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

INTRODUCTION

David L. Schwartz[*] *& Leslie Oster*[†]

We are thrilled to present a discussion of the Law–STEM intersection in this special project of the *Northwestern Law Review Online*. This project arose as part of a conference held at Northwestern Pritzker School of Law in October 2016: Bridges II: The Law–STEM Alliance & Next Generation Innovation. After a robust conference that focused on the role of different disciplines in the innovation process, a group of scholars (mostly legal scholars who do interdisciplinary work) convened informally to discuss ways to foster interdisciplinary innovation and to overcome barriers to collaboration between legal and STEM professionals. We had such an interesting discussion that we decided to ask participants to submit written answers to questions discussed at that session. We provided five questions to the participants. Participants answered either a subset of the questions or wrote essays responding to the questions as a whole. The questions are:

How do views on rewards and burdens differ between the law and STEM fields in academia? (Consider administrative differences, requirements for tenure, different emphasis on types of publications v. conference proceedings, etc.)

How do lawyers think differently from STEM professionals when approaching problems and risk?

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

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Provide an example of a situation in which a Law–STEM collaboration aided a project or where the lack of collaboration between these two disciplines impeded a project.

Technological change recently has altered business models in the legal field, and these changes will continue to affect the practice of law itself. How can we, as educators, prepare law students to meet the challenges of new technology throughout their careers?

We are grateful to the *Northwestern Law Review Online* for providing us the forum to disseminate this information. This project is part of a larger effort at Northwestern Pritzker School of Law to focus on the intersection of Law and STEM. The "Bridges" conferences (starting with Bridges I & II and continuing with Bridges III in April, 2018, focusing on Law & Computation) have been an important aspect of our efforts, and there are many others. Four years ago, we introduced the Master of Science in Law (MSL) program, an interdisciplinary master's degree designed to prepare STEM professionals to address the multi-faceted legal and regulatory issues they are facing in today's STEM-centric economy. As of this Fall, the MSL program will have enrolled over 200 students, from a variety of science and engineering backgrounds—bench scientists, technology managers, researchers, entrepreneurs, post-docs in various STEM fields, medical professionals, etc. We also co-hosted (with Penn Law and Stanford Law) an inaugural forum for young scholars working at the Law–STEM intersection in October, 2017. We have collaborated with faculty from Northwestern's McCormick School of Engineering to increase cross-disciplinary understanding and develop curricular initiatives. And there is a lot more to come—stay tuned.

We hope that you enjoy the take-aways and insights from this project and that they spur further discussion and collaboration of this all-important intersection.

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

THE CENTRALIZATION PARADOX OR HOW TO BE A GOOD COUNSEL

Devin R. Desai[*]

Lawyers, at their best, are counsel. When technology changes or disrupts the core economic and social structure of fields and industries, it also challenges a counsel's ability to do her work well. On one hand, a counsel may see her job as simply aiding a client's drive to be the winner in the field, in part by pushing the edge of the law or arguing for deregulation. On the other hand, just because a technology is cutting edge does not mean it is gospel.

[1] Society can reject even good science, if the social cost is high. Good counsel thus must understand its client's business sector, the technology at hand, and the law that does, or could, govern the business and technology. Even then her work is not done. Good counsel looks into the future and asks not whether something can be done, but what the risks are. Ultimately, good counsel presents clients with insights about whether it *should* be done. These realities mean good lawyers must not shy away from STEM. At the same time, they must not embrace STEM to the exclusion of economics, sociology, history, and ethics, lest they stop being counsel and become cheerleaders.[2]

Although these ideas apply for any counsel, they become acute when a practice becomes decentralized and democratized.[3] Lawyers are trained in a system that assumes large, centralized players. In simplified terms, law tends

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[1] *See* STEVEN SHAPIN & SIMON SCHAFFER, LEVIATHAN AND THE AIR PUMP: HOBBES, BOYLE, AND THE EXPERIMENTAL LIFE at Kindle Loc. 555–56 and at 8093–94 (2011) (examining the way in which knowledge is constructed and offering "Solutions to the problem of knowledge are solutions to the problem of social order.").

[2] JULIE COHEN, CONFIGURING THE NETWORKED SELF: LAW, CODE, AND THE PLAY OF EVERYDAY PRACTICE 3–4 (2012) (examining the link between political and economic interests behind arguments for technological constructs and by extension arguing that technological ordering is not a given to which we should defer).

[3] *See* Deven R. Desai, *The New Steam: On Digitization, Decentralization, and Disruption*, 65 HASTINGS L.J. 1469 (2014).

to work on a business-to-business model. Despite all the celebration of deregulation and decentralization, when society moves from relatively few firms to many players, the way the law works shifts. In some cases, the economics of production and invention mean that large-scale entities like recording companies, hotel chains, taxi companies, and even automakers may be less necessary. But just because technology, especially digitization and networking technology, alters a field does not mean that a new centralized player or players will not emerge. The emergence of new, centralized players is obvious: think of AirBnB, Amazon, Apple, Facebook, Google, Lyft, Netflix, YouTube, or Uber.

The dynamic of democratized technology enabling decentralized production and regulation evasion leads to two questions a good counsel must answer: When does decentralization recentralize? What can be done when a powerful practice remains stubbornly decentralized?[4]

With recentralization, an industry that once was the darling of innovation and quasi-rebellion will be asked to fill the gaps it created. Issues of trust, safety, and sometimes the enforcement of legal and social norms do not go away after a new player upsets a possibly obsolete business model. They remain, waiting for competitors and society to demand that the new winners address the issues. Providing trust systems becomes a powerful way to assure the public that regulation is not needed—and to make money. Offering malware-free music, verified design files, background checks on drivers, dispute resolution, and safety assurance for rooms and goods has allowed Amazon, Apple, Uber, and AirBnB, respectively, to provide value despite the transaction costs. With millions or billions of transactions, they can absorb the costs, provide a marketplace, and in essence charge for being a clearinghouse service. But not all self-regulation is self-motivated. Pressure from the music industry, and perhaps a desire to enter that sector too, forced YouTube to find a way to police copyright. eBay has ramped up its anti-counterfeiting efforts. Regardless of why self-regulation occurs, once these actors attain scale and show that they can regulate, society may ask for more regulation.

With networked, monitored industries, the capacity for public or private control increases, and the ability to make money changes. For example, autonomous driving systems should reduce accidents and also ensure that cars almost always obey laws. Thus "driving while black" should vanish, because neither the driver nor the police officer will have discretion about whether an infraction occurred. If all cars obey traffic laws, almost all

[4] For one view of this dynamic as a good one, *see* Orly Lobel, *The Law of the Platform*, 101 MINN. L. REV. 87, 92 (2016) ("[L]egal disruption by the platform economy should be viewed as a feature rather than a bug of regulatory limits").

revenue from enforcing traffic laws will go away. Law enforcement could focus on more serious crime, but local police force budgets reliant on traffic violations for revenue would face gaps. Insurance rates should plummet, which is good for consumers, but the related industry would face revenue shortfalls. All these possibilities require firms and their counsel to understand the technology that drives a given change, as well as the social, moral, and economic issues that go with the change. Failing to understand all these aspects of change can mean that a firm finds its assumptions about how the sector operates are incorrect, and so the firm's business model is defunct.

Good counsel will have different perspectives on what to do depending on the client, but all counsel involved in these outcomes should try to see and explain the implications to clients as they plan what to do as a response to the changes. Thus, if the state demands that AirBnB, Lyft, and Uber meet safety, employment, and other regulations, they may object, but good counsel should also see that the companies are well-placed to use their scale to come up with solutions. As one example, after claims that a driver raped a passenger in India, Uber created a panic button for riders.[5] Yet, Uber did not deploy the panic button in the United States.[6] Uber claimed that the 911 call system is the panic button and "it would be 'a stretch' to try and do better than formal infrastructure."[7] This moment might be seen as one in a long line of Uber's missteps, but it reveals the idea of what good counsel can do. Rather than avoid responsibility or save costs, Uber could have added the panic button in the U.S. Indeed, had such a button been available to passengers of Jason Brian Dalton, who was charged with a spree of shootings and seems to have taken passengers for rides on the same day, perhaps more people would have reported claims of erratic driving, and he would have been investigated before his more violent acts. None of which is to say that the technology would have necessarily stopped Mr. Dalton.[8] The point here is the absurdist statement that Uber does not think it can do better than formal infrastructure, when that claim is a key part of its overall claim to existence. Good counsel must thus see that disruption may untether a client from current regulations, but that embracing responsibility and filling gaps created

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[5] *See* Davey Alba, *Uber's New Panic Button Beams Real-Time Alerts to Police*, WIRED.COM (April 30, 2015) https://www.wired.com/2015/04/ubers-new-panic-button-beams-real-time-alerts-police/ [https://perma.cc/VJG6-GTQX].

[6] Andrea Peterson & William Wan, *Uber Has a Panic Button in India, But Don't Expect It to Come to U.S.*, WASH. POST, THE SWITCH, (Feb. 22, 2016) https://www.washingtonpost.com/news/the-switch/wp/2016/02/22/uber-has-a-panic-button-in-india-but-dont-expect-it-to-come-to-the-u-s/?utm_term=.1a5d24546685 [https://perma.cc/5KF5-GP2W].

