence capable of falsifying hypotheses held by each field. They expanded this effort in 2011, at a more intimate meeting of experts from the two fields, hosted by Samuelson at her home in Saint Helena in the heart of Napa Valley, planned and moderated by von Hippel, Torrance, Strandburg, Samuelson, and Baldwin. The discussions were at once heated and fun; the debates, intense but constructive; and the result, a much better understanding of both the commonalities and differences between the fields. It is fair to say that most, if not all, participants gained an appreciation of how much richer, more complicated, more challenging, and daunting the project of producing a full account of innovation would be. Participants of these meetings have gone on to produce important scholarship at the nexus between intellectual property and open, user, and collaborative innovation.

A DEEPENING COLLABORATION

Torrance and von Hippel also decided to engage in personal collaboration on research projects of mutual interest. At von Hippel's invitation, Torrance spent his 2012 sabbatical at the MIT Sloan School of Management, a year that proved to be a crucible for their collaboration. Over the course of many discussions, meals, drinks, walks, and sketching sessions on the white boards in their offices, they developed an idea for a joint project: they would produce an account not only of how law thwarts user, open, and collaborative innovation, but, further, how existing provisions and principles of law could be reapplied to protect and foster such innovation. Torrance came up with a title for this concept: the "innovation wetlands." Why

innovation wetlands? The idea was inspired by transformation of views of wetlands from “malarial swamps,” good only for filling in and developing, to uniquely valuable and vulnerable ecosystems, requiring protection from destruction because of the many ecosystem services vital to humanity they provide. Torrance camped out in the Harvard Law School library, investigating any and all legal grounds for protecting innovation he could find, while von Hippel gathered evidence about vulnerabilities and requirements for protection. They worked through many drafts, and presented their ideas at numerous conferences (including the MIT Innovation Lab), all the while honing their framework of how law may harm, but may also protect, user, open, collaborative, and free innovation. The result was an article entitled “The Right to Innovate,” published in the *Michigan State Law Review* in 2013.⁶ Torrance and von Hippel were later invited to adapt this article into a chapter in an edited volume, *New Production of Users: Changing Innovation Collectives and Involvement*, winner of the 2016 Freeman Prize, awarded “for a publication which is a significant collective contribution to the interaction of science and technology studies with the study of innovation” by the European Association for the Study of Science and Technology.⁷

Uncovering compelling examples of user, open, and collaborative innovation directly affected by the law proved a source of frustration while writing the piece. In one discussion before finishing their article, von Hippel wondered aloud whether they had described a phenomenon that is important mainly in theory. It was at this point that one key advantage of a close collaboration came into stark relief: trust that their mutual instincts would bear fruit. Rather than abandon this line of research, each assumed that the other had better reasons than his own to believe that the the phenomenon actually existed. This helped sustain their work even in the absence of clear examples.

Then came NightScout. Early in the fall of 2014, von Hippel emailed Torrance a copy of an article from the *Wall Street Journal*⁸ that described a worldwide community of innovators who were modifying medical devices

⁶ See Andrew W. Torrance & Eric von Hippel, *The Right to Innovate*, 2015 MICH. ST. L. REV. 793 (2015).

⁷ Andrew W. Torrance & Eric von Hippel, *Protecting the Right to Innovate—Our Innovation Wetlands* in *THE NEW PRODUCTION OF USERS: CHANGING INNOVATION COLLECTIVES AND INVOLVEMENT STRATEGIES* 45–74 (Sampsä Hyysalo, Torben Elgaard Jensen, & Nelly Oudshoorn eds., 2016).

