Reinventing Invention:

Why Changing How We Invent Will Change What We Patent and What to Do About It

Abstract

Patent systems worldwide require applications demonstrate that the invention is nonobvious. The meaning of nonobvious has heretofore been based on the prototypical person having ordinary skill in the art (PHOSITA). Advances in technology now make comprehensive, mechanized searches for problem solutions practical, replacing insight with brute force and predefined algorithms. This, coupled with increasing insight into the mechanics of the problem solving process itself, challenge prior assumptions about the insight required for invention, with resulting policy implications for the "embarrassment of an exclusive patent"[1]. This paper addresses these challenges and describes a system of objective nonobviousness that can resolve some of the policy problems created by these changes in technology.

Collaborative Development

In May 1999, UC Berkeley launched a project called SETI@home. The goal was to enlist 100,000 volunteers to process radio astronomy data using spare PC CPU cycles to search for signs of extraterrestrial intelligence[2]. As the original Internet grid project, it quickly grew – garnering up to 3.8 million participants by July 2002[3]. Now sharing the stage with a host of other Internet grid projects, it has about 785,000 ongoing participants running 1.6 million computers[4].

After the anthrax attacks in the fall of 2001, a volunteer online project sprang up to fight biological terrorism. Using the infrastructure developed for SETI@home and managed by grid.org[5], the project operated from January 22, 2002 until February 14, 2002, ending after

---

[1] Letter from Thomas Jefferson to Isaac McPherson (13 Aug. 1813), *in* 3 THE FOUNDERS' CONSTITUTION, at 42 (Philip B. Kurland & Ralph Lerner, eds., 1986) (2000), *available* at http://press-pubs.uchicago.edu/founders/documents/a1_8_8s12.html (last visited Nov 25, 2008).

[2] About SETI@home, http://setiathome.berkeley.edu/sah_about.php (last visited Nov 17, 2008).

[3] David P. Anderson et al., *SETI@home: An Experiment in Public-Resource Computing*, COMM. OF THE ACM, Nov. 2002, at 56, *available at* http://setiathome.berkeley.edu/sah_papers/cacm.php.

[4] AllProjectStats.com | Overview, http://www.allprojectstats.com/overview.php?type=new (last visited Nov 17, 2008).

screening a total of 3.57 billion molecules.[6] Shortly thereafter, the grid.org sponsored research into Smallpox[7]. Working through the spring and summer of 2003, the world wide, Internet-based collaboration finished, having screened 35 million potential drug molecules against several smallpox proteins, resulting in 44 strong potential treatments, and shaving years off of the normal research time required.[8] The infrastructure used for these projects is open source[9], freely available, and currently in use on at least 59 projects[10] ranging from serious scientific inquiry to the search for a better Belgian beer.

Genetic Programming

In a parallel, but separate, development, John Koza, an adjunct professor at Stanford and entrepreneur, developed a software system to create patentable electrical designs from scratch[11]. In 1998 using genetic programming, he was able to recreate a number of simple circuit designs that had been previously patented[12]. He continued to expand his work, ultimately building a cluster of 1000 PCs[13] that, through 2003 had either created or recreated 36 "human competitive" designs[14]. Of these, 15 either would infringe or duplicate patents issued in the 20th century, six would infringe or duplicate patents issued in the 21st century, and two were patentable new

[5] grid.org has since changed directions. For current information about them, see About Grid.org, http://www.grid.org/about-grid-org (last visited Nov17, 2008).

[6] grid.org, http://en.wikipedia.org/wiki/United_Devices_Cancer_Research_Project (last visited Nov 17, 2008).

[7] *Id*.

[8] *Id*.

[9] BOINC Open-source software for volunteer computing and grid computing, http://boinc.berkeley.edu/ (last visited Nov 17, 2008).

[10] All Project Stats. Com, *supra* note 4.

