Demystifying the Academic Research Enterprise

Becoming a Successful Scholar in a Complex and Competitive Environment

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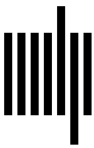

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12

Yours, Mine, and Ours: Ownership of Research Outcomes

Chapter Overview and Learning Objectives

As research and creative activity proceed and scholars give thought to disseminating the associated work products (chapter 11), they also must consider ownership rights and protections of those products, also known as intellectual property (IP). This chapter provides a foundation for understanding IP, the policies and laws governing its ownership, how it is protected, methods of disposition, and benefits accruing to the owner/inventor, his or her institution, and society more broadly. Additionally, it discusses challenges associated with IP in the context of multisector R&D partnerships. After reading this chapter, you should

- Be able to define and explain IP and the important role it plays in research and innovation;
- Explain federal policies and laws governing IP ownership;
- Differentiate among the various types of IP protection and know how to access and apply them;
- Understand how the academic enterprise supports researchers in IP commercialization and the various mechanisms available for the disposition of IP; and
- Be able to describe the value to society of IP.

12.1 Context, Definition, and Importance of Intellectual Property

In chapters 1 and 3, we discussed how research and creative activity follow naturally from our innate human curiosity about, and our desire to improve, the world in which we live. We also discussed the spectrum of research, from so-called basic/fundamental/discovery research—which does not necessarily

have a practical end in mind but is the seed corn of innovation—to use-inspired, applied research and development, which frequently builds upon fundamental research and seeks to create practical, implementable solutions to specific problems. Yet, as noted in chapter 11, research outcomes only have *value* (monetary and otherwise) if they are made known to others. This is where the topic of the present chapter becomes relevant. That is, the valuation of research outcomes. Not surprisingly, this leads to the related question of who owns those outcomes and thus who can benefit from them, especially financially. In this context, research outcomes are referred to as intellectual property (IP).

To understand the importance of IP and the role of academic institutions in its creation and disposition, it is useful to briefly review how universities evolved during the past 150 years. One of the most important developments was establishment of the land-grant university by the Morrill Land-grant Act, signed by President Lincoln in 1862. The Act required each state to set aside roughly thirty thousand acres of public land, per member of the state's congressional delegation, based upon the 1860 census. Proceeds from the sale of this land funded public colleges and universities, with emphasis on those specializing in the agricultural and mechanical arts. This specialization is where the acronym A&M came from, as in Texas A&M University.

Subsequent acts were passed, and the development of extension services became a core part of the land-grant model. With typically one extension office in every county of a land-grant state, these "extensions of the university" provide services and new capabilities to citizens, mostly to agricultural interests, which is a form of economic development and technology transfer. Today, the role of extension offices continues to evolve, consistent with our move from an industrial and agrarian economy to one based upon knowledge, data and information.

Up to the time of World War II, university research was funded principally by private foundations and philanthropy. Very little federal government funding was involved, though that changed rapidly after the war. Given that university researchers helped develop the atomic bomb and other innovations, such as radar, which led to the Allied victory, the federal government not only began funding university research on a much grander scale, but also helped set public and private expectations for research universities, including land-grant institutions. We discussed this "social compact" in chapter 3.

With federal government—that is, taxpayer—funding for research at universities came the notion that everyone should have equal access to research outcomes. In other words, what the public paid for, the public should be able to access. This seems logical unless you are an entrepreneur or a private company looking for a competitive advantage. If you invest money

commercializing an outcome from academic IP, but everyone else has access to the same IP, what is your leverage against the competition?

In 1980, Congress passed the Bayh-Dole Act, which allows academic institutions to protect the assets of federally funded innovations and control their disposition, subject to a few caveats. We dive more deeply into the Bayh-Dole Act in the next section, but for now, consider academic institutions themselves and how they have changed in the age of IP commercialization.

Traditionally, quoting Hill (2012, slides 14 and 15), modern research universities have served as: "a place for teaching and learning; a codifier of, and repository for, old knowledge and understanding; a generator of new knowledge and understanding; a community for personal growth; a transmitter of values and builder of citizens; a neutral space for debate; a home for criticism of society; and an organizer of entertainments." However, in the past few decades, public expectations of research universities have changed markedly. The role of research universities today encompasses most of the elements just mentioned, but also includes universities serving as "a generator of new technologies; a prime source of new ideas; a founder of new companies; a solver of practical problems; a partner in economic development; a bridge to the world; a venue for political presentation; a critical contributor to economic growth; and a source of specialist leadership." Notice the components of technology development, company creation, economic development, and economic growth. All of these connect directly to and rely upon IP. So, let us now define it.

The World Intellectual Property Organization (2020) (http://wipo.int/portal/en/) defines IP as "creations of the mind," which includes "everything from works of art to inventions, computer programs to trademarks and other commercial signs." Another good definition (van Dusen 2013) sees IP as "products of the human intellect that are unique, new and innovative, have some value in the marketplace, and are the creation of a single person or team." Some mistakenly refer to IP as patents, copyrights, trademarks, and trade secrets. Those items are *not* IP but rather are mechanisms for *protecting* IP and those who utilize it.

Some of the most well-known examples of research-based university IP that resulted in hugely successful products and services are shown below:

- Google, invented at Stanford University
- Rocket fuel, invented at Clark University
- Insulin and the electron microscope, invented at the University of Toronto
- Penicillin, discovered at Oxford University
- The heart-lung machine, invented at the University of Minnesota

- Gatorade, invented at the University of Florida
- Magnetic resonance imaging, developed at the State University of New York
- The time release capsule, developed at the University of Kansas
- The blood thinning agent Warfarin, invented at the University of Wisconsin

Not only did these and other inventions, discoveries, and contributions bring vast benefits to society on a global scale, but they also led to substantial financial windfalls for the inventors *and* their institutions.

For example, according to the sports network ESPN (Rovell 2015), those who developed Gatorade some five decades ago, and their families and friends, have made more than $1 billion in royalties from the widely used drink product. The University of Florida, where the work was performed, has made nearly $300 million in royalties. Although success stories of this magnitude are, not surprisingly, somewhat rare, the commercialization of academic IP continues to grow and yield tremendous benefits for the inventors, their institutions, and society. We examine more closely national and global statistics in subsequent sections of this chapter, as well as the challenges faced by colleges and universities, their faculty, and students in IP commercialization.

