July/August 2018 iam
www.IAM-media.com

Does the United States have the national strategy and infrastructure to establish a technological lead?

Re-establishing the quality, strength and the predictability of the US patent system would make a major contribution to ensuring the nation's leadership in a wide number of technology areas

By Jason Lye, Sam Khoury and Corrine Sukiennik

Recent shifts in geopolitical strategies, as well as leaps forward in technology innovation, have brought into question the ability of the United States and the international community to lead in the development of technology, IP protection and enforcement.

As reported in *The Economist* on January 25 2018, former President Barack Obama realised late in his last term that the United States needed to make a concerted effort to innovate and advance the fields of artificial intelligence (AI), robotics, Big Data and directed energy weapons in order to maintain its technological military advantage. These efforts are still required from a military strategy perspective, as well as in order to ensure future economic success.

Given that a strong IP system is an essential element for an innovation-based economy, the Georgia IP Think Tank recently convened to contemplate the IP strategies of other countries and compare them with the current US technology and IP strategy. An intrinsic systemic weakness was identified; clearly, a deeper and more intensive analysis is required to fully understand the system's weaknesses.

While these problems may eventually require radical legislative and administrative action, the Georgia IP Think Tank has proposed some creative new legal and procedural frameworks aimed at improving US patent quality that could be implemented in the short term and with limited resources.

IP strategies in other countries

Intellectual property underpins and supports innovation by protecting the commercial rights from R&D investment. There are two approaches to long-term technological strategy: top down and bottom up. Both approaches have benefits and detractions, and what might work for one country may not necessarily be best for another.

Top-down approach

In a top-down approach, government economists and scientists identify broad areas of technology that their country must harness to support sustained economic growth over a 10 to 20 year period. The various government agencies then decide on a number of factors that foster the advancement of those technological fields (eg, where funding is allocated, tax incentives, infrastructure development and educational emphasis), which eventually feeds into national industries. Infrastructure development might include bolstering IP and administrative systems and enhancing the legal framework for policing and enforcement.

Many industrialised nations have chosen a top-down approach and implement an articulated national IP strategy. Such strategies specify the types of R&D to be funded in terms of basic scientific research, applied research, product development and commercialisation, as well as the technological area in which to focus (eg, biotechnology, tailored medicine and robotics). The application area (eg, defence, infrastructure and public health) may also be broadly specified to provide focus for a given nation and respective industry sectors.

As a case study, China first established a top-down national IP strategy in 1959, which focused on patent system infrastructure and was designed to support the country's science and technology strategy. An earlier iteration of this policy rolled out by Deng Xiaoping and Jiang Zemin in 2001 drove prior success, focusing on building the industrialisation of technology in China, as well as green technology. In other words, the national science and technology strategy's initial focus moved the emphasis from funding fundamental research to funding applied research directed at commercialising R&D from the rest of the world.

China's R&D budget has grown from negligible to 2% of the country's gross domestic product (GDP) over the past 30 years, while the US investment in R&D remains at 2.8% of an essentially flat GDP; China's investment in R&D is increasing at the same rate as its GDP is growing. The rise of giants such as Foxconn and Baidu is evidence of a shift that has contributed to the long-term growth of China as an economic powerhouse. Further, the fact that over 1 million patents were filed in China in 2017 – compared to 300,000 filed in the United States – validates the implementation of China's national IP strategy directed at strengthening its IP infrastructure and legal framework in preparation for the transition from a mass production to an innovation-driven economy.

South Korea is another example of a country that has successfully implemented a top-down national IP strategy with a focus on science and technology. Approximately 15 years ago, a taskforce was created to identify the top technology platforms likely to provide the most significant growth for the South Korean economy over the next 10 to 20 years. Co-author of this article Sam Khoury was consulted on developing the government IP strategy, which included assessing the economic effect of each platform. Following this,

the South Korean government put in place various economic incentives to foster R&D and innovation in those particular areas, which included stem cells, superconductivity and advanced electronic materials.