[7] *Id*.

[8] *Id*.

by disruption can help a company rather than hurt it. *And* because the disruptors who have taken over a large sector are already incumbents, they would be able to keep newcomers and future disruptors at a disadvantage. New players would have to comply with regulations and accompanying technological solutions, whereas previous disruptors did not.

One can debate what regulation is proper, but that does not change the fact that new centralization means new regulation is possible. Nonetheless some practices that are now decentralized and democratized might stay that way. Those areas create a different problem for law, society, and the counsel who work in those areas. Two technologies, additive manufacturing (3D printing) and CRISPR gene editing, are powerful decentralizing and democratizing forces that can have large effects on society and do not necessarily lead to recentralization, thus showing the limits of regulation's reach.

Additive manufacturing uses files from a range of sources, but nothing requires the technology to be networked. Although the digitization of things has allowed almost anyone to have a personal or small business factory, the process can be done without the central platforms that drive Lyft, YouTube, and other platform players.[9] Indeed, 3D printer hardware and software are often open-source. Users can build and improve without a central, coordinating force. If one tried to lock down files, peer-to-peer and other strategies that fuel copyright file-sharing would take hold. Unlike music or film, where most users may prefer an authorized and fairly-priced file, those who wish to use 3D printers for weapons or pharmaceuticals will have a higher risk threshold. Issues around decentralized and democratized biological engineering tools are similar but pose larger threats. They also show how old models fail.

Responsible actors in genetic engineering saw the problems coming, yet drew on the centralized playbook to solve them. One group fully grasped that the ideals and methods of self-regulation that were born in 1975 rested on scientists and good faith.[10] This work understood that it is not only a few centralized players that matter, but that "a practitioner *community* proliferating globally"[11] is important due to the "increased ease of reading and writing genetic information."[12] Yet even if one has centralized players and a practitioner community agreeing on best practices and ethics, with

[9] On the implications of the digitization of things, *see* Deven R. Desai & Gerard Magliocca, *Patents Meet Napster: 3D Printing and the Digitization of Things*, 102 GEORGETOWN L.J. 1691 (2014).

[10] Megan Palmer, Francis Fukuyama, & David A. Relman, *A More Systematic Approach to Biological Risk*, 350 SCIENCE 1471, 1471 (2015).

[11] *Id*.

[12] *Id*.

decentralized and widespread creators, "securing materials in a handful of established labs is not feasible."[13] In short, control over inputs or "materials" works with a small number of actors but is not going to work today. Nonetheless, the authors called for regulation and a new, independent agency to address the new "scope and scale" of new biological technologies.[14] Although seeking an agency that knows the area and has power over it is not foolish, and other sectors have used the approach before,[15] it will not solve the problem that genetic engineering knowledge and tools are now low-cost. The difficulty of using the technology for possibly dangerous biological engineering is also low.

Good counsel must understand that these technologies operate outside of market discipline. The users or consumers of the end products care less about safety and reliability. Those who are near death or cannot afford healthcare are vulnerable and desperate in the deep sense of being without hope. Promises of gene therapies or low-cost pharmaceuticals would be tempting. Yet those outcomes affect the consumer rather than creating a large-scale societal change. In contrast, anyone who wanted to use CRISPR to control pests or plants in the yard or on their farm might change an entire species and related ecosystem.[16] The protocols, agreements, and regulations of an industry group, a country, or a consortium of countries would not bind such an actor.

As counsel, simply backing calls for innovation and markets in these situations will not carry the day in the long run. Understanding the underlying technology and how it affects society allows good counsel to educate the public about the changes. It also allows good counsel to provide good advice; that is to be a true counselor. A better understanding of technology permits one to say "yes, with some small changes" rather than "no, absolutely not." Knowing when other companies have faced scrutiny, lawsuits, and obstacles or product cancellation regardless of whether the law permits the activity due to technology that was not well-understood or poorly designed to address social concerns[17] allows counsel to speak with authority on law, society, and technology. It is that combination that makes a lawyer

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[13] *Id*.

[14] *Id*.

[15] *Id*. at 1472.

[16] *See e.g.*, Brad Plumer, *"Gene Drive." Learn the Term. Because It Could One Day Transform the World*, VOX, ENERGY & ENVIRONMENT, (June 12, 2016) http://www.vox.com/2016/6/9/11890472/gene-drive-benefits-risk [https://perma.cc/4DHR-U3CS]; *see also* Janet Fang, *A World Without Mosquitoes*, 466 NATURE 432 (July 2010) (noting eradication of mosquitoes could affect Arctic caribou).

[17] Products involving privacy provide examples of launches followed by quick shut downs at losses that might be in the millions.

into a good counsel who should be valued and trusted as she helps guide a company to lasting, rather than, transitory success.

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

Jay P. Kesan[*]

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

There is a clear need for professionals who are both educated and have professional work experience in science/technology and in law. Providing educational opportunities (both degree and non-degree) to increase the number of people who fall into that interdisciplinary category will result in greater collaboration between science/technology and law.

Provide an example of a situation in which a Law–STEM collaboration aided a project or where the lack of collaboration between these two disciplines impeded a project.

I have taught two courses—Digital Forensics and Privacy and Security—both of which have been true joint collaborations between law faculty and computer science/engineering faculty.

In Digital Forensics, we created a cross-listed course with extensive interdisciplinary content involving law, psychology, sociology, and computer science, supported by a grant from the National Science Foundation (NSF) and open to both computer science and law students. The course offered laboratory work that had to be performed by law and computer science students. The laboratory work required students to complete hands-on assignments by employing digital forensic tools such as EnCase, electronic discovery tools, and the like. The laboratory work also involved legal laboratory assignments such as comparing and contrasting expert reports from the parties on both sides in a case involving digital forensic evidence and testimony. The digital forensic experts and the attorneys on both sides of the case were involved in the laboratory assignment.

The lab work was accompanied by classroom lectures involving the legal issues, such as the Fourth Amendment, rules of evidence, reliability of

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scientific evidence, the *Daubert* standard, and relevant legal statues such as Electronic Communications Privacy Act (ECPA) and the Computer Fraud and Abuse Act (CFAA); psychological topics like exploring the psychological aspects of cybercrime; and computer science aspects of digital forensics.

The end result was an extraordinary appreciation among both the law and computer science students for the other discipline and for the knowledge and insights necessary to be a skilled practitioner in each discipline.

We are now working on developing a similar course on Privacy and Security that would involve an exploration of the relevant legal and policy issues, but would also involve an in-depth exploration of data mining, cookie technology, firewalls, intrusion detection systems, and anti-virus software.

Technological change recently has altered business models in the legal field, and these changes will continue to affect the practice of law itself. How can we, as educators, prepare law students to meet the challenges of new technology throughout their careers?

As lawyers and policymakers, understanding technological change will help us manage that change and respond to social problems created by technological change through meaningful policy intervention and legislation.

I would like to take a broader perspective on the impact of technological change, going beyond the legal profession, and considering its impact on all of society and the social fallout from technological change that may necessitate legal and/or policy intervention.

Technology has created or enhanced the major revolutions in our times: (a) the computer and communications revolution (from broadband access to cheap computing and communication devices to the upcoming Internet of Things), (b) the life science revolution (from personalized medicine and gene therapy to analyzing the human, corn, soybean, and bovine or porcine genome to genetically modified food), and (c) globalization—the free flow of money, raw materials, goods, labor and capital.

Humans are increasingly looking to advanced technology to address the "grand challenges" of our times. In order to provide safe drinking water, access to medicine, adequate health care, universal education, eradication of poverty, climate change mitigation and adaptation, and so on, we are relying on the capabilities of the technology revolutions noted above.

Yet, all this technological development has brought about social problems and exacerbated some others. Currently, American society is experiencing a general upheaval that is the result of economic uneasiness, cultural anxieties, and dissatisfaction with political processes. Part of the

economic uneasiness is a result of globalization, automation, and increased efficiencies brought about by information technology. The ability to vividly perceive events and circumstances through rapid communications, social media, and personal digital devices has served to increase cultural anxieties, create entrenched constituencies, and precipitate political gridlock.

In order to meaningfully address these overarching social issues, we must develop public policies and craft legislation that understand the changes brought about by technology and, at the same time, harness solutions to these problems through the careful deployment and use of technology.

Such an approach requires the next generation of lawyers to understand and embrace science and technology to solve problems in all areas of legal practice.

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

Pierre Larouche[*]

How do lawyers think differently from STEM professionals when approaching problems and risk?

It is difficult to make statements that would be true of all lawyers or all STEM professionals, respectively. Not only do individual members of these two groups differ in character, but within each of these two groups, there is a range of functions, each of which might warrant a different approach to problems and risk. For lawyers, the roles of outside counsel and in-house lawyers are distinguishable, for example. This distinction can probably be made with even greater clarity in Europe, where in-house lawyers do not have to be members of the bar. Practicing lawyers, as a matter of professional culture or as a consequence of professional liability, tend to approach problems in a more linear fashion and risks more defensively. Problems call for solutions, but attention is not often given to how these solutions can lead to additional problems elsewhere. Legal practitioners also tend to be risk-averse, often taking a defensive stance in their advice, whereby legal risks are identified and clients are advised to avoid or minimize them. In comparison, in-house lawyers (certainly in Europe) have the freedom to espouse more closely the holistic approach to problems and the more risk-neutral stance that is generally associated with STEM professionals. In that sense, in-house lawyers show that the gulf between lawyers and STEM professionals might not be so large, and might depend more on professional functions and culture than on a deep disciplinary gulf.

