

**From:** Rajendra Bera

**Sent:** Friday, January 13, 2017 6:04 AM

**To:** External Examination Time Study <ExternalExaminationTimeStudy@USPTO.GOV>

**Subject:** Request for Comments on Examination Time Goals

Dear Sir/Madam,

The attached response is specific to the USPTO's solicitation of public feedback as part of an effort to reevaluate its examination time goals. I would be happy to answer queries, if any, related to my response.

If you are placing my response for public view, please send me the URL from where it can be accessed.

Thanks.

Sincerely,  
Rajendra K. Bera

# Patent examination reforms

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## A response to

### Request for Comments on Examination Time Goals

USPTO, Federal Register, 25 October 2016, pp. 73383-73384 (2 pages) <https://www.gpo.gov/fdsys/pkg/FR-2016-10-25/pdf/2016-25758.pdf> and USPTO, Federal Register, 30 November 2016, pp. 86323-86324 (2 pages) <https://www.gpo.gov/fdsys/pkg/FR-2016-11-30/pdf/2016-28689.pdf>

This response is specific to the USPTO's solicitation of public feedback as part of an effort to reevaluate its examination time goals.

Written comments are due by January 30, 2017.

Written comments should be sent by electronic mail addressed to [ExternalExaminationTimeStudy@USPTO.gov](mailto:ExternalExaminationTimeStudy@USPTO.gov).

Title of response document: **Patent examination reforms**

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Disclaimer: The views expressed in this document are those of the author.

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**General Information:** The author's developing views on needed patent reforms are available in a series of working papers at [https://papers.ssrn.com/sol3/cf\\_dev/AbsByAuth.cfm?per\\_id=1752696](https://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=1752696)

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## Setting the context

The USPTO, in its *Request for Comments on Examination Time Goals*, has provided some background material<sup>3</sup>. In slide 2 of that material, it states its aim is now to “establish the optimal pendency and quality levels for both patents and trademarks that will enable [it] to operate efficiently and effectively in a steady-state maintenance mode, while considering the expectations of the IP community. –USPTO Strategic Plan 2014–2018.” In slide 22, the USPTO lists 7 questions, which it feels commentators might like to keep in mind when commenting. These questions reflect how patent applications are examined and examiner performance is currently appraised by the USPTO. No major reassessment of this practice has occurred in nearly 40 years during which the world has stepped into the post-industrial era with dramatically different socio-economic needs from that of the industrial era. The USPTO appears to have ignored this dramatic change and its related need for a radically different patent examination procedure along with a radically different patent application format and content. We infer this from the nature of the 7 questions provided in slide 22. The questions are largely irrelevant because they solicit suggestions to make the *status quo* more efficient, while the need is for radical change that would support the inventive spirit of the millennials and the globalized, knowledge-centered post-industrial socio-economic structures they are engaged in building.

A fundamental break from the past is that today inventions come not from artisans but university educated STEM (science, technology, engineering and mathematics) graduates. The PHOSITA (person having ordinary skill in the art) profile is vastly different from the time the first U.S. Patent Act of 1790 came into force. The admissible bar for patent grant therefore needs to be raised substantially to be consistent with the exponential progress being made in STEM<sup>4</sup>. The patent document needs to be written in a manner, devoid of legalese, that would allow STEM experts to understand the invention in relation to the technologies relevant to it. They must then evaluate the invention for patentability in view of accessible, contemporary, global store of STEM knowledge and a statistically relevant inventive profile of a contemporary PHOSITA, including its ability to independently create an invention fulfilling a similar objective as that of the said invention, say, in the next two years, if so tasked. If the invention is inevitable, it cannot be patented.

The existence of “silly” patents and disruptive patent trolls indicate that the U.S. patent system, *inter alia*, got into its present mess because the courts were given a task which it clearly could not undertake once artisans became a minority class (and eventually a vanishing class) among inventors and university educated STEM graduates began to displace them in prolific numbers in the twentieth century. Nothing can be more ludicrous than the fact that the “1-click” patent<sup>5</sup> was granted by the USPTO and the courts could not find a way of striking it down. How can the courts be trusted to deal with patent validity questions where deep STEM knowledge is required to just understand the invention and the USPTO has floundered or found itself out-of-depth in examining it?

In this paper, we describe a patent application preparation and examination process, and suggest the creation of an apex patent granting authority which we believe will better suit the needs of the post-industrial economy and be more in tune with the needs of the millennials than the present system. It will also ensure that the judiciary is not involved in deciding issues that require STEM knowledge.

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<sup>3</sup> Examination Time and the Production System, USPTO, <https://www.uspto.gov/sites/default/files/Examination%20Time%20and%20the%20Production%20System.pdf>

<sup>4</sup> See Kurzweil (1999), Kurzweil (2001).

<sup>5</sup> Method and system for placing a purchase order via a communications network, US 5960411, issued 28 September 1999.

# Patent examination reforms

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## **Abstract**

We note that industry no longer relies on the chance discoveries of gifted individuals working at random but follows a plotted course, *i.e.*, a strategically planned program of creating inventions to fit specific business needs. In light of this, we briefly comment on current examination practices of the USPTO related to patent grant and suggest reforms that we hope will better align the patent system with the socio-economic needs of the post-industrial era. Our suggestions bear in mind that the post-industrial economy is driven by disruptive technologies and innovative business practices on a scale never seen before. A distinctive feature of the post-industrial era is that patentable inventions come not from artisans but from science, technology, engineering and mathematics (STEM) educated university graduates in an environment where STEM knowledge and STEM-driven technology is advancing at an exponentially accelerated pace. We have limited our suggestions to some urgently needed reforms that have a bearing on patent examination. They are aimed at streamlining the patent system, reducing patent application examination time, and ensuring that patent validity and its monopoly scope is established before a patent is legally used in commerce or litigated in courts. We expect our suggested reforms will have fewer adverse effects on the public interest.

*Key words:* patent drafting, patent examination, patent grant, patent validation.

## **1 Core patentability conditions attached to patentable subject matter**

Patentable subject matter must face some core statutory tests of patentability before an invention can be patented. From the perspective of a relevant PHOSITA (person having ordinary skill in the art), they are utility, novelty and non-obviousness of the invention and that the invention must be teachable to a PHOSITA. In addition, the inventor must explicitly state what he claims is his inventive contribution and which parts and aspects of his invention he wants protected under the Patent Act. In this paper, we briefly examine current practices of the USPTO related to these requirements and suggest reforms that will likely better align the patent system with the socio-economic needs of the post-industrial era. We expect these reforms to have fewer adverse effects on the public interest and speed up the examination process.

To see the core patentability conditions in current perspective, we must bear in mind that the post-industrial economy is driven by disruptive technologies and innovative business practices on a scale not yet seen. It uses cloud computing (as a power source), artificial intelligence (*e.g.*, IBM's Watson to replace rote-educated workers), and data analytics (to enhance thinking) as core infrastructure blocks. Above all, today's inventors are STEM (science, technology, engineering and mathematics) graduates, not artisans. Additionally, modern companies now actively build patent portfolios following a "plotted course". As Harding notes:

Originally industry relied on the chance discoveries of gifted individuals working at random, their choice of problems being guided by their interests, backgrounds, abilities and the prospect they saw

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of making a profit from their activities. Modern research is planned to fit specific needs. A large element of unpredictability and discovery and in the value of discoveries in monetary terms, can no longer be permitted. [The so-called discovery and invention of serendipity.] In the 20th century industry saw that it could no longer rely on random discoveries and it turned to the accumulation of new knowledge. The science of invention was perfected and research discoveries were largely tailored to specific business or industrial requirements.<sup>8</sup>

The impact of IP (intellectual property) on industry is clearly evident.

With intangible assets now comprising more than 80 percent of the S&P 500 market value, understanding the effect of these assets is critical. Proof of the economic impact of intellectual property (IP) can be found in statistics like IP-intensive industries generating more than \$5 trillion in economic activity and creating 40 million jobs in the US. Similarly, companies with larger patent portfolios receive up to \$12 million more in startup funding than those without. And, the wages of employees in R&D-intensive industries are at least 30 percent higher than those in non-R&D industries.<sup>9</sup>

In this scenario, the judiciary's role in settling patent disputes also needs a fresh look. In particular, it is no longer feasible for courts, lacking deep knowledge in STEM, to decide whether a patent is valid or not, both in letter and spirit. Congress should create a new statutory body, the Patent Validation Board (PVB) (see Section 8), and all questions related to patent validity and extent of infringement that require STEM knowledge should be resolved by it and not the courts. Courts should decide only matters related to damages to be awarded in cases involving a valid and infringed patent or such other matters that are not STEM related. A publicly announced discovery of a new "law of Nature" (as conjectured by man) is likely to lead to many obvious ways of implementing active patents. Such implementations should not be seen as infringing an active patent but as an opportunity to find workarounds. Further, injunctive relief should not be granted in patent cases if the patent in suit has not been used or used only trivially in commerce or philanthropy within two years of patent grant at the time of filing the case. Patents not used in commerce or used only trivially within five years of patent grant will automatically be assigned to the government at the expiry of five years. In such cases the government will share, say, 30 percent of the profits it makes from the patent with the patentee.

For all practical purposes, human ingenuity has no limits. Humans will continue to innovate and invent till the human species dies, which it must one day before the Sun does according to the laws of physics. (We have about 7.6 billion years left before the Sun swallows the Earth<sup>10</sup> unless we accelerate our extinction in our enthusiasm for innovation by wrecking ecological havoc or exploding nuclear weapons.) One may even imagine a future where inventions emerge from artificial intelligence (AI) machines (the automaton-inventors, see Section 2.4) on demand without the need for patents.

## **2 The inventor vs. the person having ordinary skill in the art**

The post-industrial era inventor is no longer a gifted artisan, mechanic, engineer or technologist of the past but likely a gifted STEM graduate in a social structure where not only higher education is rapidly spreading but is a basic requirement in the job market. He is also far more likely to be an employed inventor working for a company focused on building a patent portfolio and to which company his inventions will be assigned. The PHOSITA too, though less gifted, is a STEM worker and generally superior to gifted artisans. It is thus necessary to reinterpret the basic nomenclature of the patent act. In Section 2.1 we redefine prior art, patentable invention, and inventor; in Section 2.2, the PHOSITA.

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<sup>8</sup> Harding (1941) at 386-387.

<sup>9</sup> Thomson Reuters (2015). Internal citations omitted.

<sup>10</sup> Big Think Editors, Stephen Hawking's Warning: Abandon Earth—Or Face Extinction, (undated; over a year ago), <http://bigthink.com/dangerous-ideas/5-stephen-hawkings-warning-abandon-earth-or-face-extinction>

## 2.1 Prior art, patentable invention, and inventor

Our revised definitions are:

### *Prior art*

“Anything that has existed or exists or can exist in nature in the absence of a thinking human belongs to prior art. Anything, since a thinking human began to populate the Earth, that exists or is known to have existed or was conclusively known that it could have been created by human, machine, or some human-machine combination in the past also belongs to prior art, except those human-created inventions which have been held secret so diligently that unless disclosed by the inventor they would remain so.”<sup>11</sup>

### *Patentable invention*

“Anything [not in the prior art] that reasonably could not have been created in nature without human intervention, observation, insight, serendipity, reasoning, ideation, or ingenuity, is eligible patent subject matter if that invention is replicable by others, if necessary, after diligent training, instruction, access to necessary materials, and availability of the requisite environment.”<sup>12</sup> Anticipation undermines patentability. The best inventions are often unforeseeable and bring in the aha! factor.

### *Inventor*

Any human capable of producing a patentable invention. To be named as a joint inventor in a patent, there should have been collaboration in the technical arts among inventors related to the invention claimed.<sup>13</sup> An inventor on a patent is one who first conceived of the invention (or some part of it) described in the patent in sufficient detail so that someone skilled-in-the-art can reproduce the invention. Ideas by themselves do not qualify as statutory subject matter, therefore they are not patentable. The idea must be augmented with sufficient details of the means for successfully implementing it. That is, a person who merely suggests an idea or a result absent the means of accomplishing it, is not an inventor. Likewise, one who has only followed instructions from another in making or assisted in the making of the invention (*e.g.*, a shop worker, or a supplier of reagents, or a technical assistant, who exercises only routine skills in following instructions) cannot claim inventorship.

## 2.2 Know the PHOSITA

The industrial revolution showed that science is not just about esoteric theories but also a social enterprise. It is more so in the post-industrial society. A patent system that aspires to march lockstep with scientific and technical developments to effectively serve the post-industrial economy, must intimately know the contemporary relevant PHOSITA, the most likely end user of patents. PHOSITA profiles of today are vastly different from those of the early 20th century, which ended with declining employment in the manufacturing sector while rising in the knowledge intensive service sector. The dominance of the service sector is now obvious as is the relative affluence of knowledge workers.