⁸ Kate Linebaugh, *Citizen Hackers Tinker with Medical Devices*, WALL ST. J. (Sept. 26, 2014), <https://www.wsj.com/articles/citizen-hackers-concoct-upgrades-for-medical-devices-1411762843> [https://perma.cc/D56Y-SSKK].

against the wishes of both the manufacturer and the United States Food and Drug Administration (FDA). Immediately, von Hippel and Torrance contacted key participants in the NightScout community to learn more about a phenomenon that seemed an ideal example of what they had predicted. NightScout had arisen around efforts to make needed improvements to a commercially-available, but technologically-limited, continuous glucose monitor (CGM) manufactured by Dexcom, Inc., of San Diego, California. Under Dexcom's strict FDA licensure, broadcasting signals from a Dexcom CGM were limited to short distances. In practical effect, this licensing limitation meant that anyone wanting to monitor a patient's blood glucose levels would have to stay in close physical proximity to that patient. Because maintenance of healthy blood glucose levels could mean the difference between consciousness and diabetic coma, patients had to remain close to those monitoring them. A loose confederation of medical device hackers had taken apart Dexcom's CGM, modified it, produced a mobile phone app capable of viewing data from CGMs remotely, and freely published all the technical details necessary to allow others to do the same.

NightScout's innovations allowed parents, partners, or friends of patients with type-1 diabetes to monitor their loved ones' blood glucose levels anywhere and anytime. The NightScout innovation liberated both patients and those monitoring them. However, the FDA expressed strong reservations about modified and unlicensed versions of Dexcom's CGMs, leading the agency to apply considerable pressure on both the company and the community of device hackers to curtail device modifications lacking FDA approval. This dispute evolved rapidly as von Hippel and Torrance watched. In the end, the FDA licensed an official Dexcom version of what the NightScout innovation community had developed. Torrance and von Hippel had found proof of their concept. Since then, they have discovered numerous additional examples. Their theoretical framework seemed helpful not only in describing, but also in anticipating a trend beginning to bubble up among communities of open, user, collaborative, and free innovators. Their mutual trust had helped them persevere through early doubt.

Torrance and von Hippel continue to collaborate. Rarely does a week pass without several email exchanges or phone calls between the two discussing new collisions of law and user, open, collaborative, and free innovation. They often find themselves together as parts of lengthy conversations with innovators or innovation scholars who come to their attention. Each also uses the other's expertise to pollinate their own field with ideas from the other's. Von Hippel makes sure Torrance attends Innovation Lab meetings. Torrance brings von Hippel to law conferences focused on proprietary innovation, such as the Patent Conference, to explain,

and often champion, the open, user, collaborative, and free paradigms of innovation, and to reveal the growing body of empirical evidence in support of their importance. Von Hippel regularly brings Torrance to MIT to present research at the interface of law and innovation in the MIT classes he teaches, or at the Innovation Lab. They also converge on outside conferences, enjoying the opportunity to meet other interesting scholars together. They trust and understand each other, making regular collaboration easy and fun. Indeed, through their collaboration, they have become very good friends as well as productive colleagues. They have each learned much from the other, and, as a result, personally embody a sort of synthesis of fields.

Von Hippel and Torrance feel fortunate they have had the opportunity to develop such a close meeting of the minds across quite different disciplines. This has greatly enriched their own scholarship and understanding of innovation. Perhaps most importantly, their collaboration continues to be fun and invigorating, heralding a rich seam of common research interests and projects they hope to continue to mine together. They have a few suggestions about how to foster good collaborations. First, cultivate a mind open enough to consider that scholars in other fields might have valuable insights into your own field. Second, when getting to know a scholar in a field disparate from one's own, persevere in trying to understand why they believe what they do, even if their beliefs directly challenge one's own. Third, introduce interdisciplinary scholars to one's own intellectual community so that the benefits of collaboration can spread and have maximum influence; acting as an ambassador can catalyze openness for the seemingly-alien views of a collaborator from a different field. Finally, when possible, enjoy the collaboration not only on an intellectual level, but also on a personal level, so that the collaboration can weather poor results or deep disagreements. Von Hippel and Torrance feel deeply fortunate to have been able to find such well-matched colleagues, collaborators, and friends in each other. That in itself has been an important innovation for them.