

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

$$a = dv/dt = d^2r/dt^2$$

$$L = (r - r_0) \times p$$

$$E_k = W = \frac{1}{2} m$$

$$(v^2 - v_0^2)$$



Friday, October 28, 2016

Summary prepared by Ivory Mills, Thomas Rousse, and Ryan Whalen,
with input from other Bridges II conference participants.

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Bridges II: The Law-STEM Alliance & Next Generation

Innovation will explore the role of law, business, policy, and regulation in the innovation process, and the role of scientists, engineers, and entrepreneurs in the process of law and policy-making. There will be three panels that each focus on a particular new technology or innovation: (1) CRISPR, a new DNA-related technology; (2) The Internet of Things; and (3) User Innovation Platforms.

The panelists and our keynote presenters—Joel Mokyr (Northwestern) and Eric von Hippel (MIT-Sloan)—will highlight areas of similarity and distinction among the new areas of innovation. Together, we hope that these similarities and distinctions can lead to insights that will help businesses, scientists, and policy-makers in the future. Four Northwestern deans, of the law school, engineering school, business school, and the college of arts & sciences, will share their views. Our goal for the conference is to bring together a diverse group of academic scholars from law, engineering, business, economics, sociology, and other fields for a robust discussion that we hope will facilitate cross-disciplinary collaboration.

Bridges II continues the tradition of innovation at Northwestern Pritzker School of Law and is one in a series of programmatic initiatives—including our Master of Science in Law program and our June 2015 Bridges I conference—that are designed to bring together the disciplines of law, business, technology, and science.

REGISTRATION & BREAKFAST

8:00 a.m. \ Rubloff Atrium

INTRODUCTION & WELCOME

8:30-8:45 a.m. \ Aspen Hall – Room 150

KEYNOTE SPEECH: “INCENTIVIZING INNOVATION: THE HISTORICAL ORIGINS OF THE MARKET FOR IDEAS”

8:45-9:30 a.m.

Joel Mokyr, Robert H. Strotz Professor, Northwestern University Weinberg College of Arts and Sciences, Department of Economics

THE INTERNET OF THINGS

9:30-10:45 a.m.

Moderator:

John O. McGinnis, George C. Dix Professor In Constitutional Law, Northwestern Pritzker School of Law

Panelists:

Mark C. Hersam, Walter P. Murphy Professor of Materials Science and Engineering, McCormick School of Engineering

and Applied Science, Northwestern University

Lee W. McKnight, Associate Professor, Syracuse University School of Information Studies

Paul Ohm, Professor of Law, Georgetown University Law Center

James B. Speta, Class of 1940 Research Professor of Law, Senior Associate Dean of Academic Affairs and International Initiatives, Northwestern Pritzker School of Law

COFFEE & TEA BREAK

10:45-11:00 a.m.

KEYNOTE SPEECH: “FREE INNOVATION”

11:00-11:45 a.m.

Eric von Hippel, T. Wilson (1953) Professor in Management, Professor of Management of Innovation and Engineering Systems, MIT Sloan School of Management

LUNCH & DEANS’ PANEL

12:00-1:15 p.m.

Sally Blount, Dean of Northwestern University Kellogg School of Management, Michael L. Nemmers Professor of Management & Organizations

Julio M. Ottino, Dean of Northwestern McCormick School of Engineering and Applied Science, Distinguished Robert R. McCormick Institute Professor, and Walter P. Murphy Professor of Chemical and Biological Engineering

Adrian Randolph, Dean of Northwestern University Weinberg College of Arts and Sciences, Professor

Daniel B. Rodriguez, Dean of Northwestern Pritzker School of Law, Harold Washington Professor

COFFEE & TEA BREAK

1:15-1:30 p.m.

CRISPR

1:30-2:45 p.m.

Moderator:

David L. Schwartz, Professor of Law, Northwestern Pritzker School of Law

Panelists:

Laura Pedraza-Fariña, Assistant Professor of Law, Northwestern Pritzker School of Law

Matthew Porteus, Associate Professor of Pediatrics—Stem Cell Transplantation, Stanford School of Medicine

Arti K. Rai, Elvin R. Latty Professor of Law; Co-Director, Duke Law Center for Innovation Policy, Duke University Law School

Laurie S. Zoloth, Professor of Bioethics and Medical

Humanities, Feinberg School of Medicine, Professor of Religious Studies, Northwestern University Weinberg College of Arts and Sciences; Director of Graduate Studies

USER INNOVATION PLATFORMS

3:00-4:15 p.m.

Moderator:

Sarah B. Lawsky, Professor of Law, Northwestern Pritzker School of Law

Panelists:

Kristian J. Hammond, Professor of Electrical Engineering and Computer Science, McCormick School of Engineering and Applied Science, Northwestern University

Mohanbir Sawhney, McCormick Foundation Chair of Technology, Clinical Professor of Marketing, Director of the Center for Research in Technology & Innovation, Northwestern University Kellogg School of Management

Katherine Jo Strandburg, Alfred B. Engelberg Professor of Law, New York University School of Law

Eric von Hippel, T. Wilson (1953) Professor in Management, Professor of Management of Innovation and Engineering Systems, MIT Sloan School of Management

COFFEE & TEA BREAK

4:15-4:45 p.m.