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

I can see a number of possibilities here.

As a starting point, it is important to create the right environment for inter-disciplinary dialogue, whether in academia or in business; this begins with education and training, so as to overcome prejudices and create appetite for collaboration.

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Fostering education and training in both fields can certainly contribute to increasing collaboration: academics and professionals who have obtained degrees in both fields usually have personal experience of the ins-and-outs of each field, and they should have a personal incentive (hopefully) to foster collaboration between the two fields. However, in the current circumstances, there will only be so many individuals with dual training.

Less intensive education programs might be practicable for a broader range of individuals and therefore deliver significantly more value. In my view, the operational threshold here is to enable graduates from these programs to join multi-disciplinary teams and interact with colleagues from other disciplines. In order to reach that threshold, the crucial element in the education program is to bring students to the point where they know enough of the other field to realize that it is not monolithic, i.e. that law and STEM fields do not deliver easy, ready-made and unequivocal answers to any questions. Once students realize that the other discipline is just as lively as their own, they will usually also see that the other discipline does not pre-empt discussions in their own discipline, but rather enriches them with additional elements. For instance, privacy and security are not obvious issues either in law or in information and communications technology (ICT): once that realization dawns upon the lawyer or the ICT scientist, then they should be able to see how inter-disciplinary dialogue helps them enrich their respective fields. The type of program that would bring graduates to that level of knowledge of the other field is less intensive than a true multi-disciplinary program: typically, this can be achieved through a one-year master's degree.

Aside from education programs, further incentives could arise from more limited measures. In academia, a critical mass of conferences and periodicals at the law–STEM intersection would give academics the confidence that their efforts have an audience. In business, putting lawyers and STEM graduates in closer contact would probably give them more incentive to work together. At this juncture, lawyers often intervene outside of STEM-centered processes: they come in later and are given a critical role (certainly for outside lawyers, and even for in-house lawyers). 'Embedding' lawyers into STEM-centered teams would provide better conditions for constructive collaboration.

Technological change recently has altered business models in the legal field, and these changes will continue to affect the practice of law itself. How can we, as educators, prepare law students to meet the challenges of new technology throughout their careers?

Not all law students are the same: some have a STEM background and will accordingly be ahead of the curve, in that they will already be able to form their own view as to what technological advances mean to them and their career prospects. Leaving these students aside, the rest of the law student population is typically at most as technologically-savvy as their age group across the university, if not less.

In response to the question, I would argue that legal education should expand its scope to cover two additional issues (in addition to any training in technology that one might want to provide to students, as is done by Paul Ohm at Georgetown Law and others).

The first issue is the strategy and organization of the provision of legal services. Traditional business models are changing, but it is less clear that legal services are changing as well. It would be interesting to put together a course that surveys the different business models, in existence or in development, regarding legal services (big law, boutique firms, in-house centralized, in-house decentralized, sub-contracting and outsourcing, networks, etc.), so that students are aware of the range of possibilities. In addition, that course should also examine comparable industries that have been changed or upended by technology, such as media, pharma/biotech, healthcare, etc. Here as well, there is a wealth of information out there.

I would call the second issue "interdisciplinary epistemology," and it would cover the interplay between disciplines, seen from the perspective of law (and in particular from the generation of knowledge in law, hence the title). On one hand, it is important to properly frame the law–STEM relationship. Short of the technological singularity that some ICT scientists dream about, the governance of human affairs will continue to be central, and thus law should retain its 'gatekeeper' function. Technological developments have to be translated into the law. On the other hand, there is more to law than rules, which are too often the focus of legal education. The wonderful thing about technological developments is that, by putting rules into question, they force lawyers to go back to underlying policies and principles. Once lawyers figure that policies and principles are much more impervious to technological change and are actually flexible enough to be re-implemented in a changed technological environment, then they should be less worried about the impact of technological change.

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

Daryl Lim[*]

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

Collaboration between law–STEM experts can be fostered through facilitating intellectual property (IP) commercialization, enabling regulatory "sandboxes," and promoting local and international partnerships.

1. Facilitate IP Commercialization at Institutes of Higher Learning (IHLs)

Bringing ideas from IHLs to the marketplace provides a natural platform for law–STEM experts to collaborate. Several factors can help facilitate IP commercialization. First, law–STEM experts can draft joint model IP protocols to provide clarity and consistency in commercializing IP. These also help to simplify and shorten negotiations between IHLs and industry partners. Second, patent monetization entities (PMEs), working with law–STEM experts, can help value IP, strategize, market, and license or assign IP rights. PMEs can also help IHLs to bundle and translate innovation into commercial value. Third, experienced and successful law–STEM partners can groom and inspire future generations through a mentorship system. This is important in strengthening a sense of community among budding collaborators.

2. Invest in Regulatory "Sandboxes"

Regulatory "sandboxes" are particularly important in facilitating the growth of new sectors created by disruptive technologies, as the boundaries between regulated and unregulated areas can become blurred. These "sandboxes" are "safe spaces" where law–STEM collaborations can experiment with innovative products, services, and business models without being concerned about infringing legal or institutional restrictions. These "sandboxes" thus allow a "test and learn" approach that mitigates risks while keeping the collaborative environment conductive to innovation. "Sandbox"-specific regulations may be time-limited so new regulations can

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be devised that incorporate appropriate parameters while giving –STEM collaborations nimbleness and freedom to operate.

3. Promote Local and International Partnerships

IHLs can partner with local legal and STEM experts to teach and perform applied research on a full-time or part-time basis. These experts can work with industry partners and government agencies in planning projects and proposing technological solutions. Additionally, international connections expand the pool of opportunities to spark new nodes of law–STEM collaboration. Working across geographical and cultural boundaries also fosters the open mindset necessary for law–STEM collaborations to succeed. These connections can link local law–STEM nodes with overseas partners and key markets. Local law firms and tech companies may set up innovation launchpads with IHLs to access foreign opportunities and ideas. Similarly, IHLs can also serve as welcome centers for foreign law–STEM experts and enterprises seeking out partners in the United States.

Technological change recently has altered business models in the legal field, and these changes will continue to affect the practice of law itself. How can we, as educators, prepare law students to meet the challenges of new technology throughout their careers?

1. At School

Acquiring technological skills is an individually driven endeavor. Educators can prepare law students to be future-ready by inculcating an openness to acquire multidisciplinary skills throughout their lives. Educators can impress on their students the need to acquire new skills to remain relevant and to continue creating value for employers. Through internships, students can be exposed to the technological demands of the legal field. Internships at STEM-centric companies also expose students to opportunities available to attorneys who invest in new skills and knowledge. Educators can also invite partners in government, corporations, and private practice to play an active role in student admission and curriculum design. For example, these partners can sit on admissions committees and/or interviews. These partners can also provide substantive input into the courses taught to make sure that the content of what is taught is in sync with workplace demands.

2. Back to School

Educators can offer industry-endorsed modularized training that enables lawyers to return and retrain. Programs can be conducted remotely via video and over handheld devices so lawyers can retrain on their own time. One-step education, training, and career guidance portals can also help to

coordinate training efforts across institutions. At the same time, educators should also collaborate with employers so that employees who invest in reskilling themselves are professionally recognized and rewarded. It is crucial that employers take ownership in skill utilization, and that they reward attorneys who reskill in emerging practice areas, since the workplace is ultimately what gives relevance to the employees' efforts. This supportive milieu will in turn help set in motion a virtuous cycle where successful employees inspire their colleagues to invest in reskilling themselves.

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

Ivory Mills[*]

How do lawyers think differently from STEM professionals when approaching problems and risk?

STEM professionals and lawyers approach problems and risks in dramatically different ways. By trade, scientists are curious. They explore and dig into the unknown for the sake of knowledge, understanding, and the advancement of human progress. More often than not, their explorations involve a variety of risks—professional, methodological, operational, and perhaps even physical. For example, Professor Keith Yamamoto of the University of California San Francisco's School of Medicine argues that the willingness to take risks is the trait that separates the best scientists because it helps to solve problems and discover new techniques and phenomena.[1] Often, such risks require going against the norms or institutions of their field, creating potential threats to professional socialization, while also offering the greatest rewards. STEM professionals also take risks operationally and physically, exploring dangerous and unknown substances, locales, and practices. From risking their lives facing unpredictable natural disasters, utilizing toxic chemicals, and even engineering hazardous weaponry, STEM professionals embrace risk to solve challenging problems and to contribute to a critical and growing body of knowledge.