### *A person having ordinary skill in the art (PHOSITA)*

The PHOSITA as an entity is a person (or a team of persons) *prima facie* deemed to be a non-inventor but knowledgeable in the technical arts with respect to a given invention. It is deemed capable of reproducing an invention involving the technical arts it knows or is deemed capable of knowing in the normal course of its professional advancement. A PHOSITA is deemed to possess “normal creativity”

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<sup>11</sup> Bera (2016).

<sup>12</sup> Bera (2016).

<sup>13</sup> See Court Rules against University of Utah in RNAi IP Inventor Dispute, GenomeWeb, 29 September 2015, <https://www.genomeweb.com/gene-expression-research/court-rules-against-university-utah-rnai-ip-inventor-dispute>.

that comes from normally observed genetically coded curiosity, its general educational background, its general ability to learn and use its learning, and the general knowledge it is likely to absorb from its social and professional surroundings. The PHOSITA is a legal fictional entity capable of being profiled only in a statistical sense. Being an unlikely inventor, it serves as a base reference for determining, or at least evaluating, whether a given invention could have come from its normal professional efforts.

A PHOSITA's profile, at the minimum includes an ability to search and understand the prior art, an ability to pick up tacit knowledge, an ability to fit the teachings of prior art together like pieces of a puzzle, and the ability to meticulously follow and execute instructions from an expert, if necessary after an appropriate regime of training. It possesses a modicum of spontaneous creativity and is curiosity- or career-driven to self-learn to expand its skills in the art(s) and closely related arts relevant to its profession over time. Without this minimal profile, it is unlikely to remain employable in the long run. A PHOSITA "of necessity [has] the capability of understanding the scientific and engineering principles applicable to the pertinent art."<sup>14</sup> "This knowledge is not defined by way of educational credentials, but may be defined by evidence of the technical knowledge and work experience such a person may acquire in the workplace."<sup>15</sup>

A report<sup>16</sup> by the President's Council of Advisors on Science and Technology said that more than one million new STEM graduates will be required to fill high-tech jobs for the U.S. to stay competitive. The National Academies note that only 16% of American high school seniors are proficient in math and interested in a STEM career. Clearly, America's competitiveness is at stake. Success in providing STEM education will automatically raise the PHOSITA population, its profile, and its native ability to invent. It is important to note that for a given invention, the PHOSITA profile is a globally applicable profile and *not* a national profile.

A special issue of *Nature*<sup>17</sup> on *The 21<sup>st</sup> Century Scientist*, a report from the President's Council of Advisors on Science and Technology<sup>18</sup>, and two reports<sup>19</sup> from the National Academies underscore the need to build a massive workforce of STEM graduates to serve the 21<sup>st</sup> century economy of the United States. These graduates are the 21<sup>st</sup> century's PHOSITA in various technological areas. The editorial in *Nature* began with the observation that in essence describes the attributes of the new PHOSITA:

What does it take to be a successful scientist in the modern world? The obvious answers are deep knowledge of a discipline and mastery of the scientific method. But there are other key requirements, such as the ability to think critically and solve problems creatively and collaboratively. Communication skills are a must, and mastery of modern technology helps. For generations, classes in science, technology, engineering and maths (STEM) have been focused almost exclusively on building knowledge alone. A steady diet of lecture-based learning was designed to fill students up with facts and test their ability to memorize them. ... Now educators and education researchers are calling for change. They argue that creative thinking, problem solving, motivation, persistence and other 'twenty-first-century skills' can, and should, be taught and fostered through well-designed courses.<sup>20</sup>

Published prior art, PHOSITA profile, tacit knowledge and ordinary creativity are crucial for determining the usefulness, novelty, and non-obviousness of an invention vying for a patent. Inventions likely to

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<sup>14</sup> BPAI (1988).

<sup>15</sup> AIPPI (2010). *See also*: BPAI (1988).

<sup>16</sup> Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Report to the President, Executive Office of the President, President's Council of Advisors on Science and Technology, February 2012, [https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final\\_2-25-12.pdf](https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf)

<sup>17</sup> *Nature*, Vol. 523, 16 July 2015.

<sup>18</sup> White House (2012).

<sup>19</sup> Singer, *et al* (2012), Kober (2015).

<sup>20</sup> The Scientist of the Future, *Nature*, Vol. 523, 16 July 2015, p. 271,

[http://www.nature.com/polopoly\\_fs/1.17963!/menu/main/topColumns/topLeftColumn/pdf/523272a.pdf](http://www.nature.com/polopoly_fs/1.17963!/menu/main/topColumns/topLeftColumn/pdf/523272a.pdf)

come from a PHOSITA, if pressed to create, are not patent-eligible. Of the PHOSITA, the SCOTUS (Supreme Court of the United States) observed in *KSR Int'l v. Teleflex* (2007):

As our precedents make clear, however, the [obviousness] analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ. ... Common sense teaches, however, that familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle. ... A person of ordinary skill is also a person of ordinary creativity, not an automaton.<sup>21</sup>

However, SCOTUS' observation is myopic and incomplete in the context of the post-industrial era. For example, if a bunch of physics-PHOSITA facing mass unemployment decide to become cobblers, should this not change the cobbler-PHOSITA profile? How are patent examiners to deal with the situation when examining inventions coming from the cobbler community? There is another problem: say, a physicist, using his "common-sense", spontaneously and unknowingly solves a cobbler's problem and so infringes a related patent, should he be charged with infringement for doing something that comes naturally to him but not to a cobbler-PHOSITA? This anomaly remains unaddressed because it was never anticipated. In the future, such anomalies will arise frequently. Artisan inventors are an extinct species. They have been stamped out by STEM-PHOSITAS, who in turn are likely to be decimated by AI machines well before the end of this century.

The difficulty of PHOSITA profiling is currently partly mitigated by the fact that patent examiners and administrative patent judges on the Board<sup>22</sup> are "persons of scientific competence in the fields in which they work" and that their findings are "informed by their scientific knowledge, as to the meaning of prior art references to persons of ordinary skill in the art."<sup>23</sup> In addition, examiners "are assumed to have some expertise in interpreting the references and to be familiar from their work with the level of skill in the art."<sup>24</sup> This, however, is insufficient to handle unanticipated anomalies. In Section 6.2, we suggest that inventors themselves include relevant PHOSITA profiles in their patent applications at the patent filing stage to bring in greater clarity in contemporary PHOSITA profiling.

### 2.3 The prospecting form of innovation

Today, geeks among the knowledge workers rule.<sup>25</sup> The Silicon Valley in the U.S. is in big competition with Wall Street as another hub of American capitalism. The Valley's tech companies are worth over \$3 trillion. More importantly, it is the innovation hub of America. The innovations it spews, especially those that enable massive networking among people, touch the lives of almost anyone of worth. Its innovations are often disruptive, and it attracts huge investments and ambitious STEM talent; it has created a charmed circle of young people with great wealth, enthusiasm, and ideas. Their mantra is that technology can solve a vast majority of society's problems that government can't. "Silicon Valley also dominates markets, sucks out the value contained in personal data, and erects business models that make money partly by avoiding taxes."<sup>26</sup> The post-industrial economy and its innovators are radically different from that of the industrial economy. The pace of change is blistering. The patent system must rush to align itself to these changes.

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<sup>21</sup> SCOTUS (2007).

<sup>22</sup> Refers to the Board of Patent Appeals and Interferences (BPAI), which was an administrative law body of the USPTO which decided issues of patentability. Under the America Invents Act, the BPAI was replaced with the Patent Trial and Appeal Board (PTAB), effective September 16, 2012.

<sup>23</sup> CAFC (2003).

<sup>24</sup> CAFC (2008) (quoting CAFC (1984))

<sup>25</sup> See, e.g., Economist (20150725) (2015).

<sup>26</sup> Economist (20150725) (2015).

The 21<sup>st</sup> century economy needs STEM graduates who can use what they have been taught as tools for making connections between the unfamiliar new and the familiar old facts, draw inferences, create new information, and generally learn the art of making conjectures and incessantly test them to find errors. This requires radical changes in undergraduate science education.<sup>27</sup> Clearly, the workforce needed to support science-rooted innovations are researchers and not artisans. A researcher-PHOSITA no longer lives in an isolated ivory tower but is an active participant in turning universities into engines of economic growth.<sup>28</sup> He must develop not just multi-disciplinary STEM skills<sup>29</sup> but also soft skills required to connect and collaborate with the real world (because people are not entirely rational),<sup>30</sup> where inventions are now increasingly prospected via a planned business strategy.<sup>31</sup>

The prospecting form of innovation needs long-term vision and continuous investment from business leaders in cutting-edge R&D, and hence patience from stockholders regarding return on investment. Prospecting is a large-scale activity outside the realm of lone or small collaborative teams of artisan inventors. Patenting is now a grandly funded, organized, goal-specific, institutionalized, and business-oriented corporate activity. Indeed, most inventors today prefer to work as employees in such corporations to avoid the hassles of participating in the licensing or marketing of their inventions.<sup>32</sup> Most patents acquired through prospecting have very little direct commercial scope but serve as an arsenal in litigation. Small firms, on the other hand, often build a patent portfolio to look attractive to potential buyers.<sup>33</sup>

Prospecting generates an overlap of shared invention-specific STEM knowledge between inventor-employees and end-user employer who has complete access to the invention well before the patent application is filed. This large-scale source and means of funding innovation, built on a symbiotic relationship between inventors and end-users, had not been anticipated by the framers of the Constitution when they empowered Congress<sup>34</sup> *“To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries”*. (Article 1, Section 8, Clause 8 of the U.S. Constitution, September 17, 1787.)<sup>35</sup> As the terms were used at that time, “science” referred to knowledge, and the “useful arts” are what we now call technology. The resulting patent system was not geared to deal with an avalanche of patent applications arising from prospecting, and the massive debris of questionable patents that it spawned.

## 2.4 The automaton-PHOSITA

The patent system was never intended to be so altruistic as to turn every PHOSITA into an inventor worthy of a patent for whatever he invents under the Sun. In 1883, the SCOTUS admonished:

It was never the object of patent laws to grant a monopoly for every trifling device, every shadow of a shade of an idea, which would naturally and spontaneously occur to any skilled mechanic or operator [PHOSITA] in the ordinary progress of manufactures. Such an indiscriminate creation of exclusive privileges tends rather to obstruct than to stimulate invention. It creates a class of speculative schemers who make it their business to watch the advancing wave of improvement, and

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<sup>27</sup> Bradforth, *et al* (2015).

<sup>28</sup> Bera (2009b).

<sup>29</sup> For example, biological research has changed dramatically since mid-1990s to incorporate physical and computational sciences. Cutting-edge synthetic biology is even more multi-disciplinary in nature and requires sophisticated engineering skills. See Bera (2015a).

<sup>30</sup> Leiserson & McViney (2015).

<sup>31</sup> Silbey (2015); Harding (1941) at 386-387.

<sup>32</sup> Silbey (2015).

<sup>33</sup> Silbey (2015).

<sup>34</sup> Constitution of the United States, [http://www.archives.gov/exhibits/charters/constitution\\_transcript.html](http://www.archives.gov/exhibits/charters/constitution_transcript.html)

<sup>35</sup> This clause was proposed in 1787 by James Madison and Charles Cotesworth Pinckney. In Federalist No. 43, Madison wrote, “The utility of the clause will scarcely be questioned. The copyright of authors has been solemnly adjudged, in Great Britain, to be a right of common law. The right to useful inventions seems with equal reason to belong to the inventors. The public good fully coincides in both cases with the claims of the individuals.”

gather its foam in the form of patented monopolies, which enable them to lay a heavy tax on the industry of the country, without contributing anything to the real advancement of the arts. It embarrasses the honest pursuit of business with fears and apprehensions of unknown liability lawsuits and vexatious accounting for profits made in good faith.<sup>36</sup>

The observation went largely unheeded by the USPTO. Over a century later, the SCOTUS had to remind it in *KSR v. Teleflex* (2007) that a “person of ordinary skill is also a person of ordinary creativity, not an automaton.”<sup>37</sup> This time the USPTO took note but the SCOTUS should have gone further. By then artificial intelligence had already shown signs of maturing. Cognitive systems, *e.g.*, IBM Watson that beat two former *Jeopardy* champions in February 2011<sup>38</sup> and the intuitive decision making capabilities of Google DeepMind’s AlphaGo that beat the world Go champion Lee Sedol in March 2016 are now stark realities.<sup>39</sup> Intelligent machines outsmarting the average intelligent human have arrived. It is widely anticipated that future progenies of such machines will possess much greater creativity than that of many a PHOSITA of today or tomorrow, but being automatons their inventions cannot be patented nor can they be held guilty of infringement. The “patent exhaustion” doctrine<sup>40</sup> and the fact that automatons are not humans ensures that.