Based on the examples just presented, it may appear as though IP is relevant only to technological inventions and discoveries. Such is not the case. From your favorite books you read as a child to the songs you listen to in the car to the latest TV show or movie you watched, a great deal of IP exists in forms of scholarship including but not limited to: novels and poems, films, music scores, plays, ballets, dances, paintings, and sculptures. This is why you, as a next-generation scholar, need to understand what IP is *and* is not, how to protect it and yourself, and how to utilize IP effectively.

Unfortunately, many students go through college without ever hearing about or understanding IP, and as a result, they pay a price upon entering the workforce. For example, if you invent something valuable and do not patent it, you may miss a huge opportunity to see it put into practice, or even worse, watch helplessly as someone else takes your idea and becomes very wealthy from it. If you do not understand the notion of copyright, you could end up creating major problems for your employer or miss an opportunity to receive royalties from a brilliant musical composition, computer code, or piece of courseware that might see broad use nationally or internationally. So, you see, IP is not solely the domain of scientists and technology inventors, attorneys and contract negotiators, but rather is something every scholar, within *every* discipline, needs to understand.

Numerous organizations within the academic enterprise focus on IP and related topics such as technology commercialization, including the Association

of American Universities (AAU; http://aau.edu), the Association of Public and Land-grant Universities (APLU; http://aplu.org), the Government-University-Industry Research Roundtable (GUIRR; http://nationalacademies.org/guirr/government-university-industry-research-roundtable), the Association of University Technology Managers (AUTM; https://autm.net), the Federal Demonstration Partnership (FDP; http://thefdp.org), and the University-Industry Demonstration Partnership (UIDP; http://uidp.org). And a new report by COGR (Council on Governmental Relations 2022) dispels various myths about technology transfer in US universities. You should consult these and other sources if you wish to dive even deeper into the topics of IP, technology commercialization, and entrepreneurship.

Finally, it is important to remember that not every piece of IP can be protected everywhere on earth, and indeed, circumstances may exist in which "creations of the mind" can have utility without being disclosed generally. We refer to this IP as "know-how." Indeed, the intellectual capacity of faculty and students in our colleges and universities is an enormously powerful and valuable asset that sometimes is overlooked in the context of IP. Quite frequently, private companies wish to tap this know-how to help solve problems or address challenges without ever performing research or creating an outcome that could be considered IP in the classic sense. Such capability is one of the innumerable benefits of colleges and universities, as discussed in chapter 3 and described further in section 13.7.

12.2 Types of Intellectual Property Protection

In everyday life, we have certain rights, including rights to privacy, liberty, and property. In the case of IP, certain legally enforceable rights can be granted because the US and other nations recognize the rights of individuals and corporations to own and use the assets that result from intellectual endeavors—that is, research and creative activity. More specifically, as in other types of rights, IP rights represent a form of protection—for the inventor or creator of IP, as well as for the user or investor who wishes to innovate with it to provide benefit to society. The type of protection utilized depends in large part on the nature of the innovation and its novelty, and four principal types exist: *copyright*, *patent*, *trademark*, and *trade secret*. We consider them individually and then later describe circumstances under which these protections are most effectively applied as part of the research and IP commercialization processes. The type of protection also depends upon the intended use of the IP. An excellent and succinct summary of the four types of IP protection may be found in Blakeslee (2004).

Beginning with *copyright*, US Code (17 USC § 102) defines it as a protection for "original works of authorship fixed in any tangible medium of expression." Whew! Let us unpack this important sentence point by point.

First, the term "work" refers to any intellectual creation, which might be a book, musical score, painting, film, data base, choreography, poem, computer program, technical drawing, recording, photograph, set of processes, and so on. Second, this work must have an "author," which might be one or multiple individuals. We will see below that determining the amount of credit assigned among multiple authors can be a challenge. Third, a medium of expression must exist, and it must be "tangible"; that is, exist in a physical, fixed form. The examples I just gave fit this requirement. Finally, and not actually mentioned formally in our definition, the work must be "original," which is consistent with our earlier concept of research as original contributions to knowledge.

Many scholars are surprised to learn that a copyright is established for a given work as soon as the work is created in a tangible, fixed form. Even a blog post you write is automatically copyrighted once you create it. No action is needed on your part. That said, one can *register* a copyright with the US Copyright Office. Although doing so is optional, the value of registration includes proof of ownership and the ability to enforce use standards of your work.

Because some people devote their entire careers to copyright law and policy, it is not surprising that copyright contains numerous complexities and nuances. You can explore these and other topics by consulting works in the references (e.g., Blakeslee 2004; Van Dusen 2013). Ultimately, copyright affords the author protections such as clearly assigning credit and recognition for having created the work and also provides the author control over the reproduction, publication, performance, or translation of the work into other languages. Copyright also incentivizes scholarship by providing a means for authors to receive a financial reward, say via royalties for a music score, thus stimulating additional research and creative activity for the benefit of society.

The second type of protection is the *patent*, which confers on the patent holder "only the right to exclude others from making, selling, or using the patent holder's invention" (US Patent and Trademark Office n.d.). Some mistakenly believe patents confer a right or are required to utilize or market IP, but such is not the case. As you will see in the next section, the IP license fulfills that role. Three types of patents exist: utility patents, design patents, and plant patents.

Utility patents are the most common and cover items you would expect; that is, devices, processes, molecular formulations, and so on. Design patents relate to designs for something that can be manufactured, though the design itself is only ornamental, not functional (which would fall under utility patents). The third type of patent is the plant patent which, as the name implies, is granted to

inventors of certain types of plants. If any work is seen as having potentially significant financial or societal value, then patent protection usually is sought.

Drilling down now on the most common patent, the utility patent, it is granted if the discovery is novel, useful, and nonobvious. Novelty is determined by patent searching for published evidence of the invention, called "prior art," to ensure that an item to be patented has in fact not already been patented or disclosed publicly. Patents only can be obtained via a very formal process in which a series of application steps is made to the USPTO. Because the patenting process can be quite expensive, especially if substantial legal background work is required, considerable thought must be given as to whether a patent is really necessary.

A provisional patent is the easiest first step because it is relatively informal and requires only a modest filing fee. It establishes an early effective filing date but requires the inventor to make formal application within one year. No examination is required of the work—the filing is simply a place holder. It is extremely important to recognize that patents are granted not to those who are first to *create* the work, but those who are first to *file*. In the US, one has only a year to file a patent from the time the work is first made public. For example, if you present your work at a national conference and then, two years later, decide to file a patent on that same work—well, you are out of luck! And finally, patents are valid twenty years from the date of filing, and both US and international patents may be obtained depending upon the potential market for the product or service.