In contrast, lawyers approach problems and risks from a less exploratory perspective, and instead work to limit and mitigate. Traditionally, lawyers were tasked with advising clients and helping them understand the law. Over time, this role has evolved to include risk management ranging from operational, reputational, financial, and regulatory issues. While scientists and other STEM professionals work to develop novel approaches to problems by taking risks, their legal counterparts work to make sure that there is minimal harm, few threats, and manageable risks. While these risk-taking and risk-management roles can be

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[1] iBioMagazine, *Keith Yamamoto (UCSF): Taking Risks*, YOUTUBE (Sept. 20, 2010), https://www.youtube.com/watch?v=7hUMlPFlFUg [https://perma.cc/VJ3U-2YT2]

complementary to each other when solving some problems, risk management can interfere or limit the potential of risk-taking in science.

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

Globalization and increased interconnectivity in the modern world have demonstrated the need for, and benefit of, collaboration between law and STEM fields. Society currently faces a variety of social, financial, legal, and scientific challenges that have been coined wicked problems.[2] These problems are public and/or social problems with numerous participants and stakeholders that are unstructured, cross-cutting, and relentless. Examples include the environment and climate, energy, and health. To address these problems, STEM professionals, lawyers, policymakers, and the private sector have collaborated and improved outcomes. To foster further collaboration across these fields, it is important to provide regulatory, financial, and institutional incentives.

Over the last fifteen years, many countries have made efforts to incentivize collaboration between STEM, business, and legal fields. In the U.S. for example, Congress passed the Cooperative Research and Technology Enhancement Act in 2004. This legislation provided enhanced intellectual property protection to joint ventures, incentivizing collaboration and supporting cross-sector innovation between STEM and business. Such regulation also encourages cooperation with the legal fields because lawyers, legal scholars, and law students support the resulting innovations as they seek intellectual property protection.

Financial incentives are also critical to incentivizing collaboration between law, STEM, and business, particularly for scholars and entrepreneurs. Grants and other pecuniary measures supporting collaboration will increase partnerships and information exchange. Finally, it is important that universities and the scholarly community encourage interdisciplinary collaboration. Often, scholars are limited in their collaborative ventures because of the journals where the materials will be published are not recognized in their field. Increasing exposure and exchange across disciplines will expand publication opportunities and incentivize collaboration.

[2] *See* Anne M. Khademian & Edward P. Weber, *Wicked Problems, Knowledge Challenges, and Collaborative Capacity Builders in Network Settings* 68 PUB. ADMIN. REV. 334, 336 (2008) ("Wicked problems, in other words, cut across hierarchy and authority structures within and between organizations and across policy domains, political and administrative jurisdictions, and political 'group' interests.").

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

Pilar Ossorio[*]

How do views on rewards and burdens differ between the law and STEM fields in academia?

In STEM fields, tenure decisions are very heavily weighted towards research output, such as published articles describing the research done in one's laboratory or by one's research group. Academic advancement and status derive almost entirely from research accomplishments, and there is much less emphasis on teaching than in legal academia. In the biomedical sciences, many faculty rarely or never teach an entire course. Instead, they give a few lectures each semester in courses run by a course organizer. Mentoring of graduate students who work in the biomedical scientist's laboratory or research group often counts as part of their teaching obligation, as does mentoring of graduate students on whose thesis committees the academic scientist sits. Legal academics with expertise relevant to scientific research can be invited to sit on thesis committees, and I have found that doing so is educational and promotes collaborations.

Publishing in the STEM fields varies from one discipline or subfield to another, but is quite different from publishing in legal academia. In the biomedical sciences, only articles published in peer-reviewed literature count towards tenure; the biomedical sciences have nothing like student-run, non-peer-reviewed law journals. Furthermore, multi-authored articles are the norm. It is not unusual to find articles with fifteen or twenty authors and some with over one hundred authors. In such a context, what matters most is being the first author or the last author ("senior author"). First authors are often the more junior people who do most of the hands-on work. On a very large project, the first author is often the person who drafted the paper. A faculty member who runs an academic biomedical laboratory is almost never the first author of a scientific article, but to get tenure she or he should be the last author of numerous articles.

In addition, biomedical scientists are evaluated based on how many federal grants they have been awarded, by how much money they bring in to an institution and their research program, and by whether they have

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maintained continuous external grant funding throughout their career. Promotions to tenure, to full professor, and to administrative positions such as department chairs and deanships are strongly influenced by the amount of federal grant funding a scientist has obtained. Many academic bioscientists are not guaranteed their full salary by the university or medical school; they have to earn at least some portion of their salary by obtaining grants in a very competitive process. Running an academic laboratory is like running a small business, because one must obtain and maintain funding to support one's graduate students, post-doctoral fellows, laboratory assistants, and staff scientists. They, in turn, do the hands-on research that yields the new scientific knowledge published in peer-reviewed articles that helps the faculty member to secure the next round of grant funding. While legal academics are preparing to teach their courses, academic scientists are writing grant proposals. For good reasons, academic scientists generally will not want to participate in an interdisciplinary collaboration that will not lead to peer-reviewed journal articles and new grant funding. This is particularly true for untenured biomedical faculty.

Finally, legal academics should not treat STEM fields as a monolithic "other." Academics (and practitioners) in the various STEM fields do not all experience the same institutional incentive structures or professional cultures. The acronym STEM encompasses biomedical sciences, engineering, mathematics, statistics, chemistry, computer science, physics, and other disciplines. Among these diverse disciplines one finds differences in publishing cultures, interactions with the private sector, sources of government funding, and many other factors. For instance, when hiring faculty computer science departments compete with non-academic employers very differently than do bioscience departments. When legal academics want to establish collaborations with individuals in STEM fields, we need to understand the specifics of the professional cultures and institutional contexts in which our prospective collaborators operate.

How do lawyers think differently from STEM professionals when approaching problems and risk?

As somebody who trained in the biomedical sciences before entering the legal profession, I think there are more similarities than differences in our styles of thought. Many people who have not worked in science imagine that science is about "facts," but the day-to-day work of science is about data. Research produces data, humans (and sometimes algorithms) interpret that data to produce information and knowledge. Good scientists know that their interpretations, or interpretations done by algorithms, can always be incorrect or incomplete. As a result, they always have to be looking at the

data and wondering whether the story they are telling themselves about those data is the best or most correct story. They have to imagine more than one story that could be told about the same data, and then devise experiments that will differentiate among the possible stories. This skill is quite similar to the skills lawyers use when analyzing fact patterns or arguing cases.

I think success in almost any academic field, whether in law or a STEM discipline, requires a degree of creativity. Many (but not all) STEM academics express their creativity in designing experiments, while legal academics express their creativity by devising new theories or by providing new ways of understanding existing legal paradigms. In both cases, however, creativity can involve bringing new types of knowledge or new technologies to bear on an "old" problem, or thinking orthogonally to the received wisdom.

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

Laura Pedraza-Fariña[*]

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

An important concern for intellectual property law scholars is understanding how innovation incentives, and patents in particular, impact research carried out in academic and industry laboratories. Despite the importance of analyzing the impact of patents on basic and applied research, interviews with basic and applied research scientists at universities suggest that the research concerns of patent law scholars are removed from the concerns of many scientists.

[1] Patent law theory traditionally views patents as incentives to invest in risky projects or as incentives to move research from the bench to the marketplace. But interviews with research scientists reveal that research scientists tend to value patents not for their incentive or translational functions, but rather for their attributional functions.[2] The weak incentive effect of patents on innovation at universities is in many ways unsurprising—other incentive systems, including grants, reputational incentives, and background social norms, play more prominent roles. But the richness of this innovation ecosystem also suggests that legal scholars should broaden their focus beyond patent law to also include how social norms, grant-making institutions, and university intellectual infrastructures interact with each other to foster or impede innovation. Two trends in current legal scholarship are moving in this direction. The first trend is apparent in the growth of studies that complement traditional economic analyses of innovation with sociological and psychological analyses. Taken together with economic analyses, these studies can better identify the complex set of barriers and

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[1] *See, e.g.*, Laura G. Pedraza-Fariña, *Constructing Interdisciplinary Collaboration: The Oncofertility Consortium as a Constructed Knowledge Commons, in* GOVERNING MEDICAL KNOWLEDGE COMMONS (Katherine Strandburg, Brett Frischmann & Michael Madison eds., 2017); JESSICA SILBEY, THE EUREKA MYTH: CREATORS, INNOVATORS AND EVERYDAY INTELLECTUAL PROPERTY (2016); Brian J. Love, *Do University Patents Pay Off? Evidence from a Survey of University Inventors in Computer Science and Electrical Engineering*, 16 YALE J.L. & TECH. 285 (2014).

[2] *Id.*

inducements to innovation.[3] The second trend is apparent in the development of what may be called "innovation law" that broadens scholarly pursuits beyond intellectual property law. Scholarly articles in this new field contribute to a better understanding of the effect of legal and policy interventions on science-based innovation by including the study of social norms, prizes, tax and grant policies, administrative agencies such as the Food and Drug Administration and the National Institutes of Health, and the interactions among all of these policy levers, as part of a broader innovation ecosystem.[4]

Provide an example of a situation in which a Law–STEM collaboration aided a project or where the lack of collaboration between these two disciplines impeded a project.