## 2.5 Resistance to change

Attempts to bring about radical change in STEM education, no matter how important, will, of course, face obstinate resistance from older generation academics settled in their ways and views and whose promotions and tenure were based on a system that ignored and *ipso facto* penalized innovative classroom teaching but emphasized publications, citation indices, and quantum of research grants received. Overcoming their resistance is crucial to ushering in change.<sup>41</sup> Change must eventually come since students who excel as undergraduates in a rote education system can seldom cope with research because they did not acquire a basic conceptual model of the subjects they learnt. A study shows that about 60% of U.S. students who enroll in a STEM field either switch to a non-STEM field or simply drop out. The drop-out rate is roughly 80% for students from minority groups and for women.<sup>42</sup> For an economy dependent on STEM experts, this is alarming.

## 2.6 An awakened USPTO

After years of heavy criticism about the quality of the patents it grants, the USPTO has woken up to its primary role in the patent system, that of issuing correct and clear patents. It notes the obvious:

Patents of the highest quality can help to stimulate and promote efficient licensing, research and development, and future innovation without resorting to needless high-cost court proceedings. Through correctness and clarity, such patents better enable potential users of patented technologies to make informed decisions on how to avoid infringement, whether to seek a license, and/or when to settle or litigate a patent dispute. Patent owners also benefit from having clear notice on the boundaries of their patent rights.<sup>43</sup>

The USPTO has finally decided to act.

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<sup>36</sup> SCOTUS (1883).

<sup>37</sup> SCOTUS (2007).

<sup>38</sup> Jackson (2011). Visit <http://www.ibm.com/smarterplanet/us/en/ibmwatson/> for more information.

<sup>39</sup> Gibney (2016) and Gibney (2017). *See also*: Nature Editorial (20160128) (2016). “A computer program that can outplay humans in the abstract game of Go will redefine our relationship with machines.” *See also*: News (20160315) (2016).

<sup>40</sup> *See* SCOTUS (2008).

<sup>41</sup> Waldrop (2015).

<sup>42</sup> Waldrop (2015), citing White House (2012).

<sup>43</sup> Lee (2015a).

It says, “After successfully reducing the backlog of unexamined patent applications, our agency is redoubling its focus on quality,” it hopes:

The end results will be the (1) ability to provide more targeted and relevant training to our examiners with much greater precision, (2) increased consistency in work product across the entire examination corps, and (3) greater transparency in how the USPTO evaluates examiners’ work product.<sup>44</sup>

Since Galileo, much of the rapid progress in science and technology has come not from philosophers in the tradition of Aristotle but from scientists as Galileo, Newton, *et al*, who put science on a firm abstract mathematical footing that emphasizes axiomatic systems and axiomatic reasoning. It is also appropriate to recall and adapt Isaac Asimov’s three laws of robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.<sup>45</sup>

The USPTO may adapt them as follows:

1. The USPTO may not injure the free-market economy or, through inaction, allow it to come to harm.
2. The USPTO must obey statutes given it by Congress except where such statutes would conflict with the First Law.
3. The USPTO must protect its own existence as long as such protection does not conflict with the First or Second Law.

After this, if the world still feels ill-served by the USPTO, it can seek judicial or legislative remedy.

### **3 Utility**

Utility is the quality or state of being useful. The USPTO’s Manual of Patent Examining Procedure (MPEP) instructs its examiners:

If at any time during the examination, it becomes readily apparent that the claimed invention has a well-established utility, do not impose a rejection based on lack of utility. An invention has a well-established utility if (i) a person of ordinary skill in the art would immediately appreciate why the invention is useful based on the characteristics of the invention (*e.g.*, properties or applications of a product or process), and (ii) the utility is specific, substantial, and credible.<sup>46</sup>

If a well-established utility is readily apparent, the disclosure is deemed to be implicit. On the other hand, a patent examiner must accept a utility asserted by an applicant unless there is evidence or sound scientific reasoning to rebut the assertion. In rare cases, the examiner may ask for an operative model of the invention for review. The specificity requirement prevents inventors from claiming utility of such a general nature as to be meaningless and then, after someone has found a utility not conceived by the inventor, claiming that use would have been obvious to men skilled in the particular art to which that use relates.<sup>47</sup> Specifically,

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<sup>44</sup> Lee (2015).

<sup>45</sup> Asimov (1950).

<sup>46</sup> MPEP (). 2107 Guidelines for Examination of Applications for Compliance with the Utility Requirement [R-11.2013].

<sup>47</sup> SCOTUS (1966).

‘... a patent is not a hunting license. It is not a reward for the search, but compensation for its successful conclusion.’ [*In re Kirk*, 376 F.2d 936, 942, 153 USPQ 48, 53 (CCPA 1967) (affirming rejections under §§101 and 112)<sup>48</sup>.]

It therefore follows that “basic” research, no matter how groundbreaking, may not lead to patentable inventions. While the patent system may generally not provide incentives for basic research<sup>49</sup> (yet, such research proceeds unabated because it is curiosity-driven), it does try to strike a balance by “giving the incentive to actual invention and not ‘attempt[s] to preempt the future before it has arrived.’”<sup>50</sup> Regarding utility, there is no need for the USPTO to change its current stand.

## 4 Novelty

The condition of novelty is a mandatory requirement. It requires one to be extremely vigilant about prior art related to the invention if a patent is being sought. Although novelty is a basic requirement, only its absence on the basis of searched prior art, not its existence can be proved. We say novelty is present if every element of an invention is not disclosed in a single piece of prior art. Prior art related to an invention exists if the invention was known or used by others anywhere in the world before the earliest application for a patent for the said invention was filed in any office in the world (usually a patent office) with the authority to accept patent applications. Knowledge of the invention, if ancient enough, may well be undocumented traditional knowledge handed down through generations by word-of-mouth or tradition and hence remain unknown to those seeking it. Documented knowledge can be in any language that is accessible to the people who are most involved with the technology of the invention.

Prior art is inimical to novelty. It does not include information distributed on a confidential basis, such as a paper under review by a scientific journal or a proposal to the National Science Foundation. Trade secrets are also excluded. The prior art need not be still in use. Once a prior art, forever a prior art. Provable existence of prior art means the said invention cannot be patented. To meet the novelty criterion, the claims for monopoly rights in a patent application must be different in at least one material<sup>51</sup> aspect from all inventions known, used, or described in a written publication. Generally, the inventor is not under a duty to search for information, but only to disclose information known to him to be material to the patentability of the invention. Since exhaustive prior art search can be very expensive and time consuming, it was considered pragmatic in the early days of patenting to let the USPTO dig out prior art as it had its own accumulating repository of prior art. Also, patent examiners were generally well conversant with the prior art in their respective areas of expertise. However, this also means that ignorance of prior art on the part of both the applicant and the patent examiner could be fatal. For example, if prior art is discovered by somebody being sued for patent infringement, then the patent can be revoked. How much time and money to spend on prior art search thus becomes a matter of risk assessment. In most cases, exhaustive prior art search is undertaken if litigation is anticipated after the patent is granted. Searches more exhaustive than those conducted by the patent examiner are expensive but small compared to the cost of litigation or having to abandon a product alleged to infringe a patent. In the United States, this problem is partially mitigated by the duty of candor and good faith (see Section 4.1). In Section 4.2 we explain why in the post-industrial era it is far better to do an exhaustive search while the patent application is being examined rather than after the patent has been granted.

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<sup>48</sup> SCOTUS (1966).

<sup>49</sup> Patent law, by design, has always been directed to the “useful Arts,” U.S. Const. art. I, § 8, cl. 8, meaning inventions with a practical use. see SCOTUS (1966).

<sup>50</sup> See CAFC (1993).

<sup>51</sup> Information is material where there is a substantial likelihood that a reasonable patent examiner would consider it important in deciding whether to allow the application to issue as a patent.

## 4.1 Duty of candor and good faith

“Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability.... The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned.”<sup>52</sup> The duty to disclose includes (1) each inventor named in the patent application, (2) each attorney or agent associated with the preparation or prosecution of the application, and (3) every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. The duty does not extend to typists, clerks, and similar personnel who assist with an application. The duty applies only to individuals, not to organizations. For instance, the duty of disclosure would not apply to a corporation or institution as such.<sup>53</sup>

The duty with respect to prior art extends to more than the mere submission of prior art. If the Examiner errs in interpreting a prior art reference in the applicant’s favor, the applicant must correct the Examiner. Also, the applicant must explain the relevance of any publication submitted in a foreign language or of any particularly relevant prior art document if it is being submitted as part of a long list of documents. Omitting information can lead to trouble. For example, suppressing unsuccessful and reporting only successful test data would be a violation. It is prudent to disclose unsuccessful tests and explain their irrelevance to patentability. A punishable violation requires more than a good faith or honest mistake. Omission or submission of false information with malicious intent that can be viewed as “inequitable conduct” or as committing “fraud on the Patent Office”, if proven, is punishable. Such inequitable or fraudulent conduct is usually discovered after a patent issues, typically in the context of a litigation. If such conduct is found during patent prosecution, the Examiner may strike the application. In litigation involving such conduct, courts may hold the patent-in-suit to be invalid or unenforceable, and in addition, may award attorney fees to the defendant in an infringement suit. The Supreme Court of the United States has also observed that fraudulent procurement of a patent due to inequitable conduct of a patent applicant can form the basis for an antitrust suit.<sup>54</sup>

Courts are likely to assume a granted patent to be valid with respect to information or prior art considered by a patent office during examination of a patent application. Therefore, a defendant accused of infringing a patent faces a very difficult burden in trying to prove that an issued patent is invalid based on prior art or other information that has been considered by the USPTO during examination. This burden is much lower if prior art can be found that had not been considered by the USPTO. There is apparently no enforceable rule that says that the patent examiner must act with candor and good faith and avoid granting “silly patents”.

## 4.2 Invest early in prior art search

Since the inventor is not under a duty to search for information, the effectiveness of the duty of candor and good faith gets diluted; the inventor can simply ignore or avoid an in-depth study of prior art by convincing himself that the duty lies with others. This should be actively discouraged today when knowledge is so easily accessible and computer-searchable using search engines. Inventors should therefore provide keywords used in their searches and a sample of relevant documents the searches showed up to indicate how diligent their search was.

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<sup>52</sup> See 2001.04 Information Under 37 CFR 1.56(a) [R-08.2012], MPEP, [http://www.uspto.gov/web/offices/pac/mpep/documents/2000\\_2001\\_04.htm](http://www.uspto.gov/web/offices/pac/mpep/documents/2000_2001_04.htm)

<sup>53</sup> See MPEP (2000-2001-04). More generally, MPEP (2000-2001). See also: Townes (2010).

<sup>54</sup> The U.S. antitrust law is the body of laws which prohibit anti-competitive behavior (monopoly) and unfair business practices.

Lack of candor and good faith, whether attributable to the patentee and those associated with him (coinventors, attorneys, *etc.*) or the patent office, almost certainly invites avoidable problems in litigation, which become prolonged, messy, expensive, and enormously stressful. In the post-industrial era, where knowledge is expanding at an exponential rate and in tandem so is technology, the risks of not doing a thorough prior art search and a detailed PHOSITA profiling can be enormous. It makes eminent sense to do this well before the patent application examination is completed and the related technology is put in commerce, especially by corporates with a strategic policy for building a patent portfolio. This upfront expense should be built into their budget and investment plans. This can be achieved with small extra expense since their R&D teams either possess or acquire this knowledge routinely in the course of their work and document it for writing research proposals, research papers, and hiring of STEM workers. In fact, providing this information in a timely manner during patent prosecution to the patent office should be a formalized mandatory requirement.