[11] John B. Carnett & Eric Heinz, *John Koza has Built an Invention Machine*, POPULAR SCIENCE, Apr 19, 2006, http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine.

[12] *Id*.

[13] *Id*.

[14] 36 Human-Competitive Results Produced by Genetic Programming, http://www.genetic-programming.com/humancompetitive.html [hereinafter *Koza Results*] (last visited Nov 17, 2008). For a definition of "human competitive", see http://www.genetic-programming.com/humancompetitivedefinition.html (last visited Nov 17, 2008).

inventions[15]. Koza has been issued numerous patents for his invention system[16] and at least 1 patent on a generated invention itself[17]

The foundations of patent law

The foundations of patent law go back several thousand years. Hippodamus of Miletus, a prominent Greek architect in the 5th century BC proposed societal rewards for individuals who create things useful for society[18]. The modern history of patent law is considered to have started with the Venetian Statute of 1474, although the first Italian patent was actually issued in 1421 and the first English "letter patent" was issued by Henry VI in 1449[19]. These early approaches, while encouraging invention, did not actually specify criteria for determining what was worthy to be rewarded with a patent.

US Patents and Nonobviousness

In 1787, the writers of the US Constitution, recognizing the importance of technological and cultural advancement to economic growth, gave Congress the power "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"[20]. Since that time, US patent law has evolved as we attempt to strike an appropriate balance between the public, first inventors, and subsequent inventors. One of the key developments over time has been a honing of the requirements for patentability, in particular the requirement for "nonobviousness".

The key criteria for evaluating nonobviousness were laid down in *Graham v. Deere*[21] where the Court defined a 4 step test:

---

[15] *Koza Results,supra* note 14.

[16] US Patent Nos. **4,935,877 ; 5,136,686 ; 5,136,686 ; 5,148,513 ; 5,343,554 ; 5,390,282 ; 5,867,397 ; 6,058,385 ; 6,360,191 ; 6,424,959 ; 6,532,453 ; and 6,564,194 Note that Patent 4,935,877 expired on May 12, 2008.**

[17] US Patent No. **6,847,851.**

[18] Hippodamus of Miletus, http://en.wikipedia.org/wiki/Hippodamus (last visited Nov 17, 2008). Interestingly, Aristotle objected to this because of his perception that it would lead to a focus on the reward rather than on doing good for society's sake alone – thus foreshadowing the inherent tension between individual and societal interests. *Id*.

[19] History of patent law, http://en.wikipedia.org/wiki/History_of_patent_law (last visited Nov 17, 2008).

[20] U.S. Const., art I, §8, cl. 8.

[21] 383 U.S. 1 (1966).

> ***Under s 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy.***[22]

Subsequently, the Court added that an invention may be considered obvious if prior work contains a teaching, suggestion, or motivation that would lead one of ordinary skill in the art to try the invention[23]. This became known as the TSM test.

The latest refinement to the non obviousness requirement came in KSR v. Teleflex[24] where the court clarified that the TSM test should not be applied by rote. This decision led quickly to changes in patent examination guidelines. The updated US Manual of Patent Examining Procedure (MPEP) guidelines now list the following indicators of obviousness, any one of which will result in denial of patentability for lack of nonobviousness:

> ***"(A) Combining prior art elements according to known methods to yield predictable results;***
>
> ***"(B) Simple substitution of one known element for another to obtain predictable results;***
>
> ***"(C) Use of known technique to improve similar devices (methods, or products) in the same way;***
>
> ***"(D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;***
>
> ***"(E) 'Obvious to try' – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;***

[22] *Id.* at 17-18.

[23] *In re* Sponnoble, 405 F.2d 578 (1969).

[24] KSR v. Teleflex, 550 U.S. 398, 127 S. Ct. 1727, 82 U.S.P.Q.2d 1385 (2007).