WRAP-UP & TAKEAWAYS

4:45-5:15 p.m.

Ryan Whalen, Assistant Professor, Dalhousie University School of Information Management

Thomas Rouse, PhD-JD candidate, Northwestern University School of Communications, Northwestern Pritzker School of Law

Ivory Mills, PhD-JD Candidate, Northwestern University School of Communications, Northwestern Pritzker School of Law

BEER & WINE RECEPTION

5:15-6:30 p.m. \ Thorne Auditorium Lobby



LETTER FROM THE DEAN

The “Bridges” conference series, the second iteration of which has given us the rich materials included here, grew out of a collective sense that the story of multi-disciplinarity in law and the legal practice needs to be better told. In our modern universities, the tendency is to work in distinct

silos, developing research and teaching students based on well-delineated spheres of knowledge. Disciplinary boundaries emerge, after all, from a commitment to discipline, and to rigor. To be sure, these silos are not principally, and certainly not necessarily, means of walling off our fields from insights generated by colleagues elsewhere in the university.

However, the stakes and prospects for a much more collaborative and, indeed, “de-siloed” university are ever growing. And the Bridges conference herein highlighted provides exciting evidence that we are on a fruitful pathway to creating truly T-shaped professionals — that is, educated individuals who have both depth and breadth of training and of understanding.

Looking at our present world from the vantage point of law in particular, the imperative of building disciplinary bridges is clear. It emerges from two key and overlapping perspectives: First, the practice of law requires experience and knowledge that must look beyond what is seen as purely legal and historically within the domain of what lawyers (and not others) do. There is a tendency to see the “idea people”— the technologists, scientists, entrepreneurs — as most critical to innovation. In reality, though, the ecosystem is out of balance without all the players — and this includes the lawyers, businessmen and women, regulators, policymakers, and others. Thus, modern education which gives the lawyer a richer toolkit is rapidly destabilizing what it means to “think like a lawyer;” it entails true understanding of the scientific method and of business strategy. It portends greater participation by lawyers in managerial choices and in entrepreneurial decision-making. Lawyers are asked to think creatively and beyond their usual silos; and the education of lawyers thereby requires a broader focus, and, with it, bridges across disciplinary divides.

Second, the push toward a more catholic view of lawyering emerges from a fundamental reboot of the function (and perhaps even the nature?) of law in the modern world. In what Joseph Schumpeter memorably labelled our “innovation economy,” law is a key element in the ecosystem of innovation. It fuels and facilitates discovery (think of our system of intellectual property), undergirds the institutions that shape and manage the processes by which these discoveries come to our social and economic attention, and navigates the conflicts that emerge in a heterogeneous society. Yet it is not a foreign element that comes in from outside this ecosystem in a hermetically sealed package of insights and information. It grows from the exigencies of our

innovation economy; it is impacted by other elements of the system, including science, economics, and other cognate fields of knowledge. Law is critical in shaping this ecosystem; it, too, is shaped by this ecosystem.

These are not especially novel insights. Legal scholars from generations ago, writing under the banner of “Legal Realism” (and its variants, including legal sociology), understood that law is a porous field, and that legal education is enriched by insights from others within the university setting. Yet, the profound impact of modern technology, and innovative research and pedagogy emerging from, for example, Big Data and the development of ever more sophisticated predictive analytics, has made more urgent the building of bridges among teacher-scholars in order to add new color, new shape, and ultimately new understanding to our legal system and our systems of legal practice. In this collection of materials, you will see many examples of this multidisciplinary reshaping of perspective. And, of course, this is just the tip of the iceberg, as every day brings exciting breakthroughs, often from the offices and labs of academicians working collaboratively and with great regard for what they do not know, but must and will learn from their colleagues.

Lawyers learning from technologists, doctors learning from lawyers, public officials developing regulatory strategy from insightful cross-university research . . . these are the outputs of conferences such as the Bridges series. We are proud to support just this kind of collaborative work at our law school and at Northwestern University.

We are also committed to broadly sharing the insights and discussion generated by such efforts and to encouraging further dialogue. With this goal in mind, we initiated a special project with Northwestern Law Review Online. Conference participants submitted written responses to a series of questions addressing topics discussed during the conference. These responses can be found online at <http://bridges.northwesternlaw.review/>.

The great work in implementing these endeavors has been done by many valuable colleagues. I take special note of the leadership efforts of Professors David Schwartz and Leslie Oster from the Law School.

Special thanks to our colleagues elsewhere at Northwestern University, including the McCormick School of Engineering, the Feinberg School of Medicine, the Kellogg School of Management, and the Weinberg College of Arts & Sciences. The deans of these four schools enthusiastically supported this and the previous Bridges conference, and were generous with their time, including joining me on a panel at this conference. Their engagement reveals well the potential of cross-university collaboration around a common enterprise.