The third type of IP protection is the *trademark*. I am sure you have seen the capital TM symbol on logos, but what really is a trademark? Basically, it is an identifier for a "word, name, symbol, device or combination of these things to distinguish one's goods, products or services from those of another." One of the most famous is the Nike "swoosh." As another example, the logo of the University of Oklahoma is an interlocking O and U. Whenever you see it, say on clothing or the website or brochures, you will see either the symbol TM or an R within a circle, the latter of which means the trademark has been registered with the USPTO and thus cannot be used without the university's permission. Sometimes that permission is given in return for monetary or other considerations.

The final type of IP protection is the *trade secret* or "know-how." It is defined in 18 USC § 1839(3) as "All forms and types of financial, business, scientific, technical, economic, or engineering information, including patterns, plans, compilations, program devices, formulas, designs, prototypes, methods, techniques, processes, procedures, programs, or codes, whether tangible or intangible, and whether or how stored, compiled, or memorialized physically, electronically, graphically, photographically, or in writing if: (a) the

owner thereof has taken reasonable measures to keep such information secret; and (b) the information derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable through proper means by, another person who can obtain economic value from the disclosure or use of the information."

Perhaps the best example is the highly secret and well-guarded formula for Coca-Cola. Federal law makes the theft of trade secrets a crime. If, however, a soft drink company were to replicate the Coca-Cola taste and even the formula on its own, without having actually accessed the real formula directly, they would be free to produce their drink and could not be sued for patent infringement. In other words, legal protection of trade secrets is limited to situations only in which the secret was improperly obtained.

12.3 Policies, Procedures, and Challenges in the Academic Enterprise

In light of the role played by academic institutions in today's economic and technology development ecosystem, many of them, and especially research universities, now have offices of technology development, economic development, technology commercialization, and/or IP licensing (section 1.6). Not only do these offices lead the creation and enforcement of institutional policies governing IP, but they also serve as institutional focal points for moving research outcomes into practice for societal and institutional benefit. In so doing, they provide a wide array of services to faculty, staff, and student researchers in navigating the many complexities associated with IP. Most importantly, the technology transfer or licensing office can help you evaluate the protectable elements of your IP and develop a strategy for transitioning your innovation to the public domain in a way that complements your research efforts.

However, many academic institutions do not have such resources, especially MSIs and ERIs. It is vitally important that everyone in America's postsecondary research and education enterprise has access to the resources needed to be successful, including those involving IP. Fortunately, Congress, and the National Science Foundation in particular, are addressing this compelling need through a series of financial investments and programmatic innovations, one of which is NSF's GRANTED (Growing Research Access for Nationally Transformative Equity and Diversity) program. Remember, research outcomes are the end product of the research process and consequently have great intellectual and other value. Do not be discouraged if your institution lacks the resources needed to protect those outcomes and bring their benefits to society in tangible ways. Suggestions are provided throughout this chapter regarding how you can obtain the assistance needed to manage your IP.

An important question facing all researchers, and especially those in the academic enterprise, involves knowing *when* an outcome of research or creative activity becomes IP. You may recall from chapter 11 the difficulty researchers sometimes face in knowing when research results are ready to be communicated, say in publications, recitals, or exhibitions. The same is true in filing protections for IP. The answer, as noted in the previous section, is clear for copyrights, trademarks, and trade secrets. However, patents are another matter altogether. In addition, each institution, be it a university, private company, nonprofit organization, or state or federal agency, has its own internal processes for seeking patent protection. Given the focus of this book on academic research, I will discuss processes most common to academic research institutions and use the utility patent as the example of protection being sought.

At some point in the research process, one realizes the work performed is sufficiently mature or complete, and may have enough potential value in the marketplace, to warrant consideration of being patented (note that market value isn't always a strong consideration). For example, suppose an academic researcher develops a new type of battery that charges in seconds, is extremely small, but has massive storage capacity. Laboratory experiments may have been performed using only a crude model of the device and a limited number of application scenarios under highly controlled conditions. Yet, the results are unmistakably positive and perhaps revolutionary. Although additional work certainly will need to be performed prior to the battery becoming a commercial product, the researcher judges the results so potentially significant that exploring IP protection seems warranted.

To ascertain whether a patent is, in fact, appropriate, the researcher files a formal IP disclosure with their institution, usually one of the offices noted previously. This disclosure is a formal document containing a detailed description of the IP, a list of all inventors and the proportional contributions of each, background information on existing and possibly competing IP, how the disclosed IP advances the current state of the art, potential markets, how the work was funded, whether any existing commercial products are part of the IP, whether and when the IP was presented in the public domain, and sometimes other information. The office then works with the researcher and other institutional officials to determine whether to file a patent. In so doing, the institution usually pays the filing cost, though sometimes it can be recouped if the IP is licensed.

Regarding the latter point, as described in the next section, IP is made available for practice via the issuing of a license, with a portion of the revenues from associated products and services usually reverting back to the developers and their institution. The percentages governing revenue splits are set by

the academic institution and usually are designed to incentivize researchers and the institution to pursue activities that lead to more IP.

If your institution does not have an IP or technology commercialization office, speak with your advisor, department chair, or dean to learn about whether and how the institution deals with IP. If they or the institution have little or no experience doing so, opportunities exist to partner with nearby institutions which do (usually requiring some sort of payment), or utilize legal firms on retainer which specialize in IP law. Also, national organizations can be helpful, and one in particular is the APLU Office of Economic Development and Community Engagement. Although APLU does not provide IP services per se, it can be helpful in identifying partners and connecting those institutions that have needs to those that have resources.

Although the creation and disposition of IP are now common practices in many academic institutions, certain challenges exist. For example, applied research and development tend to yield more patentable outcomes, and often fewer opportunities to publish in the scholarly literature, than fundamental or discovery research. Yet, the reward system for faculty tenure and promotion still tends to place greater value on fundamental research, even though academic institutions are placing ever greater emphasis on solving practical problems, commercializing IP, and contributing to economic development.

These competing forces, which include fears about academic research being directed more toward the applied end of the spectrum (chapter 1) based upon budgetary trends of funding sources and institutional roles, lead to tensions which today are only partly resolved. Fortunately, things are improving. About a decade ago, the National Academy of Inventors (http://academyofinventors.org) was established to bring appropriate recognition to researchers at academic institutions and nonprofit research institutes. This move highlights the importance of inventions and the roles played by these institutions in economic development. The Academy also serves as an important force in modifying the academic reward system to give greater weight to the generation of IP in performance evaluations.