> ***"(F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;***
>
> ***"(G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention."[25]***

Specifically, in that opinion, Justice Kennedy stated, "A person of ordinary skill is also a person of ordinary creativity, not an automaton."[26] In using this phrase, the Court was pointing out that even someone of ordinary skill will not, when attempting to solve a problem, "be led only to those elements of prior art designed to solve the same problem"[27]. However, by wording it this way, the Court was assuming that an automaton would never be as good (or better) than a person of ordinary skill. Those words may well prove fateful.

Looking Overseas – Is the Inventive Step any different?

While US patent procedures have progressed in their definition of what nonobviousness is not, there appears to be no progress in the US in the definition of what nonobviousness is. Looking overseas provides only a little additional insight.

The European Patent Office (EPO) standard for patenting is a technical Problem-and-Solution approach[28]. While the EPO uses the term "inventive step" instead of "nonobviousness", the key issue in evaluating patentability under this system is determining "whether there is any teaching in the prior art as a whole that *would* … have prompted the skilled person, faced with the objective technical problem, to modify or adapt the closest prior art while taking account of that teaching, thereby arriving at something falling within the terms of the claims, and thus achieving what the invention achieves" [emphasis added][29]. The EPO system consists of three steps:

---

[25] U.S.P.T.O., MANUAL OF PATENT EXAMINING PROCEDURE § 2143 (8th ed., rev. 2007) [hereinafter *MPEP*].

[26] *KSR*, 127 S. Ct. at 1742.

[27] *Id.* At 1732

[28] ADMIN. COUNCIL OF THE EUR. PATENT OFFICE, IMPLEMENTING REG. TO THE CONVENTION ON THE GRANT OF EUROPEAN PATENTS, Rule 42(1)(c) (2006).

[29] EUROPEAN PATENT OFFICE, GUIDELINES FOR EXAMINATION IN THE EUR. PATENT OFFICE, Part C, Ch. IV, §11.7.3 (2007).

(i) identifying the "closest prior art" to the claimed invention, (ii) determining the "objective technical problem" that the invention claims to solve, and (iii) in light of the prior art as a whole, assessing whether or not a skilled person could have, in an obvious manner, derived the solution to the technical problem from the closest prior art.[30]

Further, the EPO requires that the inventive step must be technical. As stated in the *Comvik* decision[31],

> ***based on the ordinary meaning to be given the terms of Article 56 EPC in their context in the EPC, and consistent in particular with Rule 27 EPC,[32] as a test for whether an invention meets the requirements of Article 56 EPC, the boards of appeal have developed and applied a method known as the "problem-and-solution approach", according to which an invention is to be understood as a solution to a technical problem. This approach requires identification of the technical field of the invention (which will also be the field of expertise of the person skilled in the art to be considered for the purpose of assessing inventive step), the identification of the closest prior art in this field, the identification of the technical problem which can be regarded as solved in relation to this closest prior art, and then an assessment of whether or not the technical feature(s) which alone or together form the solution claimed, could be derived as a whole by the skilled person in that field in an obvious manner from the state of the art. For the purpose of the problem-and-solution approach, the problem must be a technical problem, it must actually be solved by the solution claimed, all the features in the claim should contribute to the solution, and the problem must be one that the skilled person in the particular technical field might be asked to solve at the priority date.[33]***

[30] *Id.* at § 11.7

[31] D E C I S I O N of the Technical Board of Appeal 3.5.1 of 26 September 2002, Case Number: T 0641/00 - 3.5.1, ¶ 5 (*Comvik* GSM AB)

[32] In the revised Implementing Regulations adopted on December 7, 2006, Rule 27 is now Rule 42.

[33] *Comvik*.

The invention may consist of technical and non-technical features, but, to qualify for a patent, the inventive step must be technical. While the requirement for an "objective technical problem" raises the bar over the US standard of simple novelty, stage iii still relies on a determination of whether or not the PHOSITA "could have, in an *obvious* manner, derived the solution to the technical problem" (emphasis added). In other words, there is still a nonobviousness requirement.