Dean Daniel B. Rodriguez

KEYNOTE SPEECH

Incentivizing Innovation: the Historical Origins of the Market for Ideas

Joel Mokyr, Robert H. Strotz Professor and Economic Historian at Northwestern University



Professor Joel Mokyr delivered the first keynote of the conference, focusing his remarks on the historical origins of the market for ideas. He described how the educated elite in 1500–1700 Europe developed a culture conducive to intellectual innovation because they solved the incentive problems better than other societies. Before this period, the market for ideas was riddled with market failure.

Essentially, within society, there

were few positive incentives for individuals to produce novel ideas, and so there was an underproduction of new knowledge. Furthermore, because new ideas would devalue and disrupt the existing orthodoxy, there were strong negative incentives for new ideas. However, during this period of industrialization and enlightenment, there was a cultural shift that increased society's belief in progress. As people began to acknowledge that useful knowledge was key to progress and cultural transformation, a cultural and knowledge market emerged. And while this market for ideas was not optimal, it was better than the alternatives because it produced meta-ideas: belief in progress; conviction that useful knowledge is instrumental; loss of blind respect for traditional authorities; and the adoption of the scientific method.

Professor Mokyr pointed out several reasons why Europe was able to successfully develop a market for ideas when it did. In addition to the institutional foundations, incentives, and cultural beliefs that emerged, Europe both increased positive incentives and reduced negative incentives in the idea market. From 1500–1700, a virtual community of intellectuals, the “Republic of Letters,” emerged. Crucial to its success were rules that are still fundamental for knowledge production and information exchange today—knowledge and data were open and shared, all knowledge was contestable, and results were checked and reproduced. Additionally, knowledge producers were credited for their contributions, as priority in production resulted in property rights. Further legitimizing this phenomenon were the egalitarian and non-hierarchical nature: anyone could contribute to the transnational community of scholars.

The Republic of Letters resulted from a complex series of lower-level interactions and featured a private order institution,

open science, and the public domain. For example, there was a common language which allowed individuals to communicate more freely. And as intellectuals produced new ideas, the printing press allowed them to reproduce their ideas and distribute them widely. Furthermore, the establishment of the postal service allowed for these printed materials to be disseminated transnationally, faster and more consistently than ever before. These developments, coupled with the sense of unity derived from the church and an increase in competitive patronage, fostered the emergence of the market for ideas that allowed knowledge production and science to flourish.

Professor Mokyr's forthcoming book, *A Culture of Growth: Origins of the Modern Economy* (Princeton University Press, 2016), discusses these ideas in much greater detail.

Panel Discussion: The Internet of Things

MODERATOR

John O. McGinnis, George C. Dix Professor of Constitutional Law at Northwestern Pritzker School of Law

PANELISTS

Mark C. Hersam, Walter P. Murphy Professor of Materials Science and Engineering at Northwestern's McCormick School of Engineering and Applied Science

James B. Speta, Class of 1940 Research Professor of Law and Senior Associate Dean for Academic Affairs and International Affairs and International Incentives at Northwestern Pritzker School of Law

Paul Ohm, Professor of Law at Georgetown University Law Center

Lee W. McKnight, Associate Professor at Syracuse University School of Information Studies

Professor Hersam began the panel conversation by discussing the evolution of interconnectedness since the 1980s, from the floppy disk to local networks to the internet and eventually the mobile internet, and then to mobile technologies being connected to people, and now to the current emergence of the Internet of Things (“IoT”), in which objects communicate with each other without human intervention. Professor Hersam then briefly discussed what the IoT looks like now: there are more than 25 billion devices connected to the internet around the world, and old-fashioned microchip devices are attached to whatever people connect them to: cars, appliances, health devices, and watches. Noting that the usage of internet-connected devices that operate without human intervention will continue to grow, Professor Hersam described what he sees as the future of the IoT: a world where electronics are ubiquitous and every single object is connected to the internet.

This scenario is possible if electronics could be produced the same way barcodes are. To achieve this, the technologies must be cheap, disposable, and seamlessly integrated, and power consumption must be minimized.

Professor Hersam described the work that he and his colleagues are doing with electronic inks that seek to meet these three requirements. They've used a new class of materials: nanomaterials, that cover all electronic properties, and when used at the nano-scale, become mechanically flexible (unlike silicon products used currently) and can be relatively easily dispersed into solution. By thinking about how barcodes are produced using printing presses, scientists are working to take these electronic inks and make them compatible with printing



presses. By formulating these inks and confirming that the electronic properties are invariable, it is possible to develop all of the elements necessary to have printable and flexible electronics that could accelerate the IoT.

Professor Speta discussed IoT from a legal perspective. He discussed the question of systems competition as he sees it developing in the IoT space. He also discussed some of the policy issues he thinks will arise as the law confronts systems competition in the deployment of IoT networks. As has often been the case in the history of telecommunications, the emerging question is what are appropriate competition law and regulatory responses when communication systems of different types are architected to be closed, as opposed to being architected to be open?

He noted that this new IoT ecosystem is being built on the back of a communications architecture that was not designed for it and that has several characteristics that inevitably feed system competition. Diversity of private ownership creates incentives to build and grow with the new ecosystem and to own a significant portion of the value chain to push up and down with respect to applications and devices. Additionally, diverse incentives for interoperability to enhance security at the device, network, and data levels are drivers of closed systems. On the policy side, standard setting is already prevalent in this

area. Professor Speta suggested that it will become even more significant, particularly when thinking about the ubiquity emerging in the IoT space.