## 5 Non-obviousness

It's amazing what ordinary people can do if they set  
out without preconceived notions.  
– Charles F. Kettering

The obviousness test of an invention is with respect to a PHOSITA at the time the patent application for the invention was first filed, and not to the inventor, a judge, a layman, those skilled in remote arts, or to geniuses in the art at hand.<sup>55</sup> Thus the skill level of a PHOSITA is a fundamental reference against which the obviousness of an invention is measured. This measurement can only be subjective as it is based on a hypothesized statistical profile of an art-specific PHOSITA, who is presumed to know or can know through personal effort the prior art related to the invention. Factors that may be considered in determining the level of ordinary skill in the art may include: (1) “type of problems encountered in the art;” (2) “prior art solutions to those problems;” (3) “rapidity with which innovations are made;” (4) “sophistication of the technology;” and (5) “educational level of active workers in the field.”<sup>56</sup> “In a given case, every factor may not be present, and one or more factors may predominate.”<sup>57</sup>

In 1964, Judge Rich had eloquently noted:

As we refrain from granting patents on inventions that are not new, we must also refrain from granting patents on those inventions which would arise *spontaneously*, given the need or the desire for them, as the yelp of the dog surely follows from stepping on his tail, or with *only a nominal expenditure of time, effort, money or wit*—especially if the invention is one of real utility likely to meet with popular demand.<sup>58</sup> [Emphasis in the original.]

“The importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry.”<sup>59</sup> Of particular importance here is that

References which do not qualify as prior art because they postdate the claimed invention may be relied upon to show the level of ordinary skill in the art at or around the time the invention was made. *Ex parte Erlich*, 22 USPQ 1463 (Bd. Pat. App. & Inter. 1992). Moreover, documents not available as prior art because the documents were not widely disseminated may be used to demonstrate the level of ordinary skill in the art. For example, the document may be relevant to establishing “a motivation to combine which is implicit in the knowledge of one of ordinary skill in the art.” *Nat’l Steel Car, Ltd. v. Can. Pac. Ry., Ltd.*, 357 F.3d 1319, 1338, 69 USPQ2d 1641, 1656 (Fed.

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<sup>55</sup> CAFC (1983).

<sup>56</sup> CAFC (1995).

<sup>57</sup> CAFC (1995). *See also*: CAFC (1986), and CAFC (1983).

<sup>58</sup> Rich (1964).

<sup>59</sup> CAFC (1991).

Cir. 2004) (holding that a drawing made by an engineer that was not prior art can, nonetheless, “... be used to demonstrate a motivation to combine implicit in the knowledge of one of ordinary skill in the art”).<sup>60</sup>

And

If the only facts of record pertaining to the level of skill in the art are found within the prior art of record, the court has held that an invention may be held to have been obvious without a specific finding of a particular level of skill where the prior art itself reflects an appropriate level. *Chore-Time Equipment, Inc. v. Cumberland Corp.*, 713 F.2d 774, 218 USPQ 673 (Fed. Cir. 1983). See also *Okajima v. Bourdeau*, 261 F.3d 1350, 1355, 59 USPQ2d 1795, 1797 (Fed. Cir. 2001).<sup>61</sup>

The profile of a PHOSITA, and a realistic assessment of his ability to solve a problem using knowledge of prior art and his ability to exercise ordinary creativity would normally be sufficient to determine if an invention is non-obvious. (Despite this the 1-Click patent survived!) In view of Section 4.2, the patent application should include a PHOSITA profile that the inventor believes is justly applicable in relation to his invention.

## 6 Knowledge transfer

The way in which the building blocks of a body of thought are designated profoundly affects the development of that discipline.  
— H. C. von Baeyer, a noted physicist.

Language shapes the way we think and communicate. Russell and Norvig note that

Language is ambiguous and leaves much unsaid. This means that understanding language requires an understanding of the subject matter and context, not just an understanding of the structure of sentences. This may seem obvious, but it was not appreciated until the early 1960s.<sup>62</sup>

All branches of knowledge, of necessity, begin with a set of primitive but undefined terms, which are instinctively and universally understood in the related community’s knowledge schema. Then there are unproven axioms or laws which form the accepted foundation of a branch of knowledge. Finally, there are rules of inference which govern the creation of new knowledge or theorems using the primitive terms and axioms. Mathematicians are avid users of this form of knowledge creation. The aim is to eliminate subjective elements in knowledge building. The symbolic system used to represent knowledge is crucial. For example, doing arithmetic using the system of Roman numerals (I, II, III, IV, etc.) is far tougher than using the system of Arabic numerals (1, 2, 3, 4, etc.). With the former, it is unlikely that we would have put a man on the Moon in 1969. Likewise, the present style and legalese used in claim writing hinders comprehension and smooth flow of thoughts. It needs a drastic change.

Logic is the foundation of rational human thought. It deals with the terms “and”, “or”, “not”, “if”, “then”. Reasoning (or propositional calculus) is built around our notions of the correct usage of the words *if ... then ... (or implies), or, and, not*. It has a vocabulary, rules that tell us how to construct correctly formatted statements, and inference rules for deriving new statements from a given set of such statements. The inference rules are chosen such that if the statements in a given set represent true statements, then subsequently derived statements will also be true statements.

Logic underpins mathematics, and the natural sciences, especially, physics. The great advances in mathematics and the sciences were made possible because mathematicians meticulously developed a symbolic system to express their concepts, axioms, theorems, and proofs. When physicists adopted

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<sup>60</sup> MPEP 2141.03().

<sup>61</sup> MPEP 2141.03().

<sup>62</sup> Russell & Norvig (1995), Chapter 1.

mathematics as their language of expression (as Galileo and Newton did), it began to advance rapidly, as have chemistry, biology, and engineering since. With the publication of Isaac Newton's *Philosophiae Naturalis Principia Mathematica* in 1686, scientists, and later engineers, have gone from strength to strength using mathematics as their principal means of communication. Jurisprudence, although founded on logic, took a different route; it has relied on natural languages, with many of its built-in ambiguities, as its mode of communication. Consequently, courts cannot always interpret the law literally but must try to divine the intent behind the law before pronouncing their decisions. Literalist interpreters see it as subverting the statutes. In severe cases of ambiguity, the SCOTUS ends up with 5-4 decisions, leaving a feeling that it may well have been decided by tossing a coin. In interpreting mathematical rules or laws of Nature, intent is irrelevant.

## 6.1 STEM inventors and judiciary speak different tongues

Modern technologies have deep roots in science. While judges are obviously trained in logic, they seldom come to the bench as trained mathematicians or physicists, leave alone in frontier areas of science. Thus, judges lack the deep understanding needed to resolve subtle technology issues in patent litigation, and the gap widens by the day as both science and technology advance at a hectic pace never witnessed before. In addition, international commerce has become more complex partly due to globalization leading to patents being litigated in several countries simultaneously. To cap it all, judges must struggle with the inadequacy of natural languages in making decisions. In 1892, the SCOTUS noted that the written description and claims "of a patent, particularly if the invention be at all complicated, constitute one of the most difficult legal instruments to draw with accuracy."<sup>63</sup> In 1944, Billings Learned Hand said,

There is no surer way to misread any document than to read it literally. ... As nearly as we can, we must put ourselves in the place of those who uttered the words, and try to divine how they would have dealt with the unforeseen situation; and, although their words are by far the most decisive evidence of what they would have done, they are by no means final.<sup>64</sup>

It is rather unfortunate that the nature of language makes it impossible to capture the essence of a thing in a patent application. Consequently, the patentee bears the risk that others will devote their efforts toward exploiting the limits of the patent's language. The United States Court of Claims (now the CAFC), in *Autogiro* (1967) observed:

An invention exists most importantly as a tangible structure or a series of drawings. A verbal portrayal is usually an afterthought written to satisfy the requirements of patent law. This conversion of machine to words allows for unintended idea gaps which cannot be satisfactorily filled. Often the invention is novel and words do not exist to describe it. The dictionary does not always keep abreast of the inventor. It cannot. Things are not made for the sake of words, but words for things.<sup>65</sup>

Quoting the above passage, the SCOTUS in *Festo v. Shoketsu* (2002) observed:

The language in the patent claims may not capture every nuance of the invention or describe with complete precision the range of its novelty. If patents were always interpreted in their literal terms, their value would be greatly diminished. Unimportant and insubstantial substitutes for certain elements could defeat the patent, and its value to inventors could be destroyed by simple acts of copying. For this reason, the clearest rule of patent interpretation, literalism, may conserve judicial resources but is not necessarily the most efficient rule. The scope of a patent is not limited to its

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<sup>63</sup> SCOTUS (1892).

<sup>64</sup> *Giuseppe v. Walling*, 144 F.2d 608, 624 (2d Cir. 1944) (L. Hand, J., concurring).

<sup>65</sup> CAFC (1967).

literal terms but instead embraces all equivalents to the claims described. See *Winans v. Denmead*, 15 How. 330, 347 (1854).<sup>66</sup>

That there are unavoidable impediments in interpreting patent law comes as a surprise to inventors trained in STEM since they rarely face this problem when communicating about their inventions in the STEM community. The Patent Act requires the inventor to provide a full public disclosure of the invention under 35 U.S.C. § 112 (a, b)<sup>67</sup> as follows:

(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

(Amended July 24, 1965, Public Law 89-83, sec. 9, 79 Stat. 261; Nov. 14, 1975, Public Law 94-131, sec. 7, 89 Stat. 691; amended Sept. 16, 2011, Public Law 112-29, sec. 4(c), 125 Stat. 284, effective Sept. 16, 2012.)

While the SCOTUS's 1892 observation may have been true in its days, in 1967, it was an exaggeration. Surely highly complex aircraft and spacecraft could not have been flying at the time if engineers then did not know how to invent words and communicate their inventions without ambiguity. They did so not only among themselves, but also with computerized numerical control (CNC) machines. Modern inventors are adept at creating words, and with electronic publishing there is no need to stick to the archaic statutory requirement of verbalizing everything or drawing two-dimensional diagrams. One can additionally use videos, interactive computer programs, *etc.* to more than fulfill in letter and spirit the requirements of 35 U.S.C. § 112 (a, b). The text-cum-diagram description of an invention conveys information; a video description provides a nuanced look-and-feel experience about the invention and is much closer to the now abandoned requirement<sup>68</sup> of providing a prototype of the invention along with the patent application. (Models of inventions were required to be submitted from 1790 to 1880<sup>69</sup>. While Congress had abolished the requirement for them in 1870, the USPTO kept the requirement until 1880.<sup>70</sup>) Abolition is not the same as prohibition nor denial of a substitute. Modern communication, documentation and manufacturing means permit eminent alternatives, *e.g.*, the invention may be described in a video, or in an interactive computer simulation, or reproduced in 3D printed form. All such forms should be encouraged and permitted to speed up the patent examination process and for informing the public.

The intent of 35 U.S.C. § 112 (a) is to ensure that the applicant was in possession of the claimed invention at the time of filing and who through implication, explicit statements, analogies, broad hints, *etc.* has indicated what could *obviously* be achieved by a PHOSITA once he was in possession of the description. § 112 (b) requires the patentee to explicitly state those useful, novel, and non-obvious parts of the invention for which he wants patent protection; the rest, he relinquishes. The claims are written for comprehension by experts in the relevant technical arts. The claims delineate the STEM territory within which the invention resides and can be practiced literally or by drawing analogies within that territory (broad claims) or by making extensions and modifications that would be obvious

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<sup>66</sup> SCOTUS (2002).

<sup>67</sup> MPEP (), Appendix L.

<sup>68</sup> See, *e.g.*, Dougherty (2011). "Currently, applicants are neither required nor generally permitted to submit any type of working model with their patent application unless the USPTO deems it necessary for any purpose in examination of the application. See 35 U.S.C. 114 and 37 CFR 1.91(b)."

<sup>69</sup> Riordan (2002).

<sup>70</sup> News (20101215) (2010). See also: Patent Materials from Scientific American, Vol. 38 new series (Jan 1878 - Jun 1878), <http://www.myoutbox.net/posa38n.htm>

to a relevant PHOSITA (narrow claims) based on the relevant prior-art applicable at the time of patent filing. As Benjamin Whorf said, “Language shapes the way we think, and determines what we can think about.” And Ludwig Wittgenstein noted, “The limits of my language mean the limits of my world.”<sup>71</sup> Thus the only competent authority to decide whether 35 U.S.C. § 112 (a, b) has been fulfilled by the patentee should be a statutory body comprising STEM experts, *e.g.*, the Patent Validation Board (PVB) (*see* Section 8) and no other. Only they should decide if the applicant was indeed in possession of the claimed invention at the time of filing the related patent application.