Japan's standard splits the difference between the US and the EPO. It does not use the problem-and-solution approach, but does start from a single prior art reference. It does not use "secret prior art" when evaluating novelty, but it does consider both technical and non technical factors of the invention. Evaluation of inventive step requires, among other things, determining if "there are suggestions to the claimed invention in the prior art."[34] In particular, secondary indicia such as advantageous or unexpected effects come into play when evaluating nonobviousness[35], but these must linked to the technical features of the invention[36]. The net result is that the standard for nonobviousness in Japan is very similar to the US standard, particularly post *KSR*.[37]

NonObviousness – The Net Result

The net result is that there are nonobviousness criteria in patent statutes around the world. However, while there are rules in each jurisdiction demarcating areas that are clearly obvious (such as the MPEP guidelines above), there are still many areas where the boundary between obvious and nonobvious remains fuzzy. With continued automation, the location of this boundary will become increasingly important. Further, there can be a distinction between brute force searches that shrink the set of possibilities to a manageable few that can be further investigated by humans, and searches that actually arrive at an answer. As examples, take protein folding, cancer research, anthrax or smallpox projects mentioned previously[38]. These examined billions of choices to cull the test set down to a few promising choices still requiring work to find the desired end result. Although the sample size in those cases was large (in the billions), it still trips on MPEP criteria (E) – "choosing from a finite number of identified,

[34] MARGO BAGLEY, JAY ERSTLING & RUTH OKEDIJI, GLOBAL PERSPECTIVES ON PATENT LAW (2008) (unpublished manuscript, on file with the author).

[35] *Id.*

[36] *Id.*

[37] Tomotaka Homma, *Comparing Japanese And U.S. Standards Of Obviousness: Providing Meaningful Guidance After KSR*, 48 IDEA 3449 (2008).

[38] For more details on the projects hosted by grid.org, see http://en.wikipedia.org/wiki/United_Devices_Cancer_Research_Project (last visited Nov 25, 2008).

predictable solutions, with a reasonable expectation of success"[39]. On the other hand, Koza's Invention Machine worked all the way to the end result – there was no human effort left but transcription of the answer[40]. This may bump into MPEP criteria (A) – (D) or (F) – depending on how predictability is defined.

Predictability is at the core of the criteria above. While the starting point of predictability must always be prior art, the end point currently depends on human perceptions of predictability. Human perceptions of predictability turn on two issues: the length of a chain of logic and the number of choices at each juncture. As the chain of logic or calculation gets longer, it becomes harder and harder for humans to estimate, much less predict, its outcome, even when the calculation, if done, has a definitive answer. Additionally, even a short chain that has many choices for each subsequent link quickly results in combinatorial explosion. This makes it effectively impossible for most humans to determine the sequence of links that will result in the desired outcome. Our estimations of predictability are based on evaluations of the ability of an average human to reach a particular conclusion in the face of these two issues[41].

While humans may find it difficult to deal with long chains or many choices, computers do not. They do not sleep, get bored, forget or get distracted. As a result, they can plow through chains of any length and as many choices as they have time. Consequently, what may not be predictable to humans could be easily predicted by computers (and is on a daily basis)[42,43].

---

[39] *MPEP*, *supra* note 25.

[40] Carnett & Heinz, *supra* note 11.

[41] The human ability to deal with these issues is limited by Miller's Magic Number (7+/- 2), the number of information chunks we can hold in short term memory. Genius may be linked to the ability to handle more than the average amount of information. See George A. Miller, *The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information*, 63 The Psychol. Rev. 81 (1956), *available at* http://www.musanim.com/miller1956/ (last visited Nov 27, 2008).

[42] Weather prediction is a good example of this. Compare attempts to predict the weather in the early 1900's with computerized approaches today. While the computerized approaches are still imperfect, they are much better than prior techniques.