There is a wide variety of IoT systems being developed and deployed. Professor Speta described an effort currently underway in Chicago to build a new system on the back of the smart grid, which inevitably represents an emerging systems competition issue. The smart grid was in and of itself an extensive communications network. On the legal side, when electric companies received regulatory approval, the telecommunication companies secured legislation that said smart grids could not be used for telecommunication services—which more than likely includes all of the things we consider when we referring to the IoT. Also, the scope of what we originally considered to be the electric company infrastructure is expanding inside and outside of the house, particularly with municipal infrastructure because the electric company and municipal infrastructure are easily integrated: street lights, traffic systems, etc.

Professor Speta concluded that the IoT systems, in spite of their novelty, will eventually fall under the same legal and regulatory mechanisms as other communications systems: standard setting, spectrum policy, network neutrality, and even privacy.

Professor Ohm continued the discussion of IoT law, focusing specifically on privacy. He began by describing the current schools of thought surrounding the risks—and solutions to those risks—of ubiquitous internet of things device deployment. The first conversation concerns devices like the Amazon Echo: the problems that can occur when a device can listen in and what happens when law enforcement officials can request that Amazon have the device listen to certain individuals of interest. The second conversation asks what we should do with our dominant “notice and accept” terms of service form of regulation in the internet of things space—especially if some, or many, of the devices do not have screens on which to provide such notice.

Professor Ohm provided an optimistic view of the future with regard to privacy and the internet of things, noting that right now devices are chosen, reified, paid for, and more often than not unitaskers; and that soon, devices will be bundled or intrinsic, abstracted, and monetized multitaskers. He also noted that now, internet privacy is a disaster, but in the emerging internet of things space, tension between privacy and security will be beneficial.

Wrapping up the internet of things panel, Professor McKnight detailed the good news that emerges from this new “things network”—cyberphysical security innovation. He discussed edgeware—a new category of software that protects devices, infrastructure, content, users and non-person entities as a way to have a secure internet of things. He noted that increasingly

frequent and highly-publicized hacking attacks have made it clear to individuals, companies, and policymakers why this sort of protection is necessary. As a result, compliance capable technology, such as VMware for cloud computing, with validated design now exists mainly for big companies and law enforcement, and its usage continues to grow.

Professor McKnight pointed out the emergence of malicious usage of the capabilities of the internet of things. These include software bugs that are parts of cyber weapons, webcams used by teenagers, and even St. Jude pacemakers that are vulnerable to hackers and short-sellers. Unfortunately, software is currently not covered by product liability, which is impeding innovation in cybersecurity. Professor McKnight argued that in light of this combination of circumstances, it is dangerous to leave the law on cybersecurity and software liability as they currently are. Professor McKnight also discussed secure internet of things architecture and applications, highlighting the importance of innovation, collaboration, and policy change in securing the internet of things.

KEYNOTE SPEECH

Free Innovation

Eric von Hippel, the T. Wilson Professor of Innovation Management at the MIT Sloan School of Management

In the day's second keynote address, Professor Eric von Hippel discussed the increasing importance of "free innovation." Defining free innovation as goods, ideas, and designs that are developed "at private cost by individuals during their unpaid leisure time" and free of intellectual property rights, Professor von Hippel argued that this sector of innovation is underappreciated by scholars, policymakers, and producers. The traditional focus on the Schumpeterian innovation model, wherein innovation is primarily producer-driven, drives attention away from the many products and improvements developed by consumers, making these contributions invisible to many scholars and policymakers.

Drawing on large scale survey results, Professor von Hippel demonstrated that users collectively invest billions of dollars annually in research and development. According to Professor von Hippel, in a country like the United Kingdom, user-innovators outnumber professional R&D workers by a ratio of

100:1. These individuals fit into varying categories of household innovators, but are united by the intrinsic motivations that drive them to innovate. Whether they are motivated by a desire to create, personal need, or altruism, the majority of these home innovators create not because the intellectual property system provides them with an economic incentive to do so, but rather because they enjoy creativity and problem-solving.

Professor von Hippel pointed out that by ignoring user innovation, the traditional Schumpeterian model provides too much credit to producer-innovators, running the risk of perpetuating misunderstandings about how innovation actually occurs. With producers hesitant to invest in small and uncertain markets, users are those most likely to develop ideas and products to fulfill their needs. Once a user community has adopted these open innovation products, producers improve on them and bring them to a larger market. Traditional research on innovation largely ignores the early stages of this process, and thereby tends to over-emphasize the role of producer-innovators. In markets with active user innovation communities—for example, the whitewater rafting market—user innovation can save producers many times their R&D costs. Producers also benefit from the techniques and use-case innovation that goes on within the user community, yet another aspect of innovation that the traditional Schumpeterian innovation model ignores.

Turning his eye to the future, Professor von Hippel expressed hope that by taking a dual paradigm approach to understanding innovation—one that encapsulates both the traditional Schumpeterian producer innovation model, as well as the user innovation model—we can understand better how these varying types of innovation interact with one another. Ultimately, von Hippel argued that this more complete treatment of the interplay between users and firms will provide more accurate insight into the extent to which intellectual property "protection is as important as it is argued to be in the Schumpeterian story."