Much of the knowledge and skills necessary to address pressing, complex technological problems are often divided in different scientific or technological communities that have few or no ties with each other. The social costs of this division are very large: many innovations considered "breakthroughs" in a given field (those that overturn existing paradigms or open new lines of research) emerge from the work of teams that combine divergent perspectives from multiple communities.[5] A poignant example concerns research into the effects of cancer treatment on fertility. As cancer treatments become more sophisticated and effective, the number of cancer survivors—and childhood cancer survivors in particular—has increased worldwide. But until recently, research on the impact of cancer therapeutics on male and female fertility, as well as research on fertility preservation

[3] *See, e.g.*, Stephanie P. Bair, *The Psychology of Patent Protection,* 48 CONN. L. REV. 297 (2015); Jeanne Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745 (2012); Jeanne Fromer, *A Psychology of Intellectual Property,* 104 NW. U. L. REV. 1441 (2010); Eric E. Johnson, *Intellectual Property and the Incentive Fallacy*, 39 FLA. ST. U. L. REV. 623 (2012); Gregory N. Mandel, *To Promote the Creative Process: Intellectual Property Law and the Psychology of Creativity*, 86 NOTRE DAME L. REV. 1999 (2011); Laura Pedraza-Fariña, *Patent Law and the Sociology of Innovation*, 2013 WIS. L. REV. 813 (2013); Laura G. Pedraza-Fariña, *The Social Origins of Innovation Failures*, 70 SMU L. REV. 377 (2017); R. Keith Sawyer, *The Western Cultural Model of Creativity: Its Influence on Intellectual Property Law*, 86 NOTRE DAME L. REV. 2027 (2011).

[4] *See, e.g.*, Dan L. Burk, *On the Sociology of Patenting,* 101 MINN. L. REV. 421 (2016); Julie Cohen, *Property as Institutions for Resources: Lessons from and for IP*, 94 TEX. L. REV. 1 (2015); Rebecca S. Eisenberg & W. Nicholson Price II, *Promoting Healthcare Innovation on the Demand Side*, 4 J.L. AND BIOSCIENCES 3 (2017); Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEX. L. REV. 303 (2013); William Hubbard, *Inventing Norms*, 44 CONN. L. REV. 369 (2011); Michael J. Madison, Brett Frischmann & Katherine J. Strandburg, *Constructing Commons in the Cultural Environment* 95 CORNELL L. REV. 657 (2010).

[5] *See, e.g.*, Laura G. Pedraza-Fariña, *Patent Law and the Sociology of Innovation*, 2013 WIS. L. REV. 813 (2013); Laura G. Pedraza-Fariña, *The Social Origins of Innovation Failures*, 70 SMU L. REV. 377 (2017).

techniques for females, lagged severely behind the advances in treatment. This was the case despite studies showing that cancer patients ranked fears of losing their fertility second only to those of facing death. One fundamental reason for this disconnect between the needs of cancer patients and the priorities of research and treatment was the lack of communication and collaboration between oncologists and reproductive endocrinologists. The goal of oncologists was to understand, treat, and, when possible, cure cancer. The goal of endocrinologists was to address infertility. And their paths seldom crossed.[6]

In this particular case, a specific policy intervention bridged the gap between these two communities: the Roadmap Interdisciplinary Research Consortia Grant through the National Institutes of Health. Roadmap Grants were designed to address the puzzle of complex diseases that defy solution by any one scientific community. The Roadmap Grant enabled the creation of the Oncofertility Consortium—through which communities of endocrinologists and oncologists began collaborating with each other and with communities of engineers and cryobiologists. As a result of this collaboration, researchers developed a new bioengineered matrix to grow eggs outside the body[7] and a new technique to test the effects of cancer drugs on fertility.[8] Importantly, researchers continued collaborating long after grant funding expired. In other words, the Roadmap Grant acted as a catalyst to collaboration—providing short-term, seed funding and infrastructure support that enabled cross-disciplinary connections.

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[6] For a fuller description of the problem of oncofertility and the emergence of the Oncofertility Consortium, *see* Laura G. Pedraza-Fariña, *Constructing Interdisciplinary Collaboration: The Oncofertility Consortium as a Constructed Knowledge Commons*, *in* GOVERNING MEDICAL KNOWLEDGE COMMONS (Katherine Strandburg, Brett Frischmann & Michael Madison eds., 2017).

[7] *See, e.g.*, Xu M, Teresa K. Woodruff & Lonnie D. Shea, *Bioengineering and the Ovarian Follicle*, *in* ONCOFERTILITY: FERTILITY PRESERVATION FOR CANCER SURVIVORS 75 (T.K. Woodruff & K.A. Snyder eds., 2007); Erin R. West et al., *Physical Properties of Alginate Hydrogels and Their Effects on In Vitro Follicle Development*, 28 BIOMATERIALS 4439 (2007); Ming Xu et al., *Tissue-Engineered Follicles Produce Live, Fertile Offspring*, 12 TISSUE ENGINEERING 2739 (2006).

[8] Richard W. Ahn et al., *Nano-Encapsulation of Arsenic Trioxide Enhances Efficacy Against Murine Lymphoma Model While Minimizing Its Impact on Ovarian Reserve In Vitro and In Vivo*, PLOS ONE, March 20, 2013 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0058491 [https://perma.cc/Z3R6-TG79].

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

Jacob S. Sherkow[*]

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

There are already significant incentives for collaboration between law and STEM: commercializing technologies, creating architectures for data-sharing, and funding for interdisciplinary research, for example.

[1] The problem is getting legal and STEM academics to think seriously about these virtues at the beginning of their work rather than as an afterthought. In particular, and despite the hype surrounding patent disputes like CRISPR, many scientists do not think about the intellectual property issues surrounding their work until late in the research process.[2] For some, encouraging scientists to think about these issues in the course of their work has the potential to taint the "purity" of scientific research, however defined.[3] But even if one views the legal incentives to conduct STEM research negatively, it's important to think about how to manage such incentives, even if the decision is made to forgo such rights or give them away.[4]

Perhaps the best way to foster law–STEM collaborations is to simply create spaces for such work. Many scientific journals, for example, have been excellent at publishing legal academics' work on the intersection between law and science.[5] But there appears to be little of the reverse: law

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[1] *See, e.g.*, Jacob S. Sherkow, *Cancer's IP*, 96 N.C. L. REV. (forthcoming 2018), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2928241 [https://perma.cc/GXA3-6WB5] (discussing these virtues in the context of cancer research).

[2] Sharon Begley, *Broad Institute Prevails in Heated Dispute over CRISPR Patents*, STAT NEWS (Feb. 15, 2017), https://www.statnews.com/2017/02/15/crispr-patent-ruling/ [https://perma.cc/5DCT-KJQ5] (describing the disconnect between patent law and "how much of the science world has viewed [the scientists'] work").

[3] Michael Eisen *Patents are Destroying the Soul of Academic Science*, IT IS NOT JUNK (Feb. 20, 2017), http://www.michaeleisen.org/blog/?p=1981 [https://perma.cc/UUY5-MQV7].

[4] *See* Brian Owens, *Montreal Institute Going "Open" to Accelerate Science*, SCIENCE (Jan. 21, 2016), http://www.sciencemag.org/news/2016/01/montreal-institute-going-open-accel-erate-science [https://perma.cc/45FK-A7V5].

[5] *See, e.g.*, Eli Y. Adashi & I. Glenn Cohen, *Going Germline: Mitochondrial Replacement as a Guide to Genome Editing*, 164 CELL 832 (2016); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter*

reviews, and the format of traditional law review articles, are less than conducive to housing the work of scientists.[6] Hosting conferences and symposium aimed at bringing together legal academics and STEM researchers—like Northwestern's recent Bridges II conference—are superlative attempts to encourage true interdisciplinary work between the two fields. These are good starts. But to truly encourage a cross-pollination of fields, such spaces need to be established with more regularity and directed more consistently. In practical terms, such events could be used to create clearinghouses for a variety of problems in the legal architecture of scientific research. Deceptively simple questions—like how to build and license a data pool—are resolved on almost exclusively ad hoc basis.[7] While such experimentation has been wonderful at producing a diversity of models, without further sustained collaboration between law and STEM, they remain daunting for an average scientist to implement.

Provide an example of a situation in which a Law-STEM collaboration aided a project or where the lack of collaboration between these two disciplines impeded a project.

Two biological repositories, AddGene and Hetionet, provide contrasting examples of how law–STEM collaborations—or the lack thereof—have contributed to STEM projects' success or failure. AddGene, for one, is a sterling example of collaboration and innovation between legal and scientific fields.[8] The organization is a not-for-profit repository of biological materials "dedicated to making it easier for scientists to share."[9] In particular, AddGene houses "a high-quality library of published [DNA modules] for use in research and discovery," allowing scientists to contribute their constructs to and borrow constructs from AddGene under a standard, nonnegotiable license: the Uniform Biological Material Transfer Agreement

Innovation? The Anticommons in Biomedical Research, 280 SCIENCE 698 (1998); Jacob S. Sherkow, *Pursuit of Profit Poisons Collaboration*, 532 NATURE 172 (2016).