[43] The Canadian concept of "sound prediction" should have implications here as to the scope of claims. Because predictions can be based on computations or computational experiments, it should be possible to make broader claims backed up by these calculations. For an overview, see Canada - The Sound Prediction Doctrine,
http://www.ladas.com/BULLETINS/2006/20060500/CanadaPatentSoundPredictionDocrtine.shtml (last visited Nov 18, 2008).

Impact on the system

The state of the nonobviousness standard and its overseas equivalents present a conundrum when placed against the generative capability of systems like Koza's or distributed problem solving software such as the protein folding or anthrax project previously mentioned. The only human intervention that Koza's Invention Machine appears to require is in defining the goal. Distributed problem solving projects require differing amounts of human intervention depending on the problem, and the sophistication of the search algorithm. However, even the simplest searches remove the need for a key creative leap. It is one thing to use inspiration to guide a limited search to find a needle in a haystack. It is something quite different to take the haystack apart straw by straw until you find the needle. In the past, such brute force methods were impractical because of the resource commitments required to complete them. Not anymore.

The USPTO has already shown that it will not grant patents where the choices are limited and can simply be comprehensively searched[44]. That decision does not have an upper limit on the set size – and using a "practical" or "reasonable" measure could easily mean a number in the billions.

Policy Implications

In order to understand why the location of the boundary between obviousness and nonobviousness matters, consider this: if we use non obviousness as criteria, do brute force searches fall under it or not? They aren't necessarily clever. They substitute the insight of where to look in the haystack with the mechanical sifting of everything in the haystack. They guarantee thoroughness as long as the solution space is properly defined.

The implications behind this are significant. Large companies have vast and underutilized computing resources. For most businesses, there is typically at least 1 computer per white collar employee, most of which are only utilized 8-10 hours a day. For Fortune 500 companies, which may have 20,000 employees or more, were those wasted compute cycles turned to search for answers to technical problems, even a less than efficient search algorithm could exhaust all possibilities in solving a problem in a reasonable amount of time. On the one hand, if we let companies patent ideas arrived at by brute force search and exhaustion, we give a tremendous advantage to the big guy. Given large company incentives, this could easily stall innovation – large companies could simply discover and patent even if they don't implement the patent.

On the other hand, if we don't allow results achieved this way, we create a huge problem in provenance – there will be no practical way to prove how someone arrived at a result. This means that, because we don't allow patents on things that WERE discovered via brute force and

[44] **Pfizer, Inc. v. Apotex, Inc.,** 480 F.3d 1348, C.A.Fed. (Ill.),(2007) (53 FDA approved anions for use in drug delivery).

exhaustion, we can't allow patents on things that COULD be discovered that way. Since we have no way to prove how they were discovered, we must assume the worst case scenario – regardless of what the facts are[45]. This could put an end to the garage inventor by effectively destroying the incentive system that patents offer. Without patents to control their technology, startups will be unable to get funding[46]. This would then leave the playing field skewed towards those with more compute power – which can also stall innovation because large companies have both incentives to keep moving in the direction they're already going AND to stop competitors in any way they can. They could easily research multiple directions while executing only a select few. This then creates a policy problem in incentive balance: we want rules that are both easy enough to meet for the garage inventor, but hard enough to meet that patents don't become dominated solely by large corporations. We are left, then, with a contradiction.

In addition to the policy question, there is a real practical problem here. Because it will be impossible to prove how an invention is created, establishing an objective standard for nonobviousness becomes critical. Without that, rulings on nonobviousness could quickly become wildly inconsistent. The next section of this paper outlines two standards than each carve out areas of invention that can be determined to be objectively nonobvious. After describing these standards, the practical and policy implications of these standards will be explored.