Much of the discussion following von Hippel's presentation revolved around how the issues raised by von Hippel in his talk actually manifest in the current IP regime. When asked why it is important who ultimately benefits from a patent if the users are going to innovate anyway because of their intrinsic motivations, von Hippel replied that the harm arises from the monopoly profits that firms are able to generate. These profits lower social welfare by raising costs on consumers. Put succinctly, von Hippel stated that "when patents are not required, they aren't desired."

Deans' Panel

PANELISTS

Dean Sally Blount of the Kellogg School of Management at Northwestern University

Dean Julio Ottino of the McCormick School of Engineering at Northwestern University

Dean Adrian Randolph of the Weinberg College of Arts and Sciences at Northwestern University

Dean Daniel Rodriguez of the Pritzker School of Law at Northwestern University



At the Deans' Panel, leaders from four different departments at Northwestern University discussed how to build bridges across the sciences, engineering, business, and law.

Dean Daniel Rodriguez, of the Law School, discussed the role of law and law schools in fostering vibrant innovation ecosystems. Categorizing rules into three types—constraining, facilitating, and regulating—Dean Rodriguez argued that these different types of rules must work in complement with one another. He suggested that maximizing innovation requires multidisciplinary collaboration and individuals with a breadth of training and experience across different fields. This need for multidisciplinary is particularly pressing when dealing with what Dean Rodriguez described as “wicked problems” or “super wicked problems” like global warming. These highly complex problems entail issues relevant across the silos that universities traditionally segment themselves into. By bridging these silos, Dean Rodriguez expressed hope that conferences like this one can contribute to efforts to solve these problems by bringing “all hands on deck.”

Dean Julio Ottino, from the McCormick School of Engineering, emphasized the critical intersection between law and engineering. Observing that many engineers have a distrust for the uncertainties inherent in policy studies, he argued that an important role of modern universities is to train people to be comfortable at the intersection of law, engineering, science, and business. Dean Ottino argued that this role as

a nexus connecting individuals across disciplines is one of the underappreciated functions of high caliber educational institutions. With regard to new technologies with potentially wide-ranging societal impacts such as the Internet of Things or artificial intelligence, Dean Ottino maintained that the value of having cross-disciplinary teams to design, understand, develop, and implement these technologies will be essential for the continued health and success of America's innovation ecosystem.

Dean Sally Blount, from the Kellogg School of Management, shared a business school perspective. She said that as the child of a Bell Labs researcher, the existence of an intersection between law, business, and technology had always seemed implicit. However, she expressed concern that contemporary research has become more short-term profit-oriented, and expressed regret about the lack of blue sky research labs like Bell. Drawing her inspiration from Kellogg's mission statement, Dean Blount argued that business schools are inherently interdisciplinary and that this interdisciplinarity is essential to the creation of effective innovating organizations. She also pointed out that the law is central to the formation of these organizations, and also as a regulating force in ongoing operations. Advocating for the importance of effective legal systems, she stated that “greed inspires innovation, but it needs to be held in check” and that “the law helps birth the company, and it helps bound it.”

From the Weinberg College of Arts and Sciences, Dean Adrian Randolph discussed the role that humanists might play at the intersection of law, business, and technology. Reflecting on the morning's discussions about the internet of things, Dean Randolph pointed out that humanists can help make sense of a world that may increasingly seem mystically charged as everyday objects are increasingly seen as agents we meaningfully engage with. Dean Randolph echoed the other deans by stating that one of his primary challenges as an educator is ensuring education is broad enough to guarantee that students have “boundary-busting experiences” that will help fertilize the innovation ecosystem.

The discussion following each dean's presentation focused on trying to determine the appropriate balance between crossing disciplinary boundaries and attaining sufficient disciplinary depth. Although opinions differed somewhat, the deans largely agreed that deep disciplinary expertise was required for effective interdisciplinary collaboration. Dean Randolph stated that “robust interdisciplinarity requires robust disciplinary.” Agreeing, Dean Blount suggested that the need for discipline-focused training increases with the level of education, with doctoral training representing the apex of disciplinary, while boundary-spanning training is more important to undergraduate and high school education. Dean Rodriguez pointed out that law schools are unique in that they do not train PhD students, but also noted that the increasing

complexity of the law and student demand for specialization poses a challenge as law schools attempt to train lawyers who are both broad and deep in their expertise. Dean Ottino responded to the disciplinary vs. interdisciplinarity binary by arguing that every revolution goes too far—suggesting that interdisciplinarity will suffer without sufficient disciplinary depth. Ultimately, the deans agreed that it was not an either/or proposition, but rather that effective organizations require a mix of individuals who excel at their respective disciplines as well as those capable of building bridges across disciplines.