[6] One notable exception to this dearth of collaborative opportunities is a recent UCLA Law Review PULSE symposium on the future of various scientific and technological developments. *See PULSE Symposium 2016*, UCLA L. REV. http://www.uclalawreview.org/pulse-symposium-2016/ [https://perma.cc/LWX7-25C7] (last visited Jun. 4, 2017). That symposium featured, among other contributions, a fascinating piece—with Bluebooked footnotes—by Christopher Kelty, a professor at UCLA's Institute for Society and Genetics, and not an attorney. *See* Christopher Kelty, *Two Fables*, 64 UCLA L. REV. DISC. 488 (2016).

[7] *See, e.g.*, Simon Oxenham, *Legal Maze Threatens to Slow Data Science*, 536 NATURE, Aug. 3, 2016, at 16 (describing the development of Hetionet, a metadatabase of gene-drug interactions).

[8] ADDGENE, https://www.addgene.org [https://perma.cc/65YU-KX8G] (last visited Jun. 4, 2017).

[9] *About AddGene*, ADDGENE, https://www.addgene.org/mission/ [https://perma.cc/QUG4-MVW7] (last visited Jun. 4, 2017).

(UBMTA).[10] Scientists at participating institutions who wish to deposit a construct with AddGene, or borrow one from the service, simply sign and go. For scientific researchers—and for their parent institutions—this process has numerous advantages: it allows researchers to outsource the day-to-day tasks of sharing to AddGene; it cuts license negotiating time down to zero by using a universal, take-it-or-leave-it agreement; it provides a central clearing house to track the results of borrowing—itself a separate, potential object of study; and it frees researcher time by vouching for samples' quality, purity, and identity. But for all of these goods, it bears repeating that the heart of AddGene is collaborative, legal innovation: the standard, non-negotiable UBMTA. This boilerplate, legal document—created as joint enterprise of industry and both legal and STEM academia in 1995[11]—is what allows AddGene to operate with fluidity. Deploying it in connection with an independent biological repository is one of the greater triumphs of collaboration between law and science.

By contrast, Hetionet, is a sad example of one of its failures. Hetionet survives as a meta-database: a database comprised of other data sources on the effect of drugs on certain illnesses and genetic conditions.[12] As originally reported in *Nature* in 2016, Hetionet's founder, data-scientist Daniel Himmelstein, attempted to create Hetionet by aggregating data from larger, independent databases.[13] Such an effort would have made data-mining for connections between drugs and disease substantially more powerful. But Hetionet's largest problems were not technical but legal: Himmelstein had difficulty getting licenses from each of the smaller databases to use in his larger service. Indeed, some potentially important and significant databases were not ultimately included in Hetionet simply because of vagaries of the licensing process. To date, Hetionet remains hampered by these licensing issues.[14] Some recent programs—like the Cancer Moonshot—are aimed at addressing precisely these types of issues for future projects.[15] But without direct collaboration among scientists and legal academics, success will ultimately remain difficult.

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[10] *Technology Transfer Information*, ADDGENE, https://www.addgene.org/techtransfer/ [https://perma.cc/AW29-FF32] (last visited Jun. 4, 2017).

[11] *See* Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 113 (1999) (discussing the history of the UBMTA).

[12] *Hetnets in Biomedicine*, HET.IO, http://het.io [https://perma.cc/4S6L-VJTS].

[13] Oxenham, *supra* note 7, at 16.

[14] *Id.*

[15] Sherkow, *supra*, note 1, (manuscript at 20–21) (discussing the Moonshot's data-sharing goal).

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

Jessica Silbey[*]

How do lawyers think differently from STEM professionals when approaching problems and risk?

Although I hesitate to generalize, historically the training of lawyers and STEM professionals aimed to cultivate different kinds of thinking about the domains of their expertise, and thus the scope of problems those professionals are capable of solving. Lawyers are trained to teach themselves new areas of law by reading statutes, regulations, and cases. Because of our broader understanding of the institutions that adjudicate legal disputes, such as arbitrations, mediations, courts, administrative agencies, we feel comfortable predicting the application of the law by other lawyers and the way a legal dispute will proceed through resolution. We are comfortable as generalists within the law, to an extent, and are trained to be quick, competent studies when we encounter something new. We also encounter many industries, actors, and organizations within a general practice of business consulting or dispute resolution, and thus have the experience of wide and detailed exposure to these essential elements of society. Yet whether that experience translates into particularly useful knowledge beyond law is a contested question among our clients, I think.

STEM professionals circumscribe their expertise more narrowly, I believe. They are trained within disciplines that respect boundaries and defer to (or defend) those boundaries as meaningfully separating roles and functions within, for example, science and engineering. Interdisciplinarity within science and engineering may be embraced through collaborations by adding parts to each other brick by brick, but laboratories and experiments that seek to answer questions or test propositions tend to rely on constrained and unitary disciplinary methods. Facts or knowledge produced in science and engineering may be perceived as less constrained by social factors (although I think that is a misperception), and they are perceived to be more durable because by definition in science and engineering facts or scientific knowledge are reproducible, predictable, and objective. There is less inclination for cross-disciplinary knowledge production, I believe, because

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of the contingencies involved in mixing disciplinary approaches. Disappointment persists with the famed legal analysis "it depends," because the lack of a predictable answer flies in the face of what science and engineering strive to accomplish.

Scientists and engineers may be as careful as lawyers in the claims they make about the part of the world they are asked to describe with accuracy, the former through experimentation and reproducibility in observable phenomena and the latter through precedent-based reasoning in socio-legal contexts. But knowledge produced in the different domains remains far apart in purpose and application. I don't believe that needs to be the case, but it is the perception I have when wrestling with the conflicts between lawyers and STEM professionals.

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings? Non-lawyers too often experience law as mysterious because of its perception as an elite and inaccessible language and space. Translating legal understanding into everyday language as a regular course of business would go a long way to break down the barriers between lawyers and their clients. Law should be understandable to those it governs. Lawyers should strive to be better translators and communicators.

Doing so will also facilitate more frequent and productive conversations early in the business process, before problems arise and in time to avert them. Just as we are encouraged to check with doctors before problems get too big, clients should be encouraged to work with lawyers from the ground up. This has the added benefit of teaching the lawyer more of the client's business, making them better advisors. It also requires a different business model for lawyers, a retainer or co-pay system rather than an hourly fee that disincentivizes regular check-ups.

In academic settings, I regularly run into unnecessary and artificial hurdles for cross-listing courses and teaching with STEM scholars. A law school course is considered too specific and specialized for STEM students to take, while law schools won't count the STEM courses for law credit. This doesn't have to be the case. It makes no sense if we think law is— and should be—accessible and understandable to more people who aren't necessarily lawyers. Lawyers seeking to be excellent and ethical in their advising of all sorts of clients should learn about those businesses and organizations before they practice. Law schools should encourage that kind of cross-disciplinary training—but too often, they don't.

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

D. Daniel Sokol[*]

DO WE NEED A NEW SYNTHESIS OF LAW AND STEM? LAW AND STEM COLLABORATION IN ENTREPRENEURSHIP

Law and STEM play important and complementary roles in bringing a business to market. Generally speaking, entrepreneurship involves new products or services or new ways of organizing businesses. A key feature of these entrepreneurial opportunities is their *novelty*. In the STEM context, entrepreneurial opportunities focus on high growth business opportunities that are technologically driven. What makes law and STEM collaboration unique in the area of entrepreneurship is that there is novel business activity that carries substantial sustained risk from the transition from firm founding to ultimate liquidity event, often in the form of IPO or acquisition by a larger company.

Understanding law is relevant for STEM professionals because law shapes business opportunities. Focusing on law as it relates to entrepreneurship can mean various things, but the basic idea of how law and entrepreneurship can shape STEM is to find either (1) a unique set of legal rules or legal practices in the entrepreneurial context (such as VC contracting in which the valuation of the start-up may be highly dependent on the technology and the IP rights), or (2) the unique interaction of more generally applicable legal rules in an entrepreneurial context (such as non-compete agreements

[1] or contracting[2]).

STEM professionals who are entrepreneurs have special skills in the areas of opportunity, discovery, and creation—the process of innovation. Law can be used to promote entrepreneurial activity and STEM professionals

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[1] Ronald J. Gilson, *The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete*, 74 N.Y.U. L. REV. 575 (1999).

[2] Steven N. Kaplan & Per Strömberg, Financial *Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts*, 70 REV. ECON. STUD. 281 (2003); Jesse M. Fried & Mira Ganor, *Agency Costs of Venture Capitalist Control in Startups*, 81 N.Y.U. L. REV. 967 (2006); D. Daniel Sokol, *Biotech Strategic Alliances in Law and Entrepreneurship*, *in* THE HANDBOOK OF LAW AND ENTREPRENEURSHIP IN THE UNITED STATES (D. Gordon Smith & Christine Hurt, eds. *forthcoming* 2018).

should use law to their competitive advantage. This may include legislation to provide for direct or indirect preferences in taxation or regulation for entrepreneurial activity, zoning that allows for clustering of entrepreneurial activity, well-defined property rights for intellectual property, a well-functioning judicial system, reductions in the cost of setting up a business, legal transparency, and reduction of the prevalence of corruption in the legal and regulatory systems.

Lawyers can do a better job of teaching legal awareness to STEM-based entrepreneurs as a way to better identify legal risk and shape entrepreneurial opportunities. STEM professionals can likewise do a better job in explaining the technology and business to the lawyers to help craft appropriate legal strategies and regulatory policies.