Bottom-up approach

Some countries – including the United States – exercise a bottom-up approach to technology strategy, particularly in the private sector. It has been argued that this approach is driven by the venture capital and stock investor community rather than relying on the government to predict which technologies will become important. A wide variety of new scientific inventions and technologies emerge as a result of basic and applied research using the bottom-up approach. Indeed, the majority of public funds invested into R&D in the United States support basic research.

Thousands of inventions in labs (and sometimes garages) across the United States are created then abandoned. Promising technologies evolve and grow and eventually attract attention. They catch the eye of investors; often such investment falls short of expectations – but occasionally, a new technology takes hold and is broadly implemented. During this process, the technological principles may eventually attract the attention of the legislature and federal funding agencies which build further on the underlying technology – as has been the case with solar energy and the Internet of Things.

A bottom-up approach can be more messy than a top-down approach, however, once the dust settles the return can be significant.

During the internet boom of the late 1990s, the NASDAQ index spiked with a frenzy of investment activity in everything internet-related – only to crash in the second quarter of 2000, as the market realised just how many companies had been overvalued. This wiped billions of dollars from the index and relegated all but a few entities to the dot-compost heap of history. However, since dusting themselves off after the crash, viable businesses such as Google Inc (now Alphabet), Amazon, Expedia, Priceline and others now play major roles in the current socio-economic environment. Therefore, the unease that accompanies the volatility and messiness associated with a bottom-up approach should be weighed against the possibility of significant unforeseen technologies emerging following the initial chaos of undirected invention.

An example of a roaring innovation success resulting from a bottom-up approach is a government initiative directed at providing funding for small, high-tech businesses. Instituted in 1983, the US Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programmes have facilitated the generation of 100,000 patents, and many commercial products spurring military, industrial and consumer technological advances in materials, manufacturing, biotech, hardware and software. The following are some success stories associated with the SBIR and STTR programmes:

- iRobot's Roomba series of domestic robots, including pool cleaners and vacuum cleaners, originated from an SBIR programme designed to develop military and submarine robots.
- Lasik technology relies on tracking eye movements during treatment, with precision and in real time. This technology was initially developed as part of the target tracking systems for anti-missile defence technology. The same capabilities that track fast-moving missiles were found to be applicable to tracking rapid eye movements in healthcare.
- More recently, Enchroma Inc was founded following an SBIR grant after researchers developing safety glasses for medical laser operators found that they could also help colourblind individuals to differentiate more colours.

Such initiatives have led to the grant of over $38 billion in public funds since 1990, which has been conjoined by

About the Georgia IP Think Tank

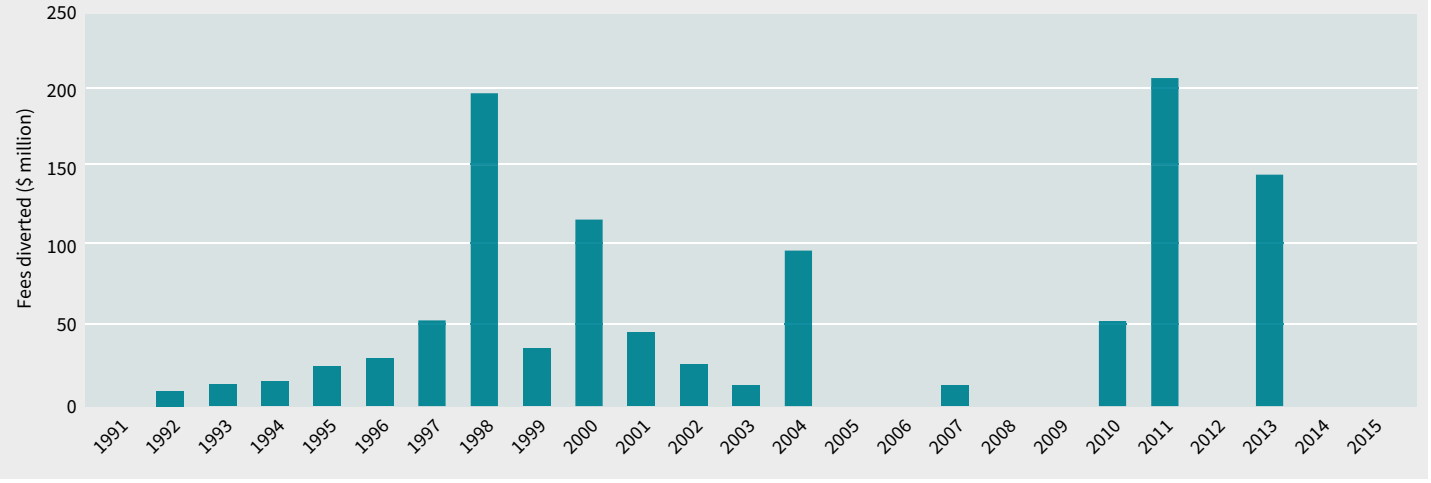
The goal of the Georgia IP Think Tank is to bring together IP professionals to work on IP strategy and policy matters affecting their businesses' economic growth and development. The think tank is organised within the broader Georgia IP Alliance, which is a partnership of the world-class legal and business schools of Georgia State University and Georgia Institute of Technology. The alliance includes major corporations, small businesses and bar associations and provides a platform for IP collaboration and networking.