Another challenge concerns ownership of IP and the distribution of royalties from it. At most academic institutions, IP is owned by the institution or its governing board. This makes sense because, in the context of research, creative activity, or the development of educational materials, the work is performed by employees of the institution, using institutional resources. However, as you might imagine, some researchers believe they should own the IP because the idea and work originated with them, irrespective of where the work was performed. In the case of students, the situation is a bit murky because at some

institutions, students—especially graduate students—are considered employees while at others, they are not.

Some academic institutions have agreed to waive their right of IP ownership, either completely or in certain situations, thereby allowing researchers to deal with it on their own. Although this can be valuable, all of the responsibility and cost, say for patenting and commercialization, rests with the researcher. The tradeoff is that researchers taking on these additional responsibilities tend to be drawn away from their work, spending considerable time on IP-related activities rather than on the research that gave rise to the IP in the first place. The bottom line is that, prior to becoming an employee of any organization, you should carefully evaluate all IP policies and ask for explanations of any that are unclear to you.

Finally, as described previously, research results are valuable only if they are made known to and used by others. This presents a bit of a dilemma in academia because, on the one hand, academic institutions are founded upon the notion of unfettered distribution of scholarly outcomes, while on the other hand, economic engagement increasingly is a foundational mission, and innovation may require protection for the effective use by a commercial partner. Finding the right balance between openness and protection can be difficult, though general agreement exists about the value of both elements in the academic research ecosystem. The best thing to do is contact your institution's technology transfer or licensing office personnel before publishing your work. They can provide advice on the protectable aspects of your innovation and do the heavy lifting with respect to filing for protection domestically and internationally to ensure you receive attribution and retain control over how your discoveries are used in the public domain.

12.4 Disposition of Intellectual Property

Once IP has been identified and formally disclosed, what happens to it? Three principal options exist when considering disposition of IP: first, licensing the IP to an existing company or other entity, such as a nonprofit organization; second, starting a new company or entity; and third, doing nothing with the IP.

Consider first the option of doing nothing, which in fact was the norm for the US government until the Bayh-Dole Act, formally known as the Government Patent Policy Act (US House of Representatives n.d.), was signed into law in 1980 and expanded in 1983. Prior to passage of this law, the federal government held title to any invention created using federal funding. That is, the federal government owned it all. The government also controlled patents and

would not grant exclusive licenses to IP. Consequently, little incentive existed on the part of private companies to license government IP because their competitors could do exactly the same thing.

As a result, in 1978, the federal government owned more than 28,000 patents, yet quite remarkably and not surprisingly, it had licensed less than 5 percent of them (US General Accounting Office 1978). And inventions reported to the government actually began to decline even though a boom in federal funding for research was underway. Lawmakers recognized this problem, and the Bayh-Dole Act was the result.

Bayh-Dole allows institutions performing government-sponsored research, including academic institutions, to hold title and right to the IP resulting from the research, and to be able to license it, including exclusively, to anyone they wish.[1] As you might imagine, Bayh-Dole quickly incentivized colleges and universities to commercialize their IP, thus bringing the benefits of their research to the public in more tangible ways while also generating royalties to support additional work. It also incentivized more colleges and universities to spin out companies and, in many cases, hold equity in them. In the last section of this chapter, you will see the fruit of Bayh-Dole, which you may find quite impressive.

With the Bayh-Dole Act in place, the licensing process took center stage in the academic IP world. An IP license, known as a license agreement, is a formal, legally binding contract, issued by the owner of the IP, such as a university or its contracting agent, which conveys upon the recipient certain rights related to the practice of IP. Thus, instead of doing nothing with IP, an institution may choose to license it to an existing company or entity, which is the second overall option for disposition.

Although many types of licenses exist, numerous elements are common among them. First, the license enumerates the parties involved, provides a rationale for creation of the license, and defines various terms used. Second, the license very clearly defines the IP in question, be it patented or not, and lays out certain conditions for commercialization. One of the most important of these is due diligence, especially for exclusive licenses. That is, the university issuing the license wants to ensure the IP is acted upon and not left sitting on the shelf. Consequently, a specified period of time is agreed to in which the company obtaining the license must act in good faith to commercialize the IP. If such commercialization is unsuccessful, the license describes the consequences.

Third, the license sometimes specifies the domain or domains in which the IP may be practiced (for example, in a certain component of an industry, such as the exploration of oil in deep water only), and whether the license is

exclusive or nonexclusive. An exclusive license is exactly what it sounds like, and in exercising this option, academic institutions must carefully weigh the tradeoff of engaging with a single entity only, which may not succeed, against the freedom to engage with many others, thereby increasing the opportunity for success. Usually, even in the case of exclusive licenses, the academic institution owning the IP maintains a right to utilize it in research and education, which of course is in the interest of the licensee.

Fourth, the license agreement lays out terms of the license, such as recouping fees paid by the college or university (or its licensing agent) for patenting, as well as royalties that will be paid to the academic institution or licensing agent by the company licensing the IP. This latter point often is challenging because the value of the IP in the commercial marketplace usually is unknown at the start. This is because, as noted previously, academic research leads to outcomes but not to products and services that are immediately commercializable. Most of the time, additional work is needed to innovate on research outcomes and turn them into products.

The gap between research outcome, which usually was funded by the government, and innovated product, which usually is produced and funded by a company, is referred to colloquially as the "valley of death" (figure 3.4). Why? Because non-research (i.e., development) funding—usually from private foundations, venture capitalists, angel investors, or other sources—is needed to bridge this gap and translate research outcomes into practicable products and services. Even if a product is forthcoming, it may not be competitive or may have been overtaken by a development elsewhere. Thus, the valley of death is the valley of big bets and big uncertainty.

Finally, the license agreement covers other topics such as options for sublicensing, indemnification, insurance, termination, publicity, use of logos, and the manner in which disputes will be litigated.

In many cases, the IP to be commercialized does not yet exist, but is developed via a partnership between a company and an academic institution (chapter 13). The partnership often takes the form of a sponsored research agreement, whereby the company funds academic researchers to study a particular topic of interest. Such agreements, also legally binding, lay out IP provisions prior to the work being undertaken. In most cases, existing IP brought to a project by an academic institution continues to be owned by it, and vice versa for the company. Any IP developed jointly by company and academic researchers is jointly owned, with each party usually having undivided, nonexclusive rights to the invention. Most colleges and universities also retain a nonexclusive right to practice the IP for educational and research purposes. To that point, they typically will not agree to perform any work that involves restrictions on

publication of results, especially for student theses and dissertations, though a delay of two or three months, prior to publication, often is allowed for the company or university to evaluate the IP and file for patent protection if deemed appropriate.