REWARDS AND BURDENS IN LAW AND STEM IN ACADEMIA

Incentives matter in academia. Fifty years ago, power at research universities often resided in law schools. Law schools made significant money and university-sponsored entrepreneurship mattered less to the bottom line of a university. Often, university presidents and many members of university boards of regents were trained as lawyers. This is no longer quite as true at major research universities.

Law schools also suffer in terms of university revenue generation. Law schools, with a small cohort of students, do not bring in significant tuition revenue. Their small class size combined with highly paid faculty and nearly no research grants make law schools underperformers from a financial perspective in many universities where the drivers of research dollars and the commercialization of university technology fall largely within STEM fields. As in any complex organization, there is competition for resources at universities. In the context of research universities, law schools jeopardize their relative standing at such universities unless they adapt to show that they add "value".

Law schools can make an impact by redefining the market of students that they serve. They should expand their education to non-lawyers and in particular to STEM undergraduate and graduate students. This approach can be summarized simply as teaching classes *outside* of the law school (or law school classes geared toward non-law school students).

If we set expanding the number of consumers of law school as the goal, we need to understand that law schools must sell a differentiated product to non-law school students. This requires an investment of time and resources. For law school administrators looking to create such a program, it requires not only new classes but a reconceptualization of existing class topics. This includes creating classes where law matters without a focus on teaching

traditional cases. The traditional model of law versus business versus STEM is as follows: engineering schools teach how to get from point A to point B to point C. Business school teaches how to monetize point C, while law schools discuss the precedent dealing with point C. Law school courses for non-lawyers need to encompass all three elements, but teaching with the traditional case method is not always the best way to integrate all of these issues.

How to teach is only one limitation for a traditional law school that wants to engage effectively with a much larger student population than law school students. There is at present an insufficient cohort of law professors who can teach such courses. STEM students and professionals need to understand how law regulates technology and how law shapes business opportunities. This is very difficult for law faculties to grasp because teaching to such students takes power away from the traditional core of law faculty hires—public law, and in particular constitutional law, broadly defined.[3] Hiring for "best player available" almost never means a business or science/technology scholars involved in medical technology or technology issues within intellectual property. Instead, law schools hire medical ethics professors or IP scholars focused on constitutional issues. Even in administrative law, the number of tenure-track professors who research the Federal Trade Commission, covering issues such as big data, antitrust/IP and antitrust/innovation; the Federal Communications Commission, including networks and data protection; or the Federal Drug Administration and medical technology, are in short supply in law schools.[4] Yet for both law firms and for non-lawyer STEM students, demand is high. On the business law side, the number of scholars who regularly study issues of technology start-ups is small—as are people who teach or write on contracts, with an emphasis on venture capital and corporate governance for start-ups. There is even less research in the areas of dispute resolution, joint ventures, and supply chain management of tech-related start-ups.

Beyond teaching, increased research collaboration is necessary to bring in significant research dollars to law schools. Because law schools provide faculty sufficient funds for legal research, there are not strong incentives to spend time on research grants—course relief is expensive due to law school salaries, there is no infrastructure for grant writing, and paying for graduate

[3] At numerous conferences that in any way touch upon business law issues, professors across schools complain that colleagues are often openly hostile to candidates who take business seriously. This needs to change, particularly as applicants to law school increasingly think about return on investment for their increasing tuition payments.

[4] This is not to suggest that traditional public law hires are not valuable. Rather it is to suggest that a law school would add to its research and teaching richness by hiring more people focused on pressing questions in the intersection of law/regulation, business and technology.

student assistance is not quite as feasible. The research grant model also requires faculty to have greater research incentives for joint peer-reviewed publications with non-law faculty, using different metrics and giving credit for a wider range of publication venues outside of law journals. Currently, such publications are not on legal databases and hurt faculty productivity ratings based on citations in law journals.

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

Harry Surden[*]

Technological change recently has altered business models in the legal field, and these changes will continue to affect the practice of law itself. How can we, as educators, prepare law students to meet the challenges of new technology throughout their careers?

It is helpful to provide law students with a basic understanding of the current state of artificial intelligence (AI) and its likely near-term impact on law. With this knowledge, students can orient their careers to avoid those legal positions that are most vulnerable to automation and focus instead on activities for which their legal training and cognitive abilities provide the most value for clients.

Overall, the trend in AI has been toward automating tasks that that are highly structured and repetitive, or that have discernible underlying patterns. For example, the field of machine learning focuses on algorithms that are able to detect patterns in large amounts of data to automate various tasks, ranging from automated product recommendations to credit card fraud detection.

[1] Notably however, current AI technology has been unable to replicate higher-order human cognitive tasks, such as abstract reasoning and open-ended problem solving. [2]. This distinction is important for students to appreciate, because lawyers engage in a wide range of activities, some of which demand higher order cognitive skills—such as legal analysis, judgment, advising clients, constructing novel legal and policy arguments, and complex brief writing—and others of which are more mechanical, repetitive, and routine.[3]

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[1] *See,* Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87 (2014).

[2] *See, e.g.*, Will Knight, *AI's Language Problem*, MIT TECHNOLOGY REVIEW, 2016, https://www.technologyreview.com/s/602094/ais-language-problem/ [https://perma.cc/ZH22-3GRF] (last visited Jun 28, 2017), MICHIO KAKU, THE FUTURE OF THE MIND: THE SCIENTIFIC QUEST TO UNDERSTAND, ENHANCE, AND EMPOWER THE MIND (2015), 220 ("Although CYC can process hundreds of thousands of facts and millions of statements, it still cannot reproduce the level of thought of a four-year-old human").

[3] Some legal tasks can be mix of both, such as corporate contract writing, with some aspects routine and structured (e.g., document assembly), and other aspects demanding complex legal and policy comprehension (e.g., customizing terms for a deal).

With this framework in mind, students can understand some general currents concerning the impact of AI on legal practice. Historically lawyers have been able to charge similar rates for both mechanical and less mechanical legal tasks. However, legal activities that are relatively repetitive or have underlying structural patterns will be most susceptible to automation. Discovery document review provides a good example—large aspects of the process involve routine, patterned work (e.g., excluding emails outside the timeline of consideration as likely irrelevant). Today, this activity is already being automated through machine learning[4]. In the not-too-distant past, however, document review was a lucrative task performed solely by attorneys. We can thus aid our students by focusing their career skill development on the higher value-added, cognitive legal tasks that are unlikely to be automated away in the near future. I summarize this idea to my students with the following phrase: "Where today lawyers are acting like computers, tomorrow they will be replaced by computers." Although it is likely that AI technology will displace some activities that are today conducted by lawyers, I am largely optimistic about the impact of AI on the practice of law. Overall, I believe that AI will primarily act as a complement to, rather than a substitute for, legal practice, creating new sets of skills for the attorneys of tomorrow (e.g., legal data analysis), and providing new tools that attorneys can leverage to improve their overall lawyering for clients.

Provide an example of a situation in which a Law–STEM collaboration aided a project or where the lack of collaboration between these two disciplines impeded a project.

A good example of a useful interdisciplinary law–STEM collaboration comes from my own recent experience in autonomous vehicle law and policy. In 2016, I co-authored a law review article with Mary-Anne Williams, a professor of engineering and robotics, on self-driving vehicle policy[5].

Cross-disciplinary collaboration was crucial to the success of the project. In order to make useful law and policy recommendations in technological areas, I believe it is crucial to have a deep understanding of the underlying technology. To this end, I was able to spend several months in Professor Williams' robotics laboratory, studying the underlying technology that allows autonomous vehicles to drive themselves. Professor Williams,

[4] *See, e.g.*, Daniel W. Linna, *What We Know and Need to Know About Legal Startups*, 67 S.C. L. REV. 389, 412–13 (2016).

[5] Harry Surden & Mary-Anne Williams, *Technological Opacity, Predictability, and Self-Driving Cars*, 38 CARDOZO L. REV. 121 (2016).

and her engineering graduate students, made critical contributions to the technological aspects of our law review article. Similarly, I was able to help the engineering team understand some of the most important dimensions of self-driving vehicle law and policy. This interdisciplinary collaboration sharpened not only our technical contributions, but also our overall legal and policy suggestions in ways that would not have been possible absent a deep cross-disciplinary interaction between the legal and STEM fields.

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

Ryan Whalen[*]

ENCOURAGING BOUNDARY SPANNING LEGAL SCHOLARSHIP

Law schools are in many ways the most unique in the modern American university. Having evolved relatively independently of other academic disciplines, they have developed a variety of idiosyncratic research and teaching norms, not least of which is the legal scholarship publishing model.[1] Although every academic discipline has quirks in the way its scholarship is created and disseminated, none is more unique than American legal academia's law reviews. The idiosyncrasies of law reviews and legal academia contribute to two challenges facing the production of boundary spanning legal scholarship: article venues and article appreciation.

There are many strengths to the law review system, but disseminating research that spans the boundaries between traditional legal scholarship and the STEM fields is not one of them. This boundary spanning work tends to be empirical in nature, using research methods that are unfamiliar to most law review editors. Furthermore, it is not easily shoehorned into the doctrinal article model, featuring a long introduction, state of the doctrine, recent developments, and prescriptions. This can make it more difficult for legal scholars to find appropriate homes for their interdisciplinary research.