## 6.2 Write for the expert; provide PHOSITA profile

Since 1900, advances in STEM and life sciences have been so remarkable that the average inventor is now university educated and communicates not just through written documents but also through the internet using audio-video recordings, *etc.* In the post-industrial era, these advanced modes should be intelligently used in describing an invention in a patent to satisfy the requirements of 35 U.S.C. § 112 (a, b). Patents are about useful, novel, and non-obvious technical inventions. Therefore, the inventor should diligently highlight the STEM content of the invention. Since the inventor, the PHOSITA, the end-user, the patent examiner, and members of the PVB are all STEM educated, and all are conversant with technical report writing, the entire specification should be written as a scientific/technical report. It should include (1) a summary description of the invention, its usefulness, and related prior art; (2) novel features of the invention; (3) non-obvious features of the invention; (4) detailed description of the invention and instructions for implementing it (including formulas, tables, charts, figures, videos, *etc.*) with illustrative examples; (5) claims: preamble followed by (a) core claims, and (b) peripheral claims (to claim IP territory under the doctrine of alternative equivalents) (*see* Section 6.5); (6) profile of inventors; (7) general STEM profile of PHOSITA hired to assist in the technical areas related to the invention, if applicable.

The post-industrial economy operates in a world where those engaged in agriculture in the advanced economies are a minority, while those engaged in manufacturing continue to decrease because of automation or jobs being shifted to less advanced countries. Most well-paid and sought after new jobs go to knowledge rather than blue-collar workers. Also, an overwhelming majority of inventors seeking patents are college or university educated with access to or work with STEM experts. Researchers, long used to the competitive world of “publish or perish” find themselves in an even more competitive world of “publish & patent or perish” because research universities and R&D laboratories are now turning into engines of economic growth. Thus, the most important readers of patents today are STEM experts who are inventors and potential inventors. It is therefore essential that the invention and claims are written in a language they think in and use to place the invention within the technological territory it belongs *without* consulting lawyers. Note also that the PVB comprises STEM experts and they must understand the STEM aspects of the patent so clearly that they can determine the obvious peripheral territory the PHOSITA may easily wander into and hence infringe the patent. The STEM community is well-versed in writing reports that convey knowledge in a manner their peers can use, verify, and replicate, while highlighting their personal contributions to the art. The STEM community is deemed to be well above average in intelligence and creativity. To coerce this community to write in legalese<sup>72</sup> with the help of lawyers is meaningless, if not atrocious.

The grant of a patent depends on the technical merit and social worth of an invention, which was unlikely to have been created without the incentive of a patent *and* which grant is not an embarrassment to society. On this measure, less than 10% of patent applications currently filed and currently active patents would survive if measured against a relevant contemporary PHOSITA profile. This ballpark figure is based on the fact that so few patents (about 3-5 per cent) are actually used in commerce indicating low quality or irrelevance or both of granted patents and the ease with which

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<sup>71</sup> The original statement was in German (“Die Grenzen meiner Sprache bedeuten die Grenzen meiner Welt.”)

<sup>72</sup> *See, e.g.*, Faber (2008), Burk & Lemley (2009), Petherbridge (2009), Golden (2008), and WIPO ().

patents can be obtained.<sup>73</sup> This has been known to inventors since the last few decades and the knowledge used by corporate patent portfolio builders to build IP arsenals. Therefore, the USPTO's recent initiative, although inadequate, in improving patent quality is to be welcomed. The task is daunting but absolutely necessary.<sup>74</sup>

The fact that most inventions today come from teams rather than individuals, makes the PHOSITA that much more versatile. Hence PHOSITA profiling is both critical and complex for reviewing a patent application. Therefore, it should be mandatory that the STEM profile of each inventor named in an application is provided and the nature of each inventor's contribution in creating the invention stated. This information will aid patent examiners choose an appropriate PHOSITA profile for patent application review. The same information can be used in courts if questions regarding the genuineness of named inventors in a patent arises. (This is related to § 115 Inventor's oath or declaration, and § 116 Inventors, of the Patent Act.<sup>75</sup>)

### 6.3 List inventors with care

When the SCOTUS noted that "A person of ordinary skill is also a person of ordinary creativity, not an automaton" it meant that by virtue of his training, experience, common sense and native intelligence, he will be able to decide on the required set of sub-tasks (even if not instructed in detail) and perform them in a manner so as to successfully complete the assigned task. He may even do so with a certain amount of 'ordinary creativity'. In essence, if the role of a person in the creation of an invention is that of a PHOSITA, then that person cannot be listed as an inventor in the patent application for the said invention.

Coinventors (or joint inventors) are allowed in a patent application provided each named inventor in the application fulfills the minimal requirement of providing a new idea and the means of implementing that idea in a manner that it contributes to the creation of the whole invention. That is, for each coinventor, there is at least one claim in the patent application that can be traced back to that coinventor. Note here that if an idea occurs to many people and they get together to file a patent application, that application is likely to be rejected on the ground that the idea was obvious since it occurred to so many people. If in a group of people involved in creating an invention, only one of them or some of them provided all the novel and non-obvious ideas required to create the invention, and the other(s) had only followed instructions in making the invention then only those who contributed the ideas may be named as inventors. Note also that if the final concept of the invention would not have come about without a particular person's creative involvement (even if such involvement occurred unknowingly), then that person is entitled to be a co-inventor of the invention. Those named as inventors in a particular patent application, should be able to describe to another how to practice the said invention. Correction of inventorship is permitted if the reasons for the change are due to genuine errors of omission or inclusion and non-malicious.<sup>76</sup>

A famous example of the difference between being a coauthor and a coinventor is the Cohen-Boyer patent<sup>77</sup>. Stanley Cohen and Herbert Boyer were the two inventors on U.S. Patent No. 4,237,224 issued on December 2, 1980. They invented a method of gene splicing that revolutionized biological research and launched the biotechnology industry. The patent was based on their November 1973 paper<sup>78</sup> for combining DNA from different organisms (recombinant DNA technology), which carried two additional coauthors who were not listed as coinventors in the patent. The patent was licensed to more than 450

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<sup>73</sup> Key (2010); Walker (2014).

<sup>74</sup> USPTO, Request for Comments on Enhancing Patent Quality, The Federal Register, 05 February 2015.

<sup>75</sup> MPEP ().

<sup>76</sup> See MPEP at 2137.01 Inventorship [R-11.2013], <http://www.uspto.gov/web/offices/pac/mpep/s2137.html>

<sup>77</sup> Cohen & Boyer (1980).

<sup>78</sup> Cohen, *et al* (1973).

licensees and generated \$255 million in licensing revenues from \$35 billion in worldwide product sales.<sup>79</sup>

Addition of ‘honorary’ coinventors or omission of genuine inventors in a patent application is illegal and can be a straightforward cause for invalidating the application or any resulting patent, if it is contested. In collaborative research arrangements, it is unlawful to enter into pre-patent filing agreements where it is agreed that all researchers in the project will automatically be joint inventors on patent applications resulting from the project.<sup>80</sup> Academic institutions need to be particularly careful when listing inventors in a patent application so that conventions of authorship are not inadvertently applied in place of the statutory requirements of inventorship. There is no such legal entity as an ‘honorary coinventor’.

#### **6.4 Describe the invention; claim the invention**

A critical part of the patent application requires the inventor to provide a description of his invention and distinctly claim its useful, novel, and non-obvious technical aspects as one’s rightful intellectual property. The description part conveys, with specific examples (embodiments of the invention), the technical aspects of the invention in such detail that an appropriate PHOSITA can reconstruct the invention with the information provided.

The claims should be written and annotated in a manner that the context and the technical territory it covers becomes evident to a relevant PHOSITA. This territory will generally be broader than that covered by the examples provided in the description and should include obvious extensions that a relevant PHOSITA is likely to divine once the invention’s description is placed in the public domain. Anything outside of this territory cannot be used to allege infringement of the patent. This means there will be no need for complicated Markman hearings, consideration of the doctrine of equivalents, and prosecution history estoppel. Central to achieving this objective is a multi-layered description of the invention in terms of networks (as understood in graph theory in mathematics) of subsystems.

##### **Description**

35 U.S.C. § 112 (a) provides ample freedom to the inventor to describe his invention in a manner best suited for communicating with the relevant PHOSITA and the community of STEM experts. Inventors therefore should write their invention using the language and ideas that are accepted in the field of the invention. This is because the patent application is meant to be read and understood by professionals in the field. So it is advisable to document the invention that is consistent with the community’s expected standards and conventions. However, bearing in mind the need to write unambiguous claims in their respective context, it is important that a special section be devoted in the description where the invention is decomposed into a network of subsystems (or subunits) (something in the nature of a wiring diagram or a computer flow chart). This decomposition must be provided at multiple levels of granularity at which subsystems are represented and connected to each other.

At the first level, the subsystems may be chosen to reflect their respective broad functionality so as to provide a conceptual understanding of the invention. At each subsequent lower level, each subsystem is treated as a system in its own right and further decomposed into a network of its own subsystems. Whether a subsystem at any given level must be further subdivided will depend on the amount of detail required to describe it, *i.e.*, till it is no longer meaningful to subdivide it further because further subdivisions are either obvious or not possible.

As one progresses to increasingly detailed levels of subsystems, one begins to deal less with abstract concepts and more with implementation details—the nuts and bolts—of the invention. The

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<sup>79</sup> Feldman, Colaianni & Liu (2007). *See also* Bera (2009a).

<sup>80</sup> Stell (2007).

complexity of an invention is usually decided by the way its subsystems at different levels are connected to each other. A network representation of an invention has great mathematical appeal since graph theory can be used to analyze the invention. For example, to those with a mathematical bent of mind, knowledge of graph theory would instinctively alert them to various possibilities by which the network can be changed such that for the same input its corresponding output can be delivered. This is the mathematical basis of the doctrine of equivalents (although not so understood by the courts).

The decomposition of a large system into interconnected subsystems is not unique. Different decompositions may suggest new and yet “obvious” variations, enhancements or synthesis of the original invention. This aids in expanding the scope of the invention explicitly when writing the claims without the need to evoke the doctrine of equivalents. Infringement is relatively easier to detect and prove if parts of a network representation of the alleged infringing device coincides with novel and non-obvious parts of a network representation of the patented invention in the case. The network representation of an invention does not require prosecution history estoppel to be in the picture in infringement cases. The network represents the invention and its equivalents. Claims that cannot be related to some part(s) of the network representation should not be allowed.

## Claims

Since the Patent Act of 1836<sup>81</sup>, U.S. patent applications mandatorily carry claims. At present, claims are written in legalese (stylized natural languages using patent law jargon) in which patent attorneys and patent examiners are trained in. The imprecision with which natural languages convey information also means that extracting meaning from that information may lead to linguistic ambiguities. For example, the sentence “Dust the place” may mean clean the place, *i.e.*, remove the dust *or* sprinkle powder over the place as when lifting fingerprints. Finding the right meaning often requires a context or background information.

When interpreting claims, the written description (text, equations, figures, *etc.*) of the invention provided in the patent application becomes the main source of context. Unfortunately, this source too comprises words and they too must be understood in their own context (the scientific and technical literature), and *ad infinitum*. It is a rare judge who will have more than superficial knowledge of the science and technology that underlies most modern patent worthy inventions. Therefore, the courts evolved a mechanism called the Markman hearing for the purpose of constructing claims in simpler language which can be understood by laymen, such as members of a jury, before delving into the legal aspects of a claim. Thus claim construction became central to determining the validity of a claim, and hence the validity of a patent and the scope of the covered invention.

The illogicality of the whole process seems to have escaped everyone’s notice. The judiciary seems to believe that claims must be written in legalese, even if judges have difficulty in understanding them and need them to be translated in plain English, using the fig leaf of making things understandable to a jury of non-experts and even perhaps uneducated people. Why then not insist in the first place that claims be written in a language that STEM PHOSITAs can understand and do away with Markman hearings? Indeed, the best solution is to keep the entire judiciary and jury away from anything that requires STEM expertise in patent litigation and let those things be decided by a body of STEM experts, *e.g.*, the Patent Validation Board. What perhaps got in the way is 35 U.S.C. 282(a) which says:

(a) In General.—

A patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an

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<sup>81</sup> Available at [http://ipmall.info/hosted\\_resources/lipa/patents/Patent\\_Act\\_of\\_1836.pdf](http://ipmall.info/hosted_resources/lipa/patents/Patent_Act_of_1836.pdf)

invalid claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity.<sup>82</sup>

The track record of the USPTO does not justify such a presumption, and the judiciary's record indicates that it feels so too. But how qualified is the judiciary in deciding patent validity? In 1949, well before the Markman hearing was established, Justice Jackson in his dissenting note in *Jungersen v. Ostby* wrote that

It would take a singular self-assurance on the part of one who knows as little of this art as I do, or as I can learn in the few hours that can be given to consideration of this case, to ignore the judgment of these competitors who grew up in the industry and say that they did not know something new and useful when they saw it. ... It would not be difficult to cite many instances of patents that have been granted, improperly I think, and without adequate tests of invention by the Patent Office. But I doubt that the remedy for such Patent Office passion for granting patents is an equally strong passion in this Court for striking them down, so that the only patent that is valid is one which this Court has not been able to get its hands on.<sup>83</sup>

Such is the fragile nature of a patent's validity in the present patent system!