The research agreement typically grants the sponsoring company a right of first refusal to negotiate a license once the IP has been disclosed. This can be a major sticking point for many companies that fund academic research because, in spite of such investments—which can be substantial in some cases—they understandably view their only return as an option to negotiate access to something that they already funded. Adding to their discomfort is the fact that the value of the IP is not known in advance, even though the terms of the license agreement usually must be finalized before work begins. In reality, academic institutions that perform corporate-sponsored research do in fact bring a great deal to the table, including buildings, equipment, services, personnel and their expertise, and reputation—none of which the company paid for directly. Thus, the private company is leveraging extraordinary assets, which unfortunately is a point lost during many academic-corporate negotiations. The important point to bear in mind is that academic-corporate interactions represent a partnership in which all participants invest and in which all participants reap benefits.

The third option for the disposition of IP is to start a company. This form of technology commercialization exploded across the academic enterprise after passage of the Bayh-Dole Act. Although incorporating a for-profit company is relatively simple and inexpensive, the process that follows can be quite laborious. We hear of stories, such as for Apple and Facebook, where a company was started in a garage and dorm room, respectively, with a brilliant idea and a few collaborators. That still occurs! When a college or university, however, is involved with starting a company based on IP developed by its researchers, its staff sometimes help prepare the business plan, identify capital, identify and assemble the leadership team, and perhaps even house the start-up in incubator space. And of course, the academic institution usually has a vested interest in its start-ups via holding an equity stake and receiving revenues from IP licensed to them.

In fact, the meteoric rise of maker spaces, coworking spaces for start-ups, regional innovation hubs, and multidisciplinary entrepreneurship programs that engage faculty, students and existing companies in developing business plans attests to the great interest in, and value placed by academic institutions—and the communities in which they are located—in starting new companies. The principal down side to academic start-ups is that the developers of the IP—the researchers—are the de facto subject matter experts and thus usually are heavily

involved with starting the company. Care therefore must be taken by the institution to fully support researchers in creating the company so they are able to continue their research and manage conflicts of interest. Fortunately, numerous federal funding programs exist to support the creation and growth of small companies, especially in collaboration with academic institutions. Among them are the Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), and I-Corps (Innovation Corps) programs.

12.5 The Value to Society of Academic Intellectual Property

A number of excellent sources exist for information regarding the impact to society of academic IP commercialization. Most notable among them are the Association of University Technology Managers (AUTM), NSB's biennial Science and Engineering Indicators (the gold standard for global data on the science and engineering research and education enterprise), and the World Intellectual Property Organization. I highlight here only some of the key measures and show how the US fares in the globally competitive environment in which we now live.

According to AUTM (Association of University Technology Managers n.d.-b), during the twenty-year period from 1996 to 2017, IP commercialization and technology transfer in the US academic enterprise contributed $865 billion to the US gross domestic product and supported 5.9 million jobs. More than 480,000 invention disclosures were filed by, and more than 117,000 patents were issued to, universities. Some 15,000 start-up companies were created, and 68 percent of IP to start-ups and small companies was licensed from universities. In 2020 alone, universities submitted over 27,000 invention disclosures (compared to only 10,800 in 1998), filed 17,738 patent applications, were issued 8,706 US patents, executed 10,050 licenses and options, were responsible for creating more than 900 new products, and launched 1,117 start-up companies. And the research institutions received equity from almost half of the start-ups. As one might expect, the number of invention disclosures in the US correlates directly with total US research expenditures, as shown in figure 12.1. This underscores the importance of healthy federal, corporate, and nonprofit organization funding in the nation's research enterprise.

Considering now how the US compares globally, data from NSF show that the share of patents issued in the US steadily declined from 2012 through 2016 (figure 12.2), now representing less than 50 percent of all patents issued globally. The only country showing a steady increase during this same period is China, which still issues less than 5 percent of all patents. It is interesting to see the breakdown of US patents by manufacturing and nonmanufacturing

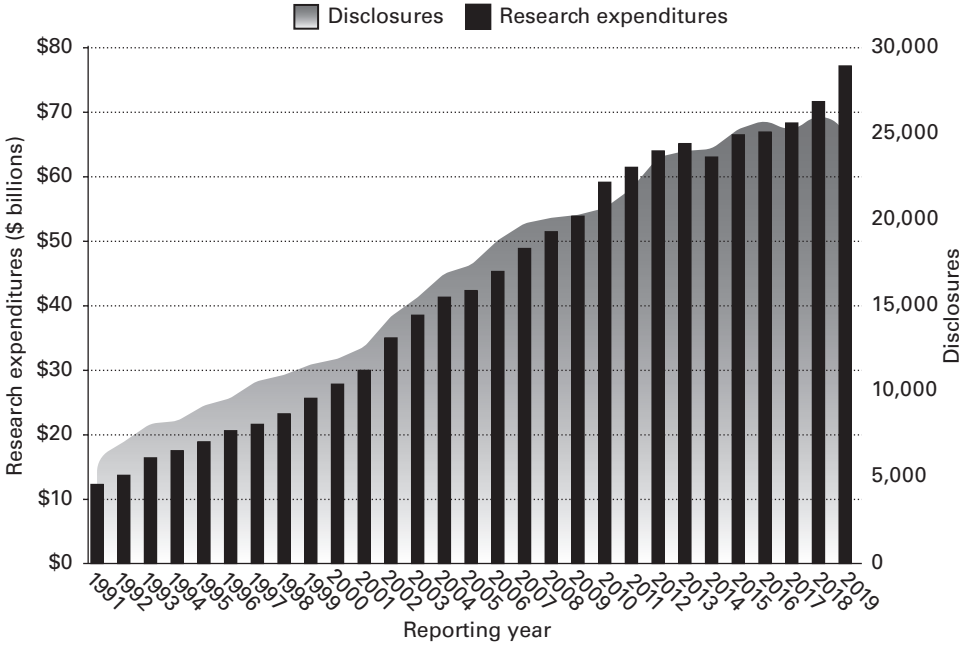

Figure 12.1
Total US research expenditures and number of invention disclosures received from 1991 through 2015. *Source*: Association of University Technology Managers (n.d.-a).