Georgia's business strength and diversity make it exceptionally well-qualified to host the think tank, which represents Fortune 100 and 500 companies, small entrepreneurial start-ups, government research organisations and institutions of higher learning. In addition, it includes IP practitioners representing private law firms and service providers that are among the best known in the world.

Sponsorship has also grown for the annual event, with funding and support coming from Georgia State University, colleges of law and business, Georgia Tech College of Business and Venture Lab, Emory University, the State Bar of Georgia, the Atlanta Bar Association and The Licensing Executive Society. More recent sponsorship has come from the private sector, including Clarivate Analytics, Cantor Colburn, Perception Partners, Smith Gambrell & Russell, Baker Hostetler, Hartman and Citrin, Murgitroyd & Co and Lyco Works Incorporated.

The members of the Georgia IP Think Tank

FIGURE 1. User fees diverted from the US Patent and Trademark Office, 1991-2015



Source: IPO.org

around $60 billion private sector venture money, fuelling one of the true innovation engines of the United States.

The US approach relies on the invisible hand of Wall Street investors to spot and boost the development of economically significant scientific advancements. Occasionally, a technology can catch the attention of a leading politician, who might publicly mention it and before long the technology works its way to the top of public consciousness and becomes hot'.

As an example, former President George W Bush promoted a hydrogen-powered economy as a potential major future energy platform. Although there were claims of this being a clean energy source, there were myriad technical and engineering complications associated with storing, handling and transporting hydrogen gas. Following years of investigation, the technology has been de-prioritised in favour of more reliable, cost-effective approaches.

Nevertheless, political influence can dramatically affect the direction of R&D and US leaders have occasionally encouraged so-called 'moon shots'. Former President John F Kennedy did exactly that in the 1960s, spurring the successful completion of the most complex technical project of that era by sending man to the moon. More recently, former Vice President Joe Biden spearheaded the Patents 4 Patients initiative; an ambitious national call to action directed at escalating the development of cancer cures. As one result, patent applications relating to curing cancer now benefit from a fast-track examination system in the United States, which demonstrates the effect that national leadership can have in setting visionary goals.

While not a formalised national IP or science and technology strategy, the effect of the moon shot and Patents 4 Patients initiatives provides insight into the extent to which leadership guidance can influence the acceleration of technological development in a given field.

There are pros and cons to both approaches to the development of technology. The top-down approach relies on the government to identify technologies – which assumes that they possess the wherewithal to identify relevant disruptive technologies before they happen. This approach also provides clear direction and facilitates a concerted effort across multiple institutions. The more market-driven bottom-up approach is guided by investments, meaning that private sector management and technologists hold the crystal ball. The flexibility of this approach allows for the inception and incubation of disruptive wild-card technologies. A hybrid fusion of both approaches by individual industry sector may provide the best combination for technological and economic success.