The challenge lies in putting words in context and in deciding when the search for a context must end. As we shall argue below, claim construction is an unnecessary burden the courts have imposed upon themselves since this burden rightly belongs to the original patentee who was the inventor as he alone is responsible for fulfilling his part of the *quid pro quo* deal between himself and the public at large. In 1853, the SCOTUS erred when it liberally extended (by creating the doctrine of equivalents) certain presumptive benefits to patentees in cases of unclaimed subject matter in the claims.<sup>84</sup> That made claim writing and claim interpretation unnecessarily complex.

Given the rising demand for patents it makes sense to shift certain claim related judicial and patent office activities to the patentee. Such demand related shift is not new to society. When demand for phones expanded exponentially, the job of telephone operators was shifted to the telephone user. When the banking system expanded, automatic teller machines (ATMs) turned customers into tellers, etc. Likewise, patent examiners must now turn to automation and specialized search engines (e.g., a variant of IBM Watson) to find prior art and provide access to those tools to inventors so that they can perform their own prior art search before filing a patent application. We further suggest a manner of writing claims that comes naturally to STEM-educated inventors. It also does away with the need for claim construction by the judiciary completely.

We first note that when writing claims, a patentee broadens the scope of his invention from the specific embodiments of the invention he has described to a wider set of other possible embodiments by claiming a generic form of the invention to which the described and related embodiments and their obvious enhancements can fit. Such claim drafting requires STEM expertise. A network representation of the invention simplifies claim drafting and in delineating claim boundaries, especially during patent prosecution so that in future infringement litigation or patent validation tests neither prosecution history estoppel nor the doctrine of equivalents are required to be invoked. The aim here is to check the tendency of inventors (or rather their lawyers) from writing broad claims that are not supported by the invention's network representation; unsupported claims should be declared invalid.

Ideally claims should not be susceptible to multiple interpretations. To approach this ideal, the description of the invention in a patent should have a definitions part where the patentee lists specific words and phrases to which he has ascribed specific meanings. For all other words and phrases the

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<sup>82</sup> 35 U.S.C. 282 Presumption of validity; defenses. <https://www.law.cornell.edu/uscode/text/35/282>

<sup>83</sup> SCOTUS (1949).

<sup>84</sup> SCOTUS (1853). See also: Bera (2015c).

patentee should specify the dictionaries and like sources where their meaning can be found. No attempt should be made to override established legal terminologies or glossaries set down by the patent office. At least for science rooted inventions, claims should be written in mathematical or near-mathematical form wherever possible to avoid ambiguity in interpretation. Synonyms of technical words and phrases in the specification should be avoided even if ambiguity is unlikely. However, a synonym list should be provided along with the definitions to facilitate indexing of the patent for use by prior art search engines. If any reasonable ambiguity arises due to multiple interpretations of text or context in describing the invention and related claims, the benefit of doubt should go to those opposing the patent. The patent application should also include a PHOSITA profile that the patentee thinks is appropriate for the invention. The patent examiner may override this profile and document his own. The Patent Validation Board, in turn, may choose its own PHOSITA profile when deciding the validity of a patent.

A valid patent application must have at least one claim. Since infringement cases are fought around claims, it is surprising that they came to be written in such obtuse ways that Markman hearings became necessary. Logically claims should be written in a language the STEM community understands. It is therefore crucial that claims are written, as far as possible, in a language that is intolerant of ambiguity and allows reasoned arguments to flow to a unanimous conclusion. The only such language known to man is mathematics in which STEM experts frequently communicate – to describe and to reason.

Use of graphs, as in mathematical graph theory, should be popularized to describe the elements of an invention and relationships among elements. Known graph algorithms can be invoked to describe the invention's functionalities and capabilities. Further, alternative embodiments of the invention can be claimed under a more powerful doctrine of alternative equivalents where each alternative produces substantially the same (or the same) thing but by following an alternative path in the graph! It is like journeying from one place to another by choosing a path from multiple alternative paths. That, in essence, is our *doctrine of alternative equivalents*, and it can be captured unambiguously using graphs. In fact, if the graph turns out to possess a path from the starting point to the goal that is obvious with respect to the prior art, the invention *prima facie* is *not* patentable. On the other hand, if specific non-obvious paths have some compelling desirable properties, they can be individually claimed without the blanket benefit of the doctrine of alternative equivalents. If an "obvious" path is discovered after the patent is issued, that path should be treated as a non-infringing work-around and the patentee can decide if he wants to abandon his patent or have it reissued in amended form by individually claiming specific paths.

## **6.5 Claim the core, claim the periphery**

There should be two categories of claims: (1) core, and (2) peripheral. There must be at least one core claim. Peripheral claims, if any, should refer to at least one core claim; it cannot be broader than any related core claim nor subtract any elements or limitations from the same, but can only add elements or limitations to the core claim to which it refers so as to narrow the scope of the core claim. Any unpreferred core claim will also serve as its own peripheral claim.

Each claim of either category should be annotated and refer to relevant parts of the specification and, if necessary, to prior art to ensure that the claim's context is clearly established. This must be meticulously done since any reasonable ambiguity that may be created in the mind of a PHOSITA on reading the claims will mean the benefit of doubt going to those challenging the patent or facing allegations of infringement. The set of claims should be preceded by a preamble that clearly states the specific scientific and mathematical principles, if any, that form the basis of the invention, and, in summary form, highlight the novel and non-obvious aspects of the invention. If any of the valid novel and non-obvious aspects of an invention does not appear in the claims, then those aspects would be assumed to have been dedicated to the public once the patent is granted. Most importantly, they

cannot be reclaimed under the present *doctrine of equivalents* in litigation. This means that relevant parts of the SCOTUS decision in *Winan v. Denmead* (1853) must be abrogated.

The great advantage of using and referring to graphs while annotating claims is that alternative equivalents become visible in the graph and can be included in peripheral claims. Unclaimed equivalents visible in the graph will be deemed dedicated to the public. When writing peripheral claims one should ensure that every “substantial practical application” of an idea, conjectured law of Nature or natural phenomena is not included because such a patent “in practical effect would be a patent on the [idea, law of nature or natural phenomena] itself.”<sup>85</sup> Even when a claim applies a mathematical formula, say, as part of a seemingly patentable process, the Patent Office should try to ensure that it does not in reality “seek[] patent protection for that formula in the abstract.”<sup>86</sup>

Core claims are protected only to the extent associated peripheral claims and their isomorphs fence it. Peripheral claims are protected only to the extent they are explicitly claimed by the patentee. The aim here is to abolish the use of the doctrine of equivalents to posteriori extend claim boundary by having the patentee fence the boundary during prosecution itself. Reach-through claims are expressly prohibited. Any claim, core or peripheral, inadequately supported in the description of the invention should be treated as invalid unless one or the other or both are modified to remove the defect during prosecution. If a core claim is modified, then all related peripheral claims should be modified accordingly. This will eliminate the need for prosecution history estoppel since what is surrendered during prosecution would no longer appear in the confined boundaries of the claims.

All claims must be date-time stamped as to when they were last amended or if not amended, first introduced in the patent application. No claim can be deemed to have been infringed before its date-stamp.

## 7 Patent examination process

A patent application must be examined in light of (1) a relevant PHOSITA profile, (2) related state-of-the-art technologies, (3) a projection of PHOSITA-led advances likely to happen in the next 2-years (*i.e.*, “inventions which would arise *spontaneously*, given the need or the desire for them”), (4) the inventor’s description of the invention (using electronic aids for visualization, animation, *etc.*), (5) statutory requirements (subject matter, utility, novelty, non-obviousness, written description, *etc.*), (6) explicit claims of technology territorial monopoly, and (7) special obligations to be fulfilled by the patent owner if the patent is granted (*e.g.*, licensing policy if the patent is declared a standards patent, fair use for research, control of epidemics, *etc.*<sup>87</sup>). Item (7) should be dealt with by the PVB so that the patent does not impede further advancement of technology or become an embarrassment to society.

We propose a three-level patent examination process for the USPTO leading to the grant of a provisional patent. The final patent grant should be made by the PVB. The validity of such a patent cannot be contested in the courts. Allegations of patent infringement will also be dealt by the PVB, which will be the final authority to decide the extent to which infringement, if any, took place; it will not decide damages. The PVB’s decision will form the basis for the courts to decide the quantum and manner damages are to be awarded.

The first level examination may be done by a web-enabled, AI-driven computer system (*e.g.*, a particularized version of IBM Watson) for a nominal fee. Alternatively, for a substantially higher fee, it can be done by the USPTO examiners. The first level examination comprises (1) a determination of subject matter eligibility, (2) adequacy of the invention’s description, and optionally (3) proposed claims. A successful crossing of this level would imply that the inventor has an invention, possibly replicable by relevant PHOSITAs, and has a reasonable idea of the patent monopoly he wants. The first

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<sup>85</sup> SCOTUS (1972).

<sup>86</sup> SCOTUS (1981).

<sup>87</sup> Bera (2015b).

level output should include a list of prior art related to the invention, list of currently active or published patents, list of recent reviews in the arts related to the invention that were consulted. This will not only generate revenues for the USPTO, but eliminate, perhaps a few hundred thousand patent applications from clogging the USPTO's patent examination system and the downstream woes it creates.

At the second level (for a fee), in light of the invention's description and of a PHOSITA profile most closely related to the invention, a review team determines, if the invention could be useful someday, is novel, non-obvious, and reproducible by appropriate experts without further reference to the inventor(s), especially for tacit knowledge.

At the third level (and for a substantial fee), a team of STEM experts should examine the claims in light of the results of the second level examination. In particular, nothing can be claimed that could have been anticipated by a PHOSITA or has been anticipated since the submission date of the immediately preceding second level examination. The inventor can, however, add, modify and extend his earlier claims to explicitly include extensions that come under the doctrine of alternative equivalents. Every claim must carry a date-time stamp as to its birth or most recent amended form in the patent application to establish the date from which its existence became legal.

A rejected claim may be salvaged by returning to the second level (with a modest fee) and appropriately modifying the description of the invention that is strictly confined by the prior art prevalent on the date the patent application was first submitted for second level examination at the USPTO. Traversing between second and third level may be permitted as many times as the USPTO permits or till such time the third level examination formally terminates it. The patent applicant may terminate the process any time earlier at its discretion. At the successful conclusion of level 3 examination, the USPTO grants a provisional patent. The actual patent is granted by the PVB (see Section 8), *inter alia*, after satisfying itself that the patent will not be an obstacle to or impede the further socio-economic progress of society through misuse by the patent owner, *e.g.*, by denying licenses to standards related patents on FRAND terms to those in need of a license.

## 8 Patent Validation Board

The need for a Patent Validation Board (PVB) arises because the courts have found themselves in an untenable role due to lack of deep STEM knowledge. The situation arose because,

there were still abundance of cases which could not be brought under rule, until they should have presented themselves under all their aspects; and these investigations occupying more time of the members of the board than they could spare from higher duties, the whole was turned over to the judiciary, to be matured into a system, under which every one might know when his actions were safe and lawful. Instead of refusing a patent in the first instance, as the board was authorized to do, the patent now issues of course, subject to be declared void on such principles as should be established by the courts of law. This business, however, is but little analogous to their course of reading, since we might in vain turn over all the lubberly volumes of the law to find a single ray which would lighten the path of the mechanic or the mathematician. It is more within the information of a board of academical professors, and a previous refusal of patent would better guard our citizens against harassment by law-suits. But England had given it to her judges, and the usual predominancy of her examples carried it to ours.<sup>88</sup> — Thomas Jefferson (1813)

The U.S. patent system seeks to encourage the creation of new inventions and their dissemination. The *quid pro quo* expectations of society vis-à-vis a patent has two main aspects. First, a need to draw "a line between the things which are worth to the public the embarrassment of an exclusive patent,

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<sup>88</sup> Jefferson (1813).

and those which are not”<sup>89</sup>, and second, full public disclosure of the invention by the inventor. In either case, the judiciary is ill-equipped to express an opinion because of lack of STEM expertise.

The creation of the Patent Validation Board (PVB) would eliminate the court’s role in dealing with STEM-related issues. This also means that Markman hearings, doctrine of equivalents, reverse doctrine of equivalents, prosecution history estoppel will cease to exist. It will also put the USPTO on guard and drastically reduce the number of patents of dubious quality it issues and thus drastically reduce the activities of patent trolls.