The Seeds of Objective Nonobviousness

TRIZ

Genrikh Altshuller grew up in Baku, Azerbaijan during Stalin's Reign of Terror. An inventor at an early age, he received his first Soviet Inventor's Certificate at age 14[47]. Working at the Caspian Sea Naval Patent Office during WWII, he began to organize and review thousands of

[45] The reason for this is that if we do not allow patents based on brute force searches, then equivalent results obtained in different ways (automated vs. by humans) will lead to different outcomes (no patent vs. patent). This will inevitably lead to both endless litigation over how an inventive idea was obtained and fraud as people look for ways to use automation to lessen human effort while not appearing to have done so. Since the PTO will not have the resources to discover the truth, and since a system that encourages fraud leads to corruption and ultimately systemic breakdown, it will quickly become apparent that the only practical solution is simply to assume that if something could be discovered automatically that it was.

[46] Trade secrets provide little succor here. Competitors could still use brute force search to discover the secret IP – and patent it out from underneath the original inventor.

[47] Who is Altshuller?, http://www.aitriz.org/index.php?option=com_content&task=view&id=12&Itemid=26 (last visited Nov 18, 2008).

patents[48]. In this process, he searched for patterns in core inventive concepts[49]. The result of that research was TRIZ - **T**eoriya **R**esheniya **I**zobretatelskikh **Z**adatch – "**Theory of Inventive Problem Solving**" a database backed methodology for generating innovative ideas and solutions to problems[50].

Primarily geared towards solving physical engineering problems, the focus of TRIZ is resolving contradictions[51]. For example, suppose I want to build a pier or boat dock. To support the pier, I need to embed posts in the sea floor. To minimize cost, these posts should be easy to insert. However, to maximize safety, they must be hard to remove. Thus, I am left with a contradiction – I want the ability to move them up and down to be both easy and hard. Applying TRIZ techniques[52], I could quickly see that one solution to this problem would be use giant screws for each post. Inserting the screws in the sea floor would be easy, but pulling them out would be hard. Resolving the contradiction is the key to finding an appropriate solution.

As part of the development of TRIZ, Altshuller identified 5 primary levels in the creative process:

> Level One: Utilization of one existing object without consideration of other objects.
>
> Level Two: Choosing one object out of several.
>
> Level Three: Making partial changes to the selected object.
>
> Level Four: Development of a new object, or the complete modification of a chosen one.
>
> Level Five: Development of a completely new complex of systems.[53]

He then outlined the basic creative process at those levels as follows[54]:

---

[48] TRIZ, http://en.wikipedia.org/wiki/TRIZ (last visited Nov 18, 2008).

[49] *Id.*

[50] *Id.*

[51] GENRICH ALTSHULLER, THE INNOVATION ALGORITHM 91, (Lev Shulyak & Steven Rodman, trans., Technical Innovation Center, 2007) (1973).

[52] An overview catalog of some common TRIZ techniques can be found at http://www.insytec.com/annonsTRIZ.htm (last visited Nov 18, 2008).

[53] ALTSHULLER, *supra* note 51, at 44.

[54] *Id.* at 43.

Levels	*Choosing the task* ***(A)***	*Choosing search concept* ***(B)***	*Gathering data* ***(C)***	*Searching for idea* ***(D)***	*Idea found* ***(E)***	*Practical implementation* ***(F)***
1	Utilize an existing task	Utilize an existing search concept	Utilize existing data	Utilize an existing solution	Utilize ready design	Manufacture an existing design
2	Choose one task out of several	Choose one search concept out of several	Gather data from several resources	Choose one idea out of several	Choose one design out of several	Manufacture a modification of an existing design
3	Change original task	Modify search concept suitable to new task	Modify gathered data suitable to new task	Change existing solution	Change existing design	Manufacture new design
4	Find new task	Find new search concept	Gather new data relative to new task	Find new solution	Develop new design	Utilize design in a new way
5	Find new problem	Find new method	Gather new data relative to new problem	Find new concept (principle)	Develop new constructive principles	Modify all systems in which new concept is implemented

Altshuller found Inventor's Certificates for problem solutions at each of the five levels dating from the 1960's or earlier[55].