Is a "couch to 5k" infrastructure programme needed for the USPTO?

Solid and protectable IP rights are widely accepted to be a cornerstone of commercial prosperity. In this way, intellectual property underpins and supports innovation by protecting the commercial rights generated by the cash invested in R&D. A 2016 report entitled "Intellectual Property and the US Economy – 2016 Update", co-authored by the US Patent and Trademark Office (USPTO) and the US Economics and Statistics Administration supports this position and highlights that in 2014:

- IP-intensive industries directly and indirectly supported 45.5 million US jobs – nearly one-third of all US employment.
- The share of US GDP attributable to IP-intensive industries rose to 38.2%, up from 34.8% in 2010.
- Workers in IP-intensive industries had on average 46% higher salaries than those in non-IP intensive industries.
- Patent and copyright-intensive industries have seen particularly rapid wage growth in recent years, with the wage premium reaching 74% and 90% respectively in 2014.

Clearly, IP intensive industries inherently rely on the legal strength of the intellectual property generated and issued within a country. The legal enforceability of intellectual property – including patents – has to be reliable and predictable, as well as resilient to challenges, in order to support these economic metrics. As far as trademarks and copyright are concerned, the United States ranks highly according to the US Department of Commerce – principally as a result of the country's entertainment industry.

However, with patent strength being of such economic importance, the US patent legal framework was recently

ranked at a shocking 12th place globally, far below fellow G7 members. This was a downgrade from its 10th place ranking in 2017. This sobering revelation in the 2018 Department of Commerce assessment of patents supporting economic growth was attributed partly to:

- the high rate of US patent trials and rejections (between 40% and 65% since 2011), and
- uncertainty regarding relatively recent US Supreme Court rulings on the patentability of certain software and biotech in the United States – both sectors have been targeted for future economic growth.

However, these are relatively recent influences; can these two factors alone really have led to this continuous decline? With US patent strength now ranked so low, what has happened to the country's patent system, which at one time was the envy of the world? While the USPTO is only one component of a larger legislative and administrative system, a closer look at its history could provide valuable clues for the reason behind the downward trajectory of US patent strength.

Budget – killing the golden goose

The USPTO is run like a business; fees associated with patent prosecution and maintenance are collected and used to fund office expenses. In return, the USPTO provides the economic golden eggs for the protection of innovation: assurance in a strong system in the delivery of quality patents, which are resilient enough to withstand legal battles over a 20-year life span.

The neglect and decline of the USPTO most likely began decades ago, starting with the practice of patent fee diversion from the office's budget to the Congress general budget. With a reduced budget, patent examination and patent quality have suffered over the years and the malnourished goose that lays the economic golden eggs has been slowly starved. Former presidents Bush and Obama, and President Donald Trump are all on record as having raised objections to fee diversion practices – in some years to the tune of hundreds of millions of dollars. However, the attrition of the USPTO continues to this day at Congress's behest.

In fact, none of this is news to anyone who has been paying attention and it certainly pre-dates the 2011 America Invents Act. In 2003, the then director of the USPTO James E Rogan warned a congressional sub-committee of an impending crisis that, unless action was taken quickly, would lead to prolonged pendency in the office and a deterioration in patent and trademark quality. This led to recruitment efforts, outsourcing prior art searches and a request that fee diversion be discontinued.

However, the very next year, almost $100 million of USPTO fees were diverted by Congress to unrelated federal programmes. Despite these diversions, the USPTO has succeeded in reducing pendency over the past 15 years, and former director Michelle Lee continued to push for further improvements in quality and reduction in pendency during her tenure.