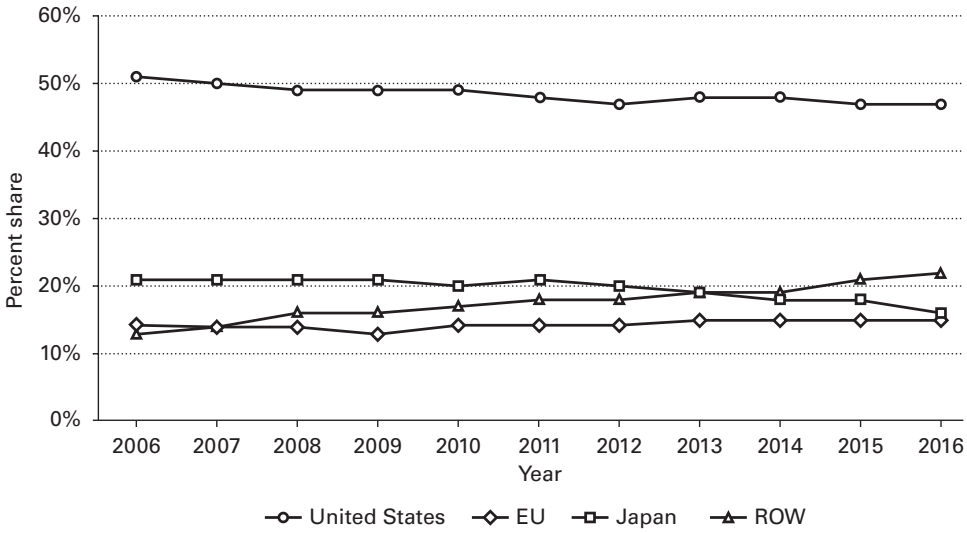

Figure 12.2
Percent share of patents granted by the US Patent and Trademark Office by region/country/economy of inventor during the period from 2006 to 2016. ROW denotes the rest of the world. *Source*: National Science Board (2018a).

industries (figure 12.3), and not surprisingly, the numbers are largest for computer and information-related technologies and services.

Consider now the degree to which a country is active in a given area of technology patented. The so-called patent activity index measures this attribute and is computed as the ratio of a country's share of a technology area to its share of all patents in that area. Thus, a ratio or patent activity index greater than one, in a given area, shows that the country is more active in that area.

Figure 12.4 shows the patent activity index for the US, the European Union (EU), and Japan. One remarkable feature is that the US has an index of one or greater in all but three of the technology areas listed, with clear emphasis on information technology and related device activities. With optics as a major focal point for decades, both in cameras and instruments, Japan continues to dominate this technology domain.

As noted previously, venture capital (VC)—which is money provided by investors, at considerable risk, to start-up companies that are believed to have long-term growth potential—is a critical component of academic IP commercialization. The degree of VC investment made is an indicator of the availability of IP, its quality, and the extent to which it is viewed as viable in the marketplace.

Figure 12.5 illustrates VC investment in the US relative to the rest of the world (ROW). Although the amount invested in the US has remained relatively steady during the period shown and has been larger than for ROW, the graph suggests significant changes are occurring. These changes are driven principally by the continued rapid rise of China and its massive investments in education, universities, and research infrastructure, as indicated in figure 12.6, which shows the breakdown of ROW among key contributing countries. Although the US celebrates the rise of other nations, especially developing countries, in the research, education, and technology commercialization enterprises, it is critical for the US to continue investing. Doing so will allow us to maintain our global leadership position and thus continue generating the benefits associated with that position to the nation and world.

Assess Your Comprehension

1. Describe the Morrill Land-grant Act and its significance in the American education and research enterprise.
2. Who had access to federally funded research outcomes prior to 1980?
3. What are the fundamental tenets of the Bayh-Dole Act?