Panel Discussion: CRISPR – (Clustered regularly interspaced short palindromic repeats): Issues in Gene-Editing

MODERATOR

David L. Schwartz, Professor of Law at Northwestern Pritzker School of Law

PANELISTS

Matthew Porteus, Associate Professor of Pediatrics at Stanford School of Medicine

Arti K. Rai, Elvin R. Latty Professor of Law and the Co-Director of the Duke Law Center for Innovation Policy

Laura Pedraza-Fariña, Assistant Professor of Law at Northwestern Pritzker School of Law

Laurie S. Zoloth, Professor of Bioethics and Medical Humanities, Feinberg School of Medicine, Professor of Religious Studies, Northwestern University Weinberg College of Arts and Sciences

Professor Porteus introduced the audience to CRISPR. CRISPR-Cas9 is a defense system for bacteria against harmful phages and it has been successfully introduced to mammalian cells. It is part of a family of techniques for genome editing, allowing geneticists to alter the DNA sequence. In general, proteins called nucleases are programmed to find a specific site within the genome and make a break, triggering the cell's own repair mechanisms to stitch the two pieces of DNA back together. By repeating this process, geneticists can control the site of mutation, if not the mutation itself. Similarly, nucleases can be manipulated to “copy and paste” new segments into a sequence. These techniques allow harmful mutations leading to disease to be repaired. Harnessing the homologous recombination process allows scientists to fix a point mutation, insert a copy of the gene into its own site to fix downstream mutations, pick a “safe harbor” and insert a cassette, a promoter and a gene into a specific location into a genome. It also allows scientists to insert multiple genes to use synthetic biology to re-engineer the properties of a cell, and find a gene expressed in a certain

cell and put a new gene into the cell. CRISPR differs from prior iterations of the technology because it is easier to use.

Professor Porteus introduced his own lab's work on sickle cell anemia, a disease that dramatically shortens lifespan. He explained how his team created a sequence to repair the mutation in test samples, finding that up to 50% of alleles were corrected by this process. Other studies suggest a correction rate of 10% would be enough to cure the disease in most patients. Professor Porteus and his team are in the process of scaling up for an initial clinical trial in 2018. Professor Porteus outlined the difficulties faced by gene mutations that have to take place in soft tissue that cannot be removed from the body and replaced, as blood can. Looking beyond the immediate challenges, like the body rejecting the inserted cells and the sheer magnitude of cells and mutations in the human body, Professor Porteus invited attendees to consider two core ethical issues: how to deliver gene editing technologies equitably throughout the world, and how to decide what should be edited.

Professor Rai addressed ownership issues and the ambiguities of how to apply intellectual property ideas and patent law to the issues surrounding CRISPR. She described the conflict between researchers at Berkeley and researchers at MIT stemming from the difficulty in defining the time of invention that determines ownership; this conflict is the source of costly litigation, which seeks to determine who owns the valuable patents involved with CRISPR. Professor Rai pointed out that the new first-to-file system would have avoided this lengthy conflict. However, what is currently at issue in the CRISPR dispute is the old first-to-invent system, which is both more difficult to place on a timeline, as well as more difficult to define. The market, Professor Rai pointed out, is indifferent to which person receives a medical patent, so long as some entity gets the patent and the invention reaches the market. She also discussed the conflict between traditional academic norms and the laws of intellectual property. Intellectual property laws are strictly consequentialist with the goal of providing new ideas and products to the public, while academia is traditionally unconcerned with providing a tangible, marketable product for the public. Reconciling these ideological differences is a productive area of focus for Law-STEM collaborations and partnerships.



Professor Pedraza-Fariña used CRISPR to illustrate the transformations in basic research in academia caused by the rise of private-public partnerships in the 1980s and 1990s.

Studies of biotechnology clusters, comprised of universities, spin-off companies, venture capitalists, and technology transfer offices point to several core principles that future innovation leaders should keep in mind based on experience in the Bay area, Boston, and San Diego. Contrary to the fears of some academics, these clusters did not lead to an erosion of the norms of science. Instead they produced private enterprises that are sensitive to openness. The innovation that took place there is an emergent property of the network itself, rather than being produced solely in universities. Technology transfer offices, entrepreneurial scientists, and geographic clusters have facilitated the transfer of basic research to commercial products. She emphasized how the change in patent law allowing federally-funded research to be patented drove this transformation, leading to conflicts between public and private motivations in scientific research, particularly between open sharing of knowledge and the monopoly on techniques granted by patent law. Professor Pedraza-Fariña explained that her research suggests scientists are using patents as an attributional currency vying for importance with published papers, thereby changing traditional incentives and career paths for their respective academic fields. Professor Peraza-Farina cautioned that the evidence is still partially anecdotal, but she indicated that the fight over intellectual property law is one motivating factor in how the scientific academy has adapted to integration with private interests.