TABLE 1. Percentage GDP dedicated to R&D by country

Year	United States	Germany	China	Japan	South Korea
1984	2.53%	2.43%	N/A	2.57%	1.5%
1994	2.32%	2.18%	0.64%	2.74%	2.26%
2004	2.49%	2.42%	1.22%	3.13%	2.53%
2014	2.8%	2.9%	2%	3.4%	3.6%

Source: S Degnan et al "What Happened And Is Happening to R&D And Technology Transfer", *Les Nouvelles*, p 138 (September 2016)

TABLE 2. European Patent Office versus US Patent and Trademark Office

	Examiner salary	Number of patent examiners	Patent training expenditure	Training budget per examiner	Average examiner tenure (70th Percentile)	Average patent pendency (months)
EPO	$157,000 net	4,300	$9.6 million	$2,230	Seven years	23.3
USPTO	$83,000 gross	8,351	$2.7 million	$320	Not found	25.3

Sources: FY 2016 USPTO accountability report, FY 2016 EPO Social Report and FY 2016 EPO Annual Report.

HR – training and tenure

In contrast to the USPTO, European governments clearly recognise the economic importance of the European Patent Office (EPO). They invest heavily in patent examiner education and ongoing training – €7.9 million ($9.6 million) in 2016 – which reflects the perceived long-term value in the EPO. EPO examiner salaries are also commensurate with the economic importance of the role: an examiner typically earns around €11,000 per month after taxes, which equates to an annual salary of $157,000 after taxes. Roughly 70% of EPO employees have a tenure of more than seven years, with some having been recruited in the 1990s.

Conversely, the USPTO pays patent examiners less than half that of their European counterparts: between $80,000 and $85,000 before taxes depending on their scientific training level. Training expenditure in 2016 was reported as being $2.7 million for patent examiners – roughly one-eighth of that of the EPO on a per-examiner basis. Anecdotally, examiner tenure at the USPTO is also pitifully low although no public records were found to statistically back this up. Columbia Law professor RJ Mann's "The Idiosyncrasy of Patent Examiners: The Effects of Experience and Attrition" (92 *Texas Law Review*, 2149 (2014)) showed that the tenure of an individual patent examiner reduced pendency and increased patent quality by a variety of metrics.

Emerging technologies

With such a low training budget, how can USPTO patent examiners possibly be expected to keep up to date with their understanding of emerging technologies? When do they get a chance to learn about new technologies so that they can judge the novelty of inventions (eg, spin-tronics, cryptography, metamaterials and blockchain) in an informed manner as they arise and are filed? Can the quality of a patent be judged if the underlying technology is not fully understood by trained experts with substantive experience?

Changes

To address the central question to this article; there is no doubt that intellectual property is essential to supporting societal economic growth and development, enhancing quality of life around the world and ensuring that national defence systems function correctly to protect citizens. There is also no doubt that there is an ongoing wealth of ideas coming out of private industry, academic research and government-funded institutions, which is a requirement for the future health of society. What is in doubt, is the ability

The Georgia IP Think Tank at work

of the US IP institutional systems in their present form to execute on these inventions in a timely and effective manner.

If the quality, strength and the predictability of the US patent system could be re-established, then there would be greater assurance to:

- make good on the billions of dollars invested by the public and private sector, as well as government and research institutions;
- advance US global competitiveness and fulfill the goals of both the business and government research and defence sectors; and
- fulfil the visions of industry and government alike in executing products, processes and programmes that could change the world for the better.

This has merely scratched the surface of what appears to be a progressive structural failure of the US patent system that continues to be in a trajectory of gradual decline. Clearly, a more in-depth examination of the system (ie, an analysis of the administration, structure, legislation, budget, leadership and policy behind it) is required to fully diagnose what is really going on and what could possibly be done to reverse the trend.

Pending a more in-depth analysis of the US patent system – above and beyond the plans implemented by the USPTO during the Bush, Obama and the current Trump administrations – the Georgia IP Think Tank had some recommendations that could potentially ameliorate the present situation. While not a silver bullet, implementing these measures may address both pendency for new technologies and enhance patent quality. Both solutions could be implemented relatively rapidly and with a low budget.