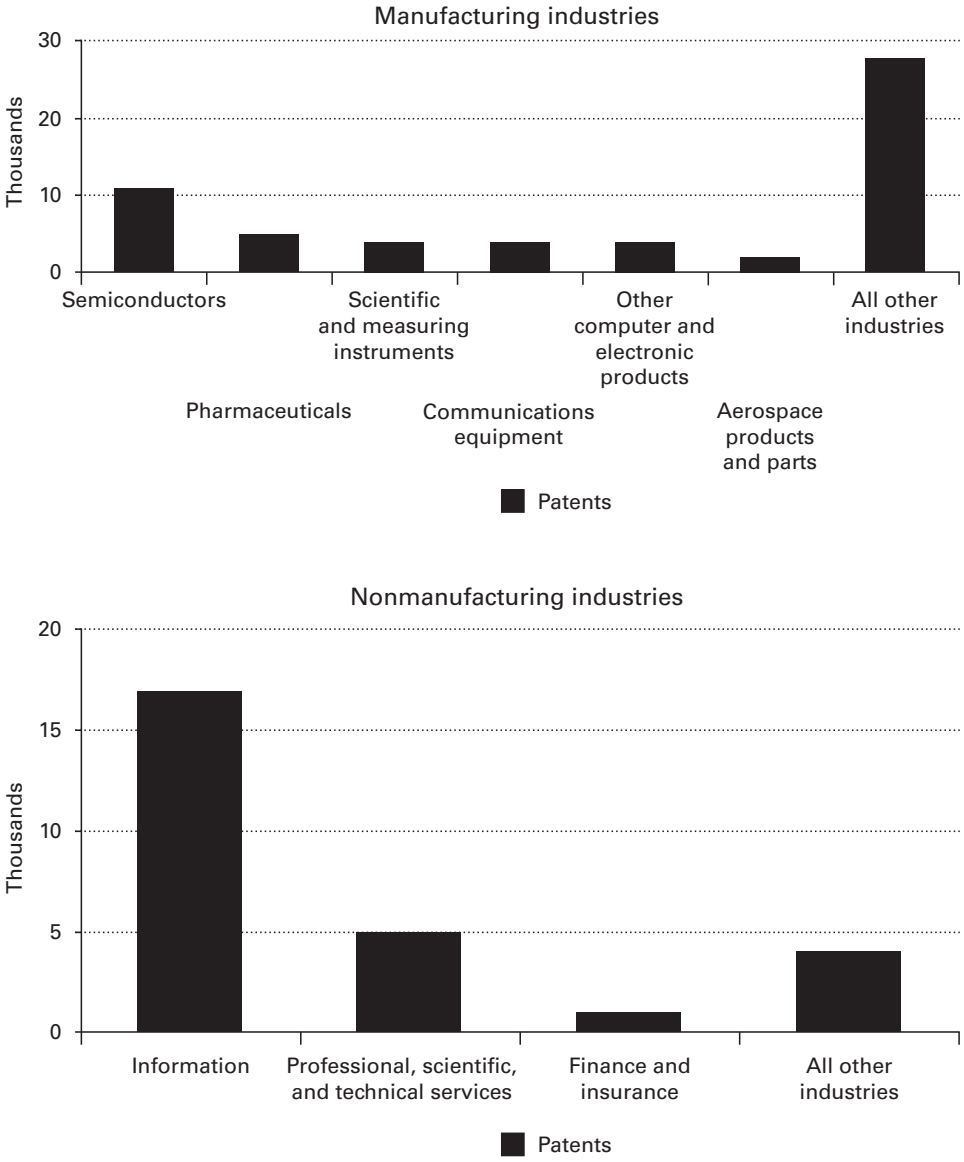

Figure 12.3
Patents granted by the US Patent and Trademark Office by manufacturing and nonmanufacturing industries for 2012. *Source*: National Science Board (2016c).

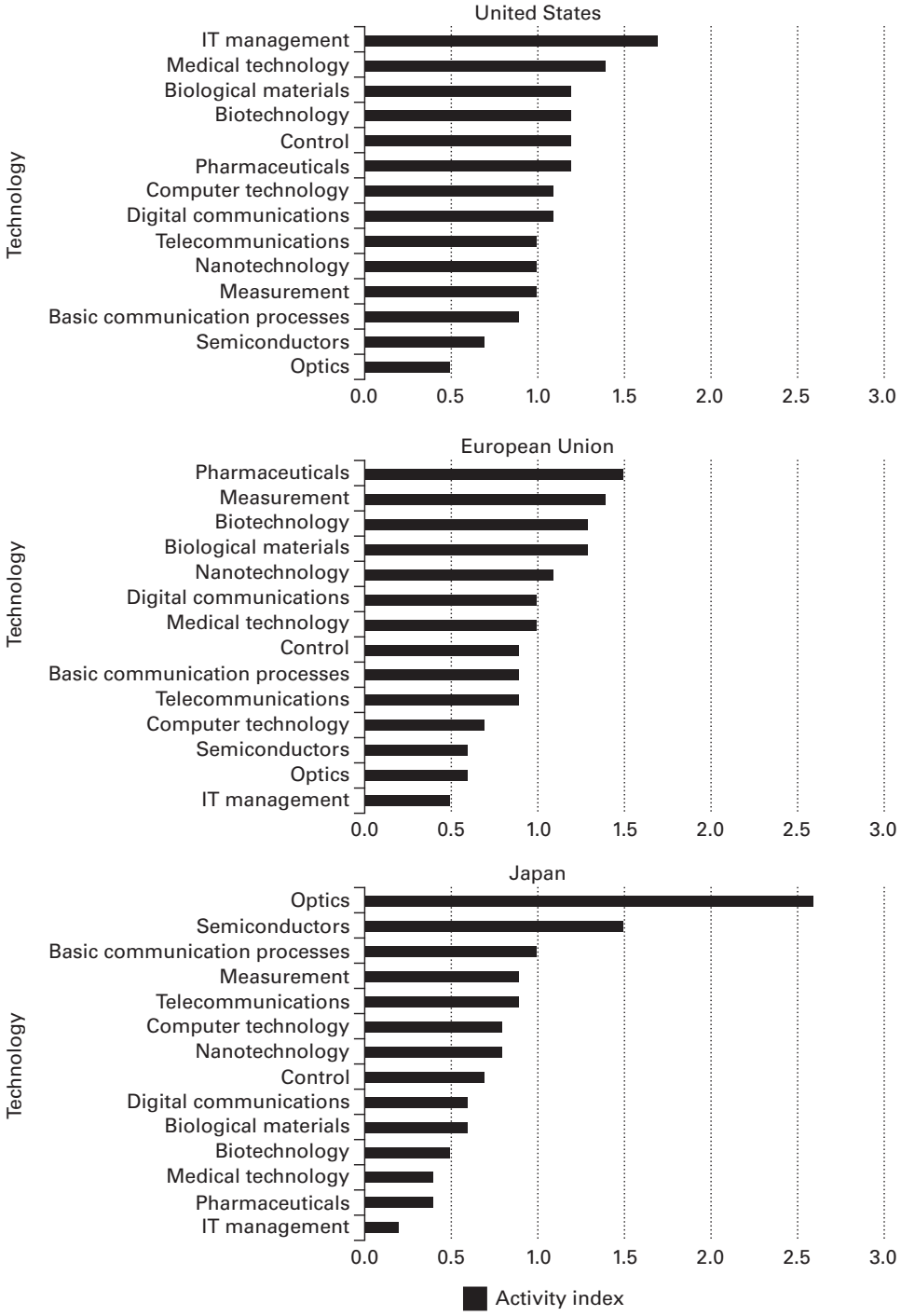

Figure 12.4
Patent activity index of selected technologies for the US, the EU, and Japan for the period from 2012 to 2014. *Source*: National Science Board (2016a).

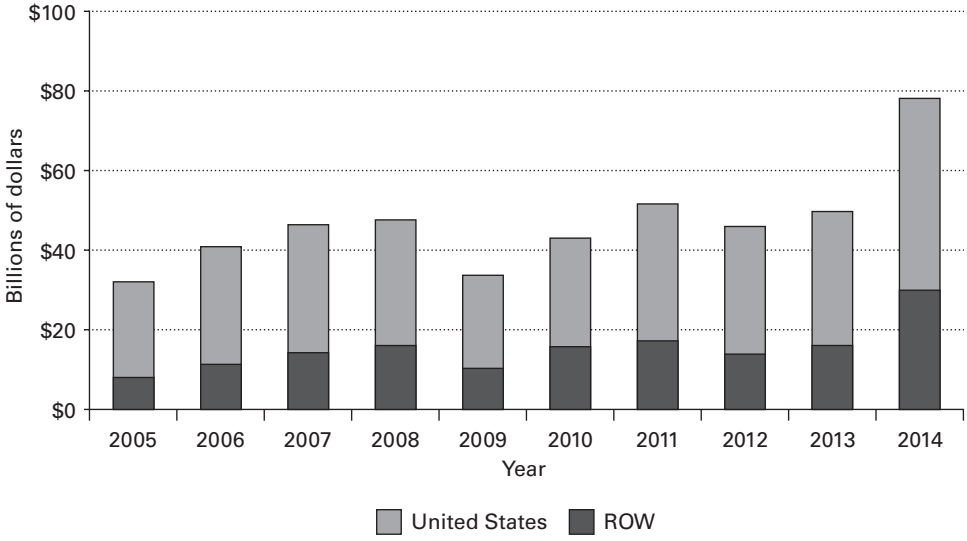

Figure 12.5
Venture capital investment in the US and the rest of the world (ROW) for the period from 2005 to 2014. ROW includes Canada, China, Europe, India, and Israel. *Source*: National Science Board (2016e).