Professor Zoloth, discussed the ethical challenges and controversies prompted by CRISPR and how they compare to other breakthroughs in genetics over the past forty years, many of which did not live up to their initial promise. A conference of scientists at Asilomar in 1973 provided a starting point of bioethics and foundational safety principles after being warned by legal collaborators that efforts were underway to regulate biomedicine in Congress. At Asilomar, three compromises were agreed upon: first, not to put pathogens into E. Coli, second, not to insert cancer sequences, and third, not to insert genes for drug resistance. Professor Zoloth argued that four changes have taken place since the Asilomar Conference, other than the realization that viral vector technology was not as promising as previously thought. First, the marketplace has changed through both Big Pharma and changing norms that encourage academic scientists to form their own firms. Second, the failures of the hyped scientific breakthroughs of the last forty years, for example stem cells, have dampened enthusiasm for considering CRISPR to be revolutionary or redemptive. Third, patient advocacy developed out of the AIDS crisis, putting pressure on institutions. Finally, the usefulness of CRISPR is years away, both practically and because of the fundamental unknowability about even the basics of molecular biology. Professor Zoloth concluded her talk by inviting the audience to think about the amount of information that was still unknown about the future of the project and what questions technological advancement may raise about human nature and the ethical limits of science.

During discussion, Professor Porteus responded to Professor Zoloth by arguing that some diseases, for example sickle-cell anemia, are profoundly understood and should be experimented on first with CRISPR. The discussion then turned to the balance between fears of experimentation and self-regulation of the industry, particularly the fear of the ethical dilemmas that could arise from a dramatically lower barrier to entry for gene-editing technology. The panel agreed that patents are less important to the CRISPR market than trade secrets and intellectual property law, particularly with the variation of regulation across national borders.

Panel Discussion: User Innovation Platforms

MODERATOR

Sarah B. Lawsky, Professor of Law, Northwestern Pritzker School of Law

PANELISTS

Kristian J. Hammond, Professor of Electrical Engineering and Computer Science, McCormick School of Engineering and Applied Science of Northwestern University

Mohanbir Sawhney, McCormick Foundation Chair of Technology, Clinical Professor of Marketing, and Director of the Center for Research in Technology & Innovation at Northwestern University Kellogg School of Management

Eric von Hippel, T. Wilson Professor in Management of MIT Sloan School of Management

Katherine Jo Strandburg, Alfred B. Engelberg Professor of Law, New York University School of Law

Professor Hammond introduced his groundbreaking work on Narrative Science, a methodology that translates raw data into readable text. Professor Hammond gave the example of transforming spreadsheet data into sentences and paragraphs, a particularly useful skill when dealing with datasets larger than humans can understand in detail. The systems that we have built to analyze data have become the means by which we use that data. These new technologies allow users to assess the information they have, predict future trends, and give advice about how to act. He emphasized how the availability of widespread data over a broad number of fields created opportunities for profound transformation, particularly in law and the creation of contracts. Machine learning and artificial intelligence will provide us with advice about our decisions, either incorporated into our decisions or replacing our decisions. The question for those looking to move the field forward is how to determine where to apply these new tools.

Professor Sawhney started from the premise that users are a vital source of innovation as well as the object of innovation.

This can happen on two levels: innovating themselves, as well as providing feedback that leads to innovation. While previous approaches to understanding how users created novel uses for new products and technology required time-intensive and expensive studies, the advancement of the internet provides a platform for interacting with users quickly and efficiently at scale. Innovation platforms connected skilled inventors with challenges from private industry. Open communities allowed community members to vote and evaluate proposed technical changes, with the best or most approved ideas bubbling to the top in real time. Crowdfunding takes open communities to the next level by combining the voting properties of open communities with funding from the users voting for a product.



Social data harvesting allows ethnographic analysis at a massive scale to understand why customers are motivated to buy products. Toolkits actually allow users to tinker with the products that they are using. Professor Sawhney pointed to the intellectual property questions inherent in community-created innovation, chiefly: How are rights and royalties distributed when a product is created through user innovation?

Professor von Hippel reframed user innovation as a question of problem-solving. He began a discussion with Professor Hammond about personalization of new approaches to data interpretation. Hammond explained how individualized data sets could use information from the broader user base to tailor results. Professor Von Hippel discussed the connection with innovation by users to tailor commercial solutions to their own problems. Professor von Hippel asked his collaborator, Professor Andrew Torrance (a scientist and a lawyer), to translate the challenges they had overcome the law professors in the audience to understand better. Professor Torrance discussed how scientists whose research could potentially violate intellectual property may avoid promising areas of research due to the fear of legal action, and how he helped a team at the University of Kansas develop a licensing system modeled on the open source community. Professor von Hippel cited the example from the University of Kansas as another example of using legal frameworks to de-marketize. He

concluded by urging patent law scholars and lawyers to help build new frameworks for sharing information.

Professor Strandburg expanded on the discussion of platforms by thinking of technological platforms as infrastructure and as knowledge commons. She stressed the diversity of innovation and how technological affordances shape the direction of user innovation. Turning to patent law, she suggested the incentives to invent, disclose, and disseminate novel ideas created by the patent law system provide useful metrics to measure the design of innovation platforms. Knowledge commons can be a superior solution to patents when the costs to disclose and disseminate innovations are low and there are non-monetary goals, such as reputation, to share information supported by appropriate infrastructure. Professor Strandburg stated her belief that most non-industrial processes do not need patents because they involve users who have common, non-competitive interests. She suggested that the debate needs to start with situations regarding user innovation processes where intellectual property law is likely to fail. Her research focuses on conducting empirical research on successful innovation and determining ways to incorporate successful models into patent law.