In fairness, the legal validity of a patent’s claims should be decided by an independent statutory body, which we here call the *Patent Validation Board* (PVB). It must be independent because if it is inside an existing organization, *e.g.*, the USPTO, its existing culture will kill it. The PVB must be the final authority to decide if the claims of a provisionally granted patent are valid in law so that the public may know, with reasonable precision, the legal limits of monopoly protection attached to the patent without recourse to judicial ruling. The Board’s decision shall not be contested in a court of law unless there is clear evidence of corrupt practices indulged by the Board that could have impacted the decision. On such evidence, the court shall have the patent re-examined by a new Board. The Board may ask the USPTO to re-examine and provisionally reissue an amended version of the patent, if feasible. Such a reissued patent shall be treated as a new provisional patent for validation purposes. A provisional patent needs to be validated only once by the Board; it can be done at any time during the provisional patent’s tenure and the validation may be requested by any one. It would be in the interest of the patentee to have his patent validated and thus legally secured before engaging in any licensing or other commercial activity or litigation.

The Board should comprise experts in patent examination, STEM experts, experts in patent law and members from the National Academies, all suitably chosen keeping the patented invention in mind. The Board should be supported by an expert prior art search team. The Board may also crowd-source to find prior art. The Board shall *de novo* determine the relevant PHOSITA for the patent. The first question it should settle before anything else is the *quid pro quo* aspect of patent grant: “Would society have benefited more if the patent had not been granted without being unfair to the patentee?” If the answer is yes, the provisional patent should be revoked. The Board must decide keeping in mind the words of Thomas Jefferson:

Considering the exclusive right to invention as given not of natural right, but for the benefit of society, I know well the difficulty of drawing a line between the things which are worth to the public the embarrassment of an exclusive patent, and those which are not.<sup>90</sup>

The real strength of the Board lies in the cutting-edge knowledge STEM experts and members from the National Academies bring to evaluate the usefulness, novelty, and non-obviousness of a given invention and whether it has been fully described for an expert in the relevant arts to understand the invention and its implementation. They possess the expertise needed to decide the extent the doctrine of alternative equivalents can be applied in scoping the invention. This eminent body, in principle, is ideally suited to focus on what the patentee actually invented, how significant that invention is, and whether the grant of a patent to it would encourage innovation without being an embarrassment to society.

The PVB would have an instinctive understanding of a PHOSITA given that the normal duties of a STEM expert include hiring, mentoring, and supervising PHOSITAs. Science is an intensely human enterprise. The STEM experts are the right people to decide *inter alia* if the requirements of 35 U.S.C. § 112 (a, b) have been fulfilled in letter and spirit, not the courts.

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<sup>89</sup> SCOTUS (1989) at 148 (quoting Thomas Jefferson).

<sup>90</sup> Jefferson (1813).

At another level, the PVB is the ideal body to eliminate abuse of the litigation process by patentees who invent one thing and later claim to own something else entirely different, *e.g.*, under the doctrine of equivalents or by resorting to clever semantic debates which would not pass muster with the PVB. The PVB could rejuvenate the *doctrine of pioneer patents* so that important advances receive broader protection (subject to the patentee agreeing to license them under FRAND (fair, reasonable, and non-discriminatory) terms) than other patents. The creation of the PVB obviously requires that 35 U.S.C. 282 be amended and made consistent with the mandate of the PVB. The courts should strictly refrain from getting involved in STEM related aspects of an invention. Patent licenses should be legally and prospectively valid only after the validity of the patent is certified by the PVB. Further, courts should decide patent infringement cases of only valid patents and after the PVB has determined the extent the patent claims are trespassed.

In short, the PVB will be a statutory body created by Congress for the following reasons:

1. To serve as the final authority on deciding patent validity and in infringement cases, decide the extent of infringement of a valid patent. It will set up its own processes for deciding patent validity and when required, the extent a patent is infringed.
2. Once the PVB is established, the judiciary will have no say in STEM-related matters in patent litigation. Thus, there will be no need for the judicially created doctrine of equivalents, Markman hearings, prosecution history estoppel, and reverse doctrine of equivalents, if the patented invention is described and claimed as suggested in Section 6. This will essentially redefine the role of the judiciary and restrict its role to deciding only the quantum of damages to be awarded in litigation of valid and infringed patents.

While President Lincoln had the sagacity to create the National Academy of Sciences by an Act of Congress in 1863, as a private, non-governmental institution to meet the government's urgent need for an independent adviser on scientific matters and to "investigate, examine, experiment, and report upon any subject of science," no president since has shown similar sagacity to create a Patent Validation Board of similar STEM caliber to meet the nation's need for an independent adjudicator to "investigate, examine, experiment, and report upon any aspect of patent grant". It is ironical that in a STEM-driven post-industrial era, we feel "gratified when a politician shows that they know about science, [when] they all should."<sup>91</sup> In America, the most STEM-advanced country in the world, lawmakers being scientifically ignorant is politically acceptable because the electorate doesn't care about scientific literacy. This is anomalous given that most science funding is decided by politicians on behalf of the public. It is about time that America discards the English example of giving patent validity matters to judges to be resolved by law suits and hands it over to a "board of academical professors" so that "a previous refusal of patent would better guard our citizens against harassment by law-suits".<sup>92</sup>

## 9 Concluding remarks

A fundamental break from the past we face today is that inventions come not from artisans but university educated STEM (science, technology, engineering and mathematics) graduates. The PHOSITA (person having ordinary skill in the art) profile is vastly different from the time the first U.S. Patent Act of 1790 came into force. The admissible bar for patent grant has therefore risen substantially higher. These changes have occurred amid exponential advances in STEM and change of era from industrial to post-industrial economy. Circumstances dictate that the patent examination and grant procedures and the role of the courts in patent litigation be radically revised. We have suggested that the patent document be completely revised in terms of content and manner of presentation. It should be written in a manner, devoid of legalese, that would allow STEM experts to

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<sup>91</sup> Nature Editorial (20160421) (2016).

<sup>92</sup> Jefferson (1813).

understand the invention in relation to the technologies involved. They must then evaluate the invention for patentability against prior art and a statistically relevant profile of a contemporary PHOSITA, including its ability to independently create a like invention, if so tasked, given the need or the desire for it. Patent examination will be done by the USPTO in three stages culminating in the grant of a provisional patent or a rejection. Provisional patents will then be vetted by a newly created Patent Validation Board (PVB) which will then decide, *inter alia*, keeping in mind the larger interests of society, if the invention should be granted a patent or not. Further, the PVB will be the sole authority to decide if a patent has been infringed and the extent of infringement. The decisions of the PVB cannot be contested in a court. The courts can decide patent related issues only of valid patents, and where applicable, award damages based on PVB assessed infringement, and such other issues that do not involve STEM related questions. All contested STEM-related issues must be decided by the PVB. We expect our suggested reforms will have fewer adverse effects on the public interest and speed up the examination process.

## References

- AIPPI (2010). Question Q213, The Person Skilled in the Art in the Context of the Inventive Step Requirement in Patent Law, AIPPI, 07 April 2010, <https://aippi.org/download/committees/213/GR213usa.pdf>
- Asimov (1950). Asimov, I., I, Robot, 1950, [https://www.ttu.ee/public/m/mart-murdvee/Techno-Psy/Isaac Asimov - I Robot.pdf](https://www.ttu.ee/public/m/mart-murdvee/Techno-Psy/Isaac%20Asimov%20-%20I%20Robot.pdf)
- Bera (2009a). Bera, R. K., The Story of the Cohen-Boyer Patents, Current Science, Vol. 96, No. 6, 25 March 2009, pp. 760-763. [http://www.currentscience.ac.in/Downloads/article\\_id\\_096\\_06\\_0760\\_0763\\_0.pdf](http://www.currentscience.ac.in/Downloads/article_id_096_06_0760_0763_0.pdf)
- Bera (2009b). Bera, R. K., The Changing Role of Universities and Research Institutions in a Global Economy: Lessons Drawn from the US Biotechnology Sector, Current Science, Vol. 96, No. 6, 25 March 2009, pp. 774-778, [http://www.currentscience.ac.in/Downloads/download\\_pdf.php?titleid=id\\_096\\_06\\_0774\\_0778\\_0](http://www.currentscience.ac.in/Downloads/download_pdf.php?titleid=id_096_06_0774_0778_0)
- Bera (2015a). Bera, R. K., Synthetic Biology and Intellectual Property Rights, Intech, Chapter 9 in Deniz Ekinci (Ed.), Biotechnology, 2015, <http://www.intechopen.com/books/howtoreference/biotechnology/synthetic-biology-and-intellectual-property-rights>
- Bera (2015b). Bera, R.K, Standard-Essential Patents (SEPs) and 'Fair, Reasonable and Non-Discriminatory' (FRAND) Licensing (January 29, 2015), SSRN: <http://ssrn.com/abstract=2557390>.
- Bera (2015c). Bera, R.K., A Rethink on the Expansive Scope of the Doctrine of Equivalents in U.S. Patent Law (May 30, 2015), SSRN: <http://ssrn.com/abstract=2612300>.
- Bera (2016). Bera, R. K., Patent Subject Matter Eligibility (December 11, 2016), SSRN: <http://ssrn.com/abstract=2883838>
- BPAI (1988). *Ex parte Hiyamizu*, 10 USPQ2d 1393, 1394 (Bd. Pat. App. & Inter. 1988)
- Bradforth, *et al* (2015). Bradforth, S. E., *et al*, Improve Undergraduate Science Education, Nature, Vol. 523, 15 July 2015, pp. 282-284, [http://www.nature.com/polopoly\\_fs/1.17954!/menu/main/topColumns/topLeftColumn/pdf/523282a.pdf](http://www.nature.com/polopoly_fs/1.17954!/menu/main/topColumns/topLeftColumn/pdf/523282a.pdf)
- Burk & Lemley (2009). Burk, D. L., and Lemley, M. A., Fence Posts or Sign Posts? Rethinking Patent Claim Construction, University of Pennsylvania Law Review, Vol. 157, No. 6, Symposium: The Foundations of Intellectual Property Reform, June 2009, pp. 1743-1799, [http://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1202&context=penn\\_law\\_review](http://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1202&context=penn_law_review)
- CAFC (1967). *Autogiro Co. of America v. United States*, 384 F. 2d 391, 397 (Ct. Cl. 1967) (Fed. Cir. 1967), <https://casetext.com/case/autogiro-company-of-america-v-united-states>
- CAFC (1983). *Environmental Designs, Ltd. V. Union Oil Co.*, 713 F.2d 693, (Fed. Cir. 1983), <https://law.resource.org/pub/us/case/reporter/F2/713/713.F2d.693.83-554.html> (*cert. denied*, 464 U.S. 1043 (1984))
- CAFC (1984). *Am. Hoist & Derrick Co. v. Sowa & Sons*, 725 F.2d 1350 (Fed. Cir. 1984), <https://law.resource.org/pub/us/case/reporter/F2/725/725.F2d.1350.83-564.83-555.html>
- CAFC (1986). *Custom Accessories, Inc. v. Jeffrey-Allan Indust., Inc.*, 807 F.2d 955 (Fed. Cir. 1986), <http://openjurist.org/807/f2d/955>
- CAFC (1991). *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714 (Fed. Cir. 1991), <http://openjurist.org/950/f2d/714/ryko-manufacturing-co-v-nu-star-inc>
- CAFC (1993). *Fiers v. Revel*, 984 F.2d 1164, 1171 (Fed. Cir. 1993), <http://openjurist.org/984/f2d/1164/fiers-v-revel>
- CAFC (1995). *In re GPAC*, 57 F.3d 1573, (Fed. Cir. 1995), <http://openjurist.org/57/f3d/1573/in-re-gpac-inc>
- CAFC (2003). *In re Berg*, 320 F.3d 1310 (Fed. Cir. 2003), <http://law.justia.com/cases/federal/appellate-courts/F3/320/1310/615653/>
- CAFC (2008). *PowerOasis, Inc. v. T-Mobile USA, Inc.*, 522 F.3d 1299 (Fed. Cir. 2008)
- Cohen & Boyer (1980). Cohen, S. N., and Boyer, H. W., Process for Producing Biologically Functional Molecular Chimeras, U.S. Patent No. 4,237,224, issued December 2, 1980,

[http://v3.espacenet.com/publicationDetails/originalDocument?CC=US&NR=4237224A&KC=A&FT=D&date=19801202&DB=EPODOC&locale=en\\_GB](http://v3.espacenet.com/publicationDetails/originalDocument?CC=US&NR=4237224A&KC=A&FT=D&date=19801202&DB=EPODOC&locale=en_GB)