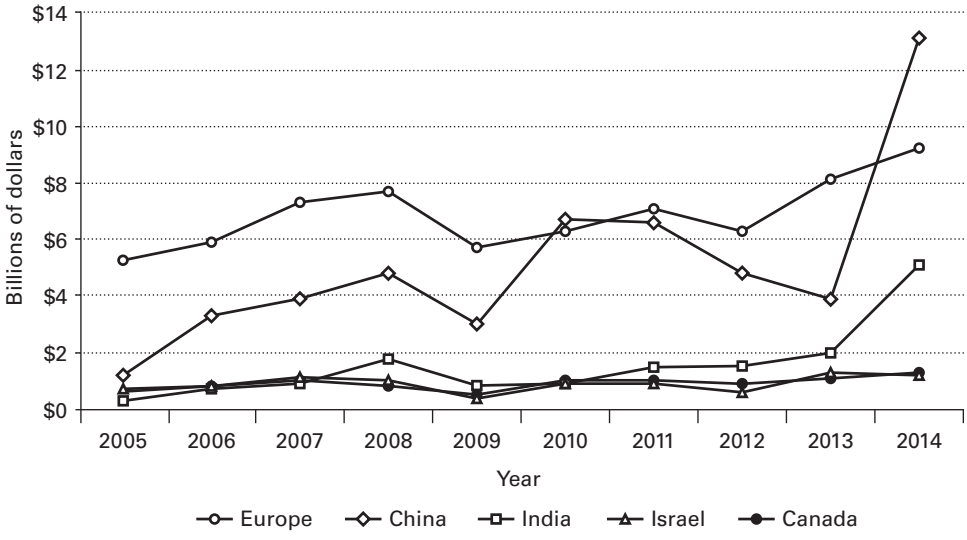

Figure 12.6
Venture capital investment by selected region/country/economy for the period from 2005 to 2014. *Source*: National Science Board (2016d).

4. How have the roles of research universities changed over the past few decades with regard to intellectual property (IP), technology commercialization, and economic development?
5. How does the World Intellectual Property Organization (WIPO) define IP?
6. Give some examples of IP developed outside the areas of science, engineering, and technology.
7. How does "know-how" differ from traditional IP?
8. List the principal types of IP protection.
9. How does US law define copyright?
10. Briefly describe the meaning of the key terms in the US definition of copyright.
11. At what point in the creation of a work is copyright formally established?
12. How does US law define a patent?
13. What are the principal types of patents in the US?
14. What are the key characteristics of a utility patent?
15. What is a provisional patent?
16. How long does one have to file a patent in the US, and when does the "clock start ticking?"
17. To whom are patents in the US granted? First to file or first to create?
18. What is a trademark and how does it differ from a patent and copyright?
19. What is a trade secret and how does it differ from other types of IP protection?
20. How do colleges and universities support their researchers in IP identification and protection?
21. What is an invention disclosure and what role does it play in IP?
22. How are colleges and universities, and the research enterprise more broadly, providing increased recognition to those who develop and act upon IP?
23. At most academic research institutions, who or what entity owns the IP?
24. Describe some advantages and disadvantages to faculty or other university researchers in engaging in IP-related activities, such as starting companies.
25. What is an IP license?
26. What attributes are common to most IP license agreements?

27. What are the most commonly used options for commercializing IP?
28. What is the "valley of death" in the context of research and technology commercialization?
29. Why are academic institutions sometimes reluctant to perform research funded by private companies?
30. What IP challenges do private companies face in collaborating on research projects with academic institutions?
31. How is the US performing in IP generation and utilization relative to other nations?
32. What is venture capital (VC), and what role does it play in IP and technology commercialization?

Exercises to Deepen Your Understanding

Exercise 1: Research and creative activity naturally tend to produce things: a process or method for accomplishing a task, a piece of software, an invention, a composition, a sculpture or piece of art, a script, and so on. Given your interests, select an outcome of research and creative activity that you have performed, or may perform in the future, and describe it. Then, discuss which mechanisms of intellectual property (IP) protection are most appropriate for your outcome, and why. How will that protection, or those protections, be useful should you wish to commercialize your outcome? What restrictions might you face by having such protection, and how might you trade them off?

Exercise 2: The US Patent and Trademark Office (USPTO) is responsible for handling all patent and trademark activities in the US. Using the USPTO website, describe the process involved in filing a US patent and then compare and contrast it with the process for filing an international patent. How do the protections offered differ from one another? What services are offered by your institution to assist you in filing a patent, including training sessions and advice, and does your institution pay associated legal and other fees?

Exercise 3: The Bayh-Dole Act of 1980 is the foundation for commercialization by colleges and universities of IP developed with federal funding. Today, the Act is being modified to increase its effectiveness. Describe the nature of and rationale for these modifications and the benefits expected from them. Then, compare the benefits to society of IP commercialized in the US, under the Bayh-Dole Act, with the benefits achieved under the

commercialization policies of Canada. How do the policies differ, and to what extent are they responsible for the differences in societal benefits?

Exercise 4: As noted in this chapter, most large colleges, and virtually all research universities, have offices of technology commercialization or transfer to assist faculty and other researchers in dealing with IP. Contact the office or offices at your institution to learn of recent patent or trademark filings. Identify two or three researchers, from different disciplines, who made such filings and have them describe their experience so you can compare and contrast them. Ask these individuals to recommend improvements to the system, and to provide specific lessons learned that will help you in your own future filing. If your institution has no such office, contact your advisor, department chair, or dean to determine how to access such services.

Exercise 5: Use the Internet to identify a high-profile case involving a legal dispute over IP (e.g., patent, trademark, trade secret). Describe the nature of the dispute and the legal basis for it, referencing material presented in this chapter. Do you believe the dispute is justified? Why or why not? How might it have been avoided? Describe the outcome of the dispute and provide your thoughts about whether justice was served.

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