A new legal instrument – the 'mini' patent

Given that patent filings and issuances have almost tripled over the past 20 years, the Georgia IP Think Tank proposed a new type of patent. The model presents a new legal instrument for the United States, which is similar to the Chinese and German utility model patents and would provide a patent that has a more narrow claim scope and expedited examination and issuance.

Alternatively, building on the unique US provisional patent application, an expanded provisional patent could be envisioned with a lifetime of between five and 10 years. This takes into account the rate of technological change in many industry sectors.

The think tank also anticipates that prioritised examination will be implemented within five years, further highlighting the need for directional guidance, if not a formalised IP strategy in the United States. This has been done in several areas previously – for example, the 2011 Green Technology Pilot Programme Initiative provided the accelerated review of patents relating to this area, including greenhouse emission reduction, energy conservation and environmental quality improvement.

Public and automated patent pre-filing examination process

The think tank contemplated configuring AI to run expedited prior art searches. This idea was further developed to envision a trained AI system generally available to the public that could be used to rapidly examine patents before patent office submission. The think tank identified the following advantages to such a system:

- Early cull – the likelihood of issuance could be assessed while investment in the patent is still low through AI assisted pre-filing examination.
- Faster information – the speed of examination could be hours and days rather than months and years.
- Standardised examination – as examiners cannot be experts in all matters, this could also act as a uniform

Action plan

The Georgia IP Think Tank has taken the initiative to identify several aspects of the problems with the US patent system. While by no means intended as a silver bullet, recommendations should help to improve US patent quality and strength. These recommendations are of course, above and beyond current initiatives already underway within the patent office and include:

- a new patent instrument – a 'mini' patent – which would be similar in function and form to German and Chinese utility model patents, with reduced scope and expedited examination; and
- a novel AI-assisted pre-examination system with the potential to greatly improve efficiency, handle applications on new emerging technologies and increase the quality of applications before they land on the examiner's desk.

The think tank also identified areas that may warrant further study:

- whether a national IP strategy should be implemented in the United States and what form this should take;
- how to balance a national strategy in conjunction with a bottom-up approach using industry and academic research investments; and
- addressing the structural and organisational flaws in the USPTO's financial governance relating to funding and examiner training and compensation.

standardised initial examination, ameliorating any limitations in examiner training or experience.
- Broader reach – appropriately trained AI could pull information from all publications in all languages through machine translation during examination.
- Patent writing quality – the above advantages would spur an overall increase in the quality of the patent writing throughout process.

Review of a national IP, science and technology strategy

With many of the industrialised nations of the world applying a formalised national IP, science and technology strategy, it could be sensible to form a taskforce charged with examining what approach is most appropriate for the United States; whether that be a national top-down strategy, a bottom-up approach or even a hybrid synthesis of the two models.

A national strategy would offer more guidance as to the types of R&D that should be funded in terms of basic scientific research, applied research and product development, the technological area in which to focus (eg, biotech, tailored medicine, robotics, data storage or materials) and the application area (eg, defence, infrastructure, public health or transport). Input necessary to develop the strategy would be required from technologists from a wide range of sectors, including US government laboratories, industry leaders from a wide range of sectors, research universities, economists and the investment community.

Is there a way for the United States to have its cake and eat it? Is there an approach that allows for the generation of truly new and exciting products through R&D programmes, while a national policy drives the commercial execution of such programmes?

Certainly a resolution is required to protect the USPTO from fee diversion and to give the office the latitude to set its own budget, including compensation and training. Given that various presidential administrations and multiple studies have identified fee diversion as a key strategic weakness in the system, but congressional leaders continue to ignore the warnings, it is difficult to know what else can be done to reverse this trend.

The hungry fox is guarding the chicken coup in this situation and until legislative changes are made to protect USPTO funds – which would have to be initiated by Congress – not much can be done aside from decrying the neglect and decline of the US system, while other jurisdictional patent offices grow stronger and stronger. iam

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