Cohen, *et al* (1973). Cohen, S. N., Chang, Annie C. Y., Boyer, H. W., and Helling, R. B., Construction of Biologically Functional Bacterial Plasmids In Vitro, *Proc. Nat'l Acad. Sci.*, Vol. 70, No. 11, November 1, 1973, pp. 3240-3244, <http://www.pnas.org/content/70/11/3240.full.pdf+html>

Dougherty (2011). Dougherty, E., What Are the Current Guidelines for Submitting Models with Your Patent Application? *Inventor's Eye*, USPTO, October 2011, <https://www.uspto.gov/custom-page/inventors-eye-what-are-current-guidelines-submitting-models-your-patent-application>

Economist (20150725) (2015). Inside Silicon Valley: Empire of the Geeks, *The Economist*, 25 July 2015, <http://www.economist.com/news/leaders/21659745-silicon-valley-should-be-celebrated-its-insularity-risks-backlash-empire-geeks>

Faber (2008), Faber, R. C., *Landis on Mechanics of Patent Claim Drafting*, Fifth Edition, 2008, <http://www.djstein.com/IP/Files/Landis%20on%20Mechanics%20of%20Patent%20Claim%20Drafting.pdf>

Feldman, Colaianni & Liu (2007). Feldman, M. P., Colaianni, A., and Liu, C. K., Lessons from the Commercialization of the Cohen-Boyer Patents: The Stanford University Licensing Program, in *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (Eds. A Krattiger, RT Mahoney, L Nelsen, *et al.*), 2007, [http://www.iphandbook.org/handbook/ch17/p22/index\\_print.html](http://www.iphandbook.org/handbook/ch17/p22/index_print.html)

Gibney (2016). Gibney, E., Google Masters Go, *Nature*, Vol. 529, 28 January 2016, pp. 445-6, [http://www.nature.com/polopoly\\_fs/1.19234!/menu/main/topColumns/topLeftColumn/pdf/529445a.pdf](http://www.nature.com/polopoly_fs/1.19234!/menu/main/topColumns/topLeftColumn/pdf/529445a.pdf)

Gibney (2017). Gibney, E., Google Secretly Tested AI Bot, *Nature*, Vol. 541, 12 January 2017, p. 142, [http://www.nature.com/polopoly\\_fs/1.21253!/menu/main/topColumns/topLeftColumn/pdf/nature.2017.21253.pdf](http://www.nature.com/polopoly_fs/1.21253!/menu/main/topColumns/topLeftColumn/pdf/nature.2017.21253.pdf)

Golden (2008), Golden, J. M., Construing Patent Claims According to Their 'Interpretive Community': A Call for an Attorney-Plus-Artisan Perspective, *Harvard Journal of Law & Technology*, Volume 21, Number 2 Spring 2008, pp. 322-29, 368-85, <http://cyber.law.harvard.edu/people/tfisher/Golden%20Claim%20Construction%20Abridged.pdf>

Harding (1941). Harding, T. S., Exploitation of the Creators, *Philosophy of Science*, Vol. 8, No. 3 (Jul., 1941), pp. 385-390, [http://www.jstor.org/stable/184309?seq=1#page\\_scan\\_tab\\_contents](http://www.jstor.org/stable/184309?seq=1#page_scan_tab_contents)

Jackson (2011). Jackson, J., IBM Watson Vanquishes Human Jeopardy Foes, *PC World*, 16 February 2011, [http://www.pcworld.com/article/219893/ibm\\_watson\\_vanquishes\\_human\\_jeopardy\\_foes.html](http://www.pcworld.com/article/219893/ibm_watson_vanquishes_human_jeopardy_foes.html)

Jefferson (1813). Letter from Thomas Jefferson to Isaac McPherson, 13 August 1813, [http://press-pubs.uchicago.edu/founders/documents/a1\\_8\\_8s12.html](http://press-pubs.uchicago.edu/founders/documents/a1_8_8s12.html) in *The Writings of Thomas Jefferson*. Edited by Andrew A. Lipscomb and Albert Ellery Bergh. 20 vols. Washington: Thomas Jefferson Memorial Association, 1905.

Key (2010). Key, S., 97 Percent of All Patents Never Make Any Money, *All Business*, 2010, <http://www.allbusiness.com/97-percent-of-all-patents-never-make-any-money-15258080-1.html>

Kober (2015). Kober, N., *Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering*, National Academies Press, 2015, <http://www.nap.edu/catalog/18687/reaching-students-what-research-says-about-effective-instruction-in-undergraduate>

Kurzweil (1999). Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, Viking Press, 1999.

Kurzweil (2001). Kurzweil, R., *The Law of Accelerating Returns*, 07 March 2001, <http://www.kurzweilai.net/the-law-of-accelerating-returns> See <http://www.kurzweilai.net/newsletters/daily/2016-10-12.html> for regular technology updates.

Lee (2015). Lee, M. K., *Enhanced Patent Quality Initiative: Moving Forward*, USPTO, 06 November 2015, [http://www.uspto.gov/blog/director/entry/enhanced\\_patent\\_quality\\_initiative\\_moving](http://www.uspto.gov/blog/director/entry/enhanced_patent_quality_initiative_moving)

Leiserson & McVinney (2015). Leiserson, C. E., and McVinney, C., Science Professors Need Leadership Training, *Nature*, Vol. 523, 15 July 2015, pp. 279-81, [http://www.nature.com/polopoly\\_fs/1.17955!/menu/main/topColumns/topLeftColumn/pdf/523279a.pdf](http://www.nature.com/polopoly_fs/1.17955!/menu/main/topColumns/topLeftColumn/pdf/523279a.pdf)

MPEP 2141.03(). 2141.03 Level of Ordinary Skill in the Art [R-6], USPTO's Manual of Patent Examining Procedure (MPEP), [http://www.uspto.gov/web/offices/pac/mpep/documents/2100\\_2141\\_03.htm](http://www.uspto.gov/web/offices/pac/mpep/documents/2100_2141_03.htm)

MPEP (). Manual of Patent Examining Procedure, USPTO, Ninth Edition, Revision 07.2015, Last Revised November 2015, <http://www.uspto.gov/web/offices/pac/mpep/>

Nature Editorial (20160128) (2016). Editorial, Digital Intuition, Nature, Vol. 529, 28 January 2016, p. 437, [http://www.nature.com/polopoly\\_fs/1.19230!/menu/main/topColumns/topLeftColumn/pdf/529437a.pdf](http://www.nature.com/polopoly_fs/1.19230!/menu/main/topColumns/topLeftColumn/pdf/529437a.pdf)

Nature Editorial (20160421) (2016). Editorial, Expect Knowledge, Nature, Vol. 532, 21 April 2016, p. 282, <http://www.nature.com/news/expect-knowledge-1.19771>

News (20101215) (2010). A Simple Fix for the US Patent System: The Legal Requirement for Working Models, KeelyNet, updated 15 December 2010, <http://keelynet.com/patentfix.htm>

News (20160315) (2016). Borowiec, S., AlphaGo seals 4-1 victory over Go grandmaster Lee Sedol, The Guardian, 15 March 2016, <http://www.theguardian.com/technology/2016/mar/15/googles-alphago-seals-4-1-victory-over-grandmaster-lee-sedol>

Petherbridge (2009). Petherbridge, L., On Addressing Patent Quality, University of Pennsylvania Law Review, Vol. 158, No. 13, 2009, pp. 13-26, <http://www.pennlawreview.com/online/158-U-Pa-L-Rev-PENnumbra-13.pdf>

Rich (1964). Rich, G. S., The Vague Concept of "Invention" as Replaced by § 103 of the 1952 Patent Act, Kettering Award Address, June 18, 1964, <http://innovation.hoover.org/media/file/ppl/GSR%20on%20Vague%20Concept%20of%20Invention%20in%20POS%201964.pdf>.

Riordan (2002). Riordan, T., Patent Models' Strange Odyssey, The New York Times, 18 February 2002, <http://www.nytimes.com/2002/02/18/business/18PATE.html?pagewanted=all>

Russell & Norvig (1995). Russell, S. J., & Norvig, P., Artificial Intelligence: A Modern Approach, Prentice Hall, New Jersey, 1995.

SCOTUS (1853). *Winans v. Denmead*, 56 U.S. 330 (1853), <http://supreme.justia.com/us/56/330/case.html>

SCOTUS (1883). *Atlantic Works v. Brady*, 107 U.S. 192 (1883), <https://supreme.justia.com/cases/federal/us/107/192/case.html>

SCOTUS (1892). *Topliff v. Topliff*, 145 U.S. 156 (1892), <https://supreme.justia.com/cases/federal/us/145/156/case.html>

SCOTUS (1949). *Jungersen v. Ostby*, 335 U.S. 560, 572, 80 USPQ 32, 36 (1949), <http://supreme.justia.com/us/335/560/case.html>

SCOTUS (1966). *Brenner v. Manson*, 383 U.S. 519 (1966), <http://supreme.justia.com/us/383/519/case.html>

SCOTUS (1972). *Gottschalk v. Benson*, 409 U.S. 63 (1972), <http://supreme.justia.com/us/409/63/case.html>

SCOTUS (1981). *Diamond v. Diehr*, 450 U.S. 175 (1981), <http://supreme.justia.com/us/450/175/case.html>

SCOTUS (1989). *Bonito Boats, Inc. v. Thunder Craft Boats, Inc.*, 489 U.S. 141, 151 (1989), <https://supreme.justia.com/cases/federal/us/489/141/case.html>

SCOTUS (2002). *Festo Corp. v. Shoketsu Kinzoku Kogyokabushiki Co.*, 535 U.S. 722 (2002), <http://www.law.cornell.edu/supct/pdf/00-1543P.ZO> (vacated and remanded)

SCOTUS (2007). *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. \_\_\_\_ (2007), <https://supreme.justia.com/cases/federal/us/550/398/opinion.html>

SCOTUS (2008). *Quanta Computer, Inc. v. L.G. Electronics, Inc.*, 553 U.S. \_\_\_\_ (2008), <http://www.supremecourt.gov/opinions/07pdf/06-937.pdf>

Silbey (2015). Silbey, J. M., The Eureka Myth: Creators, Innovators, and Everyday Intellectual Property (Stanford University Press, 2015); Suffolk University Law School Research Paper No. 15-7. Available at SSRN: <http://ssrn.com/abstract=2564768>

Singer, *et al* (2012). Singer, S. R., Nielsen, N. R., and Schweingruber, H. A. (eds), Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering, National Academies Press, Washington, D.C., 2012, <http://www.nap.edu/catalog/13362/discipline-based-education-research-understanding-and-improving-learning-in-undergraduate>

Stell (2007). Stell, D., Learning How to Get Along with Others, Published online: 23 August 2007, doi:10.1038/bioe.2007.3, <http://www.nature.com/bioent/2007/070801/full/bioe.2007.3.html>

Thomson Reuters (2015). The Future is open: 2015 State of Innovation, Thomson Reuters, <http://ip-science.interest.thomsonreuters.com/SOI2015>

Townes (2010). Townes, J. N., Ethics and Inequitable Conduct: Ethics, IDSs, and the Duty of Candor, American Intellectual Property Law Association, Patent Prosecution Training for New Lawyers, 25 August 2010, [http://www.aipla.org/Test%20Document%20Library/2010/pppt/Townes\\_Paper.pdf](http://www.aipla.org/Test%20Document%20Library/2010/pppt/Townes_Paper.pdf)

Waldrop (2015). Waldrop, M. M., The Science of Teaching Science, Nature, Vol. 523, 16 July 2015, pp. 272-4, [http://www.nature.com/polopoly\\_fs/1.17963!/menu/main/topColumns/topLeftColumn/pdf/523272a.pdf](http://www.nature.com/polopoly_fs/1.17963!/menu/main/topColumns/topLeftColumn/pdf/523272a.pdf)

Walker (2014). Walker, J., The Real Patent Crisis Is Stifling Innovation, Forbes, 18 June 2014, <http://www.forbes.com/sites/danielfisher/2014/06/18/13633/#5dce7d2f4183>

White House (2012). President's Council of Advisors on Science and Technology, Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics, White House, 2012, [https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final\\_feb.pdf](https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf)

WIPO (). WIPO Patent Drafting Manual, WIPO, [http://www.wipo.int/edocs/pubdocs/en/patents/867/wipo\\_pub\\_867.pdf](http://www.wipo.int/edocs/pubdocs/en/patents/867/wipo_pub_867.pdf)