In discussion, Professor Hammond argued that almost everything we deal with on the internet has a machine learning component, which changes user experiences accordingly. In Professor Hammond's view, Netflix, Amazon, and Facebook represent the promise of machine learning. Professor Strandburg responded that we need to be careful about what we mean when we talk about user participation in innovation, and that excluding users from the proprietary technology which creates user experience can be dangerous. Professor Sawhney argued that public good and private good are not necessarily aligned, for example, in the pharmaceutical industry. As a result, there is an important role for public institutions that represent public good, like the National Institutes of Health, to create the infrastructure that enables innovation

Reporters' Panel

PANELISTS

Ivory Mills, Law & Science Fellow, JD-PhD Candidate—Media, Technology, & Society, Northwestern Pritzker School of Law and School of Communication

Thomas H. Rousse, Law & Science Fellow, JD-PhD Student—Media, Technology, & Society, Northwestern Pritzker School of Law and School of Communication

Ryan Whalen, Assistant Professor at Dalhousie University School of Information Management



The goal of the Reporters' Panel was to highlight the variety of subjects and note key terms and themes from throughout the day. Ms. Mills continued the discussion of technology, innovation, networks, law, science, business, data, privacy, and security by noting several recurrent themes and posing the following existing and emerging questions to the audience for discussion, thought, and future research:

- How have modern technologies already changed not only the structure and function, but also our normative understanding of institutions, business organizations, and the law? How might they change these in the future?
- How can we balance the often competing interests of technological innovation and privacy and security concerns?
- What is the growing/changing role of the user/consumer in the innovative process?
- In recent years, we've seen regulatory and policy changes in American IP law, like the CREATE Act and the America Invents Act. How will the regulatory state continue to change?
- How can we use the legal and regulatory mechanisms to incentivize innovation?
- Within universities and the academy, how can we continue to improve existing collaborative scholarship to not only enhance our understanding of the innovations themselves, but also to explore the implications of innovation?

- How can we translate our understanding of innovation and the process of innovation into our teaching and curriculum development?

Mr. Rousse tied together the different roles users played across the panels and what a user-focused lens can teach us about Law-STEM collaboration. For commercial applications, users are a source of innovation: Firms bring new products to market to supply user demand. He also pointed out the value of understanding non-users, those who would benefit from a change in technology or a new product, but who were not targeted by the creators and who were otherwise resistant to adoption. Outside of those who actually adopt products, there is always a broader set of potential users for innovations that failed to find a market, failed to translate new knowledge findings to the appropriate audience, and insular communities that do not move innovations past barriers to a more general audience. Another aspect of user innovation that Mr. Rousse pointed out is innovations of technique, or how the project is used, which have the potential to transform the product itself. As an example of a transformative technique that changed the underlying product, Mr. Rousse discussed when Julius "Dr. J" Irving first began taking the basketball above the rim by introducing the slam dunk, transforming the game of basketball. Use has also been democratized, inviting a broader set of users to deploy complex products or change the way those products are developed. Intellectual property itself has been democratized by new regimes such as Creative Commons. Mr. Rousse cautioned that not all users are beneficial or sources of inspiration. There are also destructive users, such as hackers taking down user communities or marketers exploiting search engine algorithms to increase traffic to their websites while degrading the quality of results. Innovators must consider ways in which user access needs to limit users with bad faith motives. Mr. Rousse also talked about useful knowledge and knowledge transfer. He argued that interdisciplinary collaboration is essential to transforming innovation from the academic field into useful knowledge that can be deployed as products or solutions accessible to a broader audience.

Closing the reporters panel, Professor Whalen discussed two threads woven throughout the day's discussion: the notion of innovation ecosystems, and the tension between implicit and explicit innovation incentives. Innovation ecosystems came up explicitly a number of times throughout the day, including during the deans panel. However, Professor Whalen argued that the notion of the importance of innovation ecosystems—which he defined as “complementary institutional, technological, and cultural foundations that interact with one another in highly complex ways to lead to” innovative societies—were also implicit in many of the day's discussions and presentations. Professor Whalen argued that these ecosystems affect both the quantity and quality of innovation by guiding behavior, enabling interactions, and providing a framework for what

is considered a good idea. These ecosystems are inherently complex, and thus are ideal candidates for discussion at a conference like this one that weaves together multiple domains, and brings together multiple perspectives.

Turning his attention to the notion of implicit and explicit incentives, Professor Whalen reported on a poll taken of those at the conference. When asked whether implicit or explicit incentives were more important to generating innovation, a slight majority (57%) choose implicit. However, Professor Whalen argued, because of the inherent complexity in societies, we can never truly know how different sets of incentives affect innovation behavior. The lack of variation in real world incentive systems, along with the large number of potential confounds, makes causal claims very difficult to make. In response to this, much scholarship focuses on historical analyses, case studies, or theoretically-driven approaches. Professor Whalen argued that difficult problems are perhaps the clearest example of how a conference like Bridges can generate knowledge. Advocating for cross-disciplinary teams including lawyers, engineers, and computer and social scientists, Professor Whalen suggested that complex system simulation may help shed light on how incentive systems truly affect innovation behavior.