Although in recent years there has been an increase in publication venues for boundary spanning research, there is still substantial uncertainty about how law school faculties perceive this non-traditional work. Boundary spanning research is often more similar to that produced in social science or STEM fields, and thus can appear foreign to many legal scholars, law school administrators, and law review editors. While doctrinal research is the research that law schools do best, and what they should continue to focus on, work that spans disciplinary boundaries has the potential to inject fresh perspective on legal issues, and integrate law schools more cohesively with other disciplines.

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[1] As professional schools, law schools differ from many of their peers in that their faculties have historically been populated by those with professional degrees rather than research-oriented doctorates. Although this has changed somewhat in recent years, this has contributed to the uniqueness of law schools in the academy.

In recent decades, every school within the modern university—law school included—has seen an increase in interdisciplinary research.[2] This transition has been easier for non-law disciplines, because their publication models tend to be relatively similar to one another, and thus the research products more easily understood and appreciated. If law schools wish to capitalize on the promise of boundary spanning research, they need to encourage its production by fostering publication venues and clearly crediting it as relevant. This in turn will enrich research, furthering our understanding of the law and legal systems.

INTRODUCING LAW STUDENTS TO PROGRAMMING AND STATISTICS

The question about how to prepare law students to deal with changing legal technologies has parallels throughout professional education. In the post-industrial world, the work that we do is increasingly distant from the machinery and technology enabling it. One could take the position that service providers need not understand the technologies they rely upon, and that it would be more efficient to maintain the clear division of labor and expertise between the service providers and the engineers. Yet, there is something to be said for understanding—at least at some basic level—the technologies that enable our work.

The majority of law students need not, and will not, become experts in legal technologies. However, they would benefit greatly from introductory training in the technologies and tools that support legal work. At a minimum, students should have the opportunity for some exposure to a programming language and statistics to help them both understand the technologies they work with, and the systems that increasingly underpin the world around us.

Exposing future lawyers to the fundamentals of computation would not only help them understand legal technologies, it would also improve their ability to engage with technology support staff in their firms, consultants hired to perform technology-oriented services, or clients with technology-related legal issues. As an additional benefit, computer programming provides logical reasoning practice that maps well to contract and statutory interpretation.

Training in statistics would help law students understand more of the mechanics about how many legal technologies work, while also contributing

[2] *See* Alan L. Porter & Ismael Rafols, *Is Science Becoming More Interdisciplinary? Measuring and Mapping Six Research Fields over Time*, 81 SCIENTOMETRICS 719 (2009). The increasing number of law professors with doctoral degrees in non-law disciplines has contributed to more-and-more "law and" interdisciplinary research. *See* Lynn M. LoPucki, *Dawn of the Discipline-Based Law Faculty*, 65 J. LEGAL EDUC. 506 (2015–2016); Justin McCrary et al., *The Ph.D. Rises in American Law Schools, 1960–2011: What Does It Mean for Legal Education*, 65 J. LEGAL EDUC. 543 (2015–2016).

to a more well-rounded legal training. Statistical reasoning is increasingly important throughout society, and comes up in a variety of core legal areas including remedies, torts, evidence, labor law, tax law, etc.[3]

An introduction to programming and statistics can be offered in a single elective class—perhaps with a focus on legal data science or informatics, fields that feature both programming and statistics and that would be of substantive interest to many practitioners. Ultimately, this sort of course offering will produce more well-rounded lawyers who are prepared to cope with the ever-changing state of technology that their career promises.

[3] For instance, a grounding in probability and statistics can be very helpful in understanding the *PL* > *B* calculus of negligence created by Judge Learned Hand. *See* United States v. Carroll Towing Co., 159 F.2d 169 (2d. Cir. 1947).

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

Christopher S. Yoo[*]

What incentives would foster more collaboration between the law and STEM fields, in either academic or business/entrepreneurial settings?

Like any new interdisciplinary effort, the burgeoning field bridging law and STEM needs focal points to help build a sense of community. One goal would be to create fora that allow like-minded scholars to exchange ideas about current research and future directions in the field. Another goal would be to legitimize efforts in the eyes of other scholars by signaling the importance and maturation of the field. But perhaps most importantly, such focal points would encourage young scholars to pursue research at the intersection of law and STEM and give them confidence that there will be institutions where they can present and publish their work, as well as a robust group of scholars who can serve as mentors, tenure reviewers, and potential collaboration partners.

The two Bridges conferences that Northwestern has sponsored thus play a critical role in encouraging this movement to grow. As an alumnus of Northwestern Law, I am proud to see my alma mater be a leader in this important area.

It is the same reason that for the past five years, Penn Law has sponsored an interdisciplinary conference spanning law and computer science. Each year, this conference has made it a point to include junior scholars and newly minted entry-level faculty in order to encourage them to join our community. We have also always included key policymakers and business leaders to broaden the discussion to include new audiences.

Finally, Northwestern, Penn, and Stanford have decided to create an annual Junior Faculty Forum for Law and STEM in which young scholars can present their works in progress and receive comments from senior scholars in the field. The inaugural conference occurred at Penn Law on October 6–7, 2017. The conference will rotate among the three schools in future years.

Together, we hope that these efforts will foster the emergence of law and STEM as the next breakthrough interdisciplinary field.

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Provide an example of a situation in which a Law–STEM collaboration aided a project or where the lack of collaboration between these two disciplines impeded a project.

The National Science Foundation's new emphasis on translational research illustrates how the lack of collaboration between law and STEM can impede a project. All too often, technologies that the NSF has funded tend to sit on the shelf undeployed. The barriers are not technical: The results of the research tend to satisfy their goals. Instead, the barriers tend to be legal, political, social, and economic. The NSF is increasingly embracing projects that include research team members that can provide the interdisciplinary expertise needed to overcome those barriers.

A good example of a project that benefited from collaboration between Law and STEM is an NSF grant I am currently working on, "Security and Privacy for Cyber-Physical Systems." The project is driven by the insight that end users are increasingly using systems that are not entirely digital. Instead, emerging systems tend more and more to include sensors that incorporate data from the physical world. Prominent examples that we are studying include autonomous vehicles and medical devices. These technologies pose significant legal challenges. Cyber-physical systems (CPS) gather data that can be more sensitive than that gathered by previous systems. In addition, they share those data with other CPS deployments in ways that raise additional privacy concerns. Most significantly, the architects of these systems did not design them with hostile environments in mind. As a result, all of them have weak security, as demonstrated by the YouTube videos of people sitting in passenger seat of a car using a laptop to control its major systems.

CPS systems thus raise difficult questions about privacy and security. As a result, architects must consider what constitutes a properly designed product from a security standpoint. This includes situations where security is an emergent property that arises either from the interaction of multiple components each of which appears to have been designed properly or from data that the product has incorporated through experience. This raises complicated questions of causation and apportionment of liability. In addition, the law must determine the scope of liability for security flaws that emerge or are discovered after the product is sold. The privacy problems are similarly complex and benefit from a collaborative approach.

Technological change recently has altered business models in the legal field, and these changes will continue to affect the practice of law itself. How can we, as educators, prepare law students to meet the challenges of new technology throughout their careers?

The growing importance of technology is creating the need for new approaches to training students. Just as the success of the law and economics movement created the need for a new type of professional with advanced training in both of those disciplines, the increasing significance of technology is creating a burgeoning demand for graduates with expertise in both law and STEM.

I am proud to be affiliated with two institutions that have served as leaders in this regard. Northwestern's new Master of Science in Law (MSL) degree provides STEM professionals with advanced legal training to enable them to operate effectively in a world increasingly subject to regulation.

Penn offers an even broader range of programs. Similar to Northwestern's MSL degree, Penn offers a Master of Law (ML) degree that provides interested future technologists with graduate-level training in law. The ML program is open both to STEM undergraduates as well as to engineering graduate students interested in undertaking the program as a joint degree. At the same time, Penn offers joint degree programs for both undergraduate and graduate students in STEM fields to obtain expedited access to the JD. STEM undergraduates can submatriculate into the JD program. At the graduate level, another joint degree program permits students to earn both a JD and a master degree from Penn's engineering school. Particularly helpful is the fact that Penn's engineering school has two separate master degree programs, one designed for students with no prior exposure to engineering (known as the Master of Computer and Information Technology or MCIT) and a more traditional program for students who studied engineering in college (known as the Master of Science of Engineering or MSE). The net result is that regardless of whether the interested person is a graduate or undergraduate student or is a future technologist or a future lawyer, Penn has a program to suit their needs.

In addition, Penn Law offers a wide range of innovative curricular opportunities. The Detkin Technology and Intellectual Property Legal Clinic provides students with live client experience with respect to cutting-edge technologies. Special units as part of the clinic and the engineering entrepreneurship program bring law and engineering students together to simulate the types of interactions they will enjoy in the future. A new public interest organization called Students for Technological Progress does pro bono work in the tech space. We also teach advanced seminars around such

topics as the Giles S. Rich Patent Moot Court Competition, in which Penn is the defending national champion.