Something related is the impact this inventive process on the patenting process. The codification of abstract problem solutions into searchable databases will tend to collapse the inventive levels down. This won't completely eliminate the mental effort required in problem solving because determining the appropriate solution from a database can still be difficult. However, it does reduce the effort because focused searches are now possible. Over time, as the solution databases become more complete and better abstracted, and users become more familiar with them,

[55] *Id.* at 44-46

solution migration will become easier. At the lower levels (1 & 2), the relative closeness of the problems and solutions may cause some of those inventions to fall under the TSM rule or one of the MPEP guidelines. Even with this capability, though, contradiction resolution will remain a cognitively significant task, and thus still a basis for patentable inventions.

At first glance, it would appear that, post KSR, the USPTO and Japan would likely limit patents to levels 3-5, deeming levels 1-2 predictable. The EPO, because of its starting point of the single "closest prior art", will likely find the same in most but not all cases. In cases where there is no one piece of close prior art, but are several pieces that inform the invention, the US and Japan will likely reject whereas the EPO might approve. If that turns out to be the case, it will have a significant impact on both the number and quality of patents. Looking at patent statistics gleaned from Altshuller's book[56], denying patents to Level 1 solutions would eliminate nearly 1/3 of the patents issued under prior standards. Those patents that did issue would be for solutions at higher levels and would thus be higher quality. It should also be noted that MPEP guideline (F) may impact additional levels depending on how it is interpreted. While it talks of bringing information from a different field, how large that field is determined to be for a PHOSITA remains critical.

Level	Qualitative issue	Solution Key Characteristic	%age of patents	Trial Range (# of trials needed if trials used)
1	Means of solution exists within a different area of same profession (one specific section of an industry)		32.0	1-10
2	means of solution exists within a different area of same industry	Simple resolution of contradictions	45.0	10-100
3	Means of solution exists within a	Major change and resolution	19.0%	100-1000

[56] *Id.* at 47, 52

	different area of same science	of contradictions		
4	Means of solution exists within a different science	Transferring physical phenomenon from one industry to another	Below 4.0%	1000-10,000
5	Means of solution exists outside the boundary of contemporary science	Discovery of new physical phenomenon	Below 0.3%	10,000-100,000

As part of his review of patents and the history of invention, Altshuller noted that the persistence and perceived insight are often two manifestations of the same thing. He illustrates this with a description of a search for buried treasure[57]. If a village knows that a treasure is buried in a field but doesn't know where, the villagers may begin to dig anywhere. As time passes without discovery new generations of villagers may dig in new places or, if they haven't been keeping good records, dig again in places previously searched. Eventually someone finds the buried treasure. If that person has been digging for many years, she may be perceived as persistent. If that person has apparently chosen a spot at random to dig, he may be perceived as lucky. But if that person simply chooses where to dig based on avoiding where others have already dug, she may be perceived as insightful or creative. In reality, a systematic exhaustive search would have eventually resulted in discovery – the only real unknown was who the discoverer would be. Inventions obtained this way – whether the work of a single Edison, or the collective work of a society over generations – say nothing about the actual problem solving skill of the inventor. They simply say that if you take the haystack apart straw by straw, you will eventually find the needle.

In addition to defining levels of problem solving, Altshuller also discovered what he believed to be the key to invention – the resolution of contradictions[58]. His reviews of the writings of some of the Soviet Union's most prolific inventors indicate that looked precisely for the contradictions in requirements as the foundation for their inventions[59]. He even found prosecution histories of several Soviet Author's Certificates (the USSR's equivalent of a patent) that spoke directly of the

[57] *Id.* at 48

[58] *Id.* at 95

removal of a technical contradiction as the heart of the invention AND the reason the Author's Certificate was awarded[60].

Altshuller built the ARIZ (The Algorithm for Solving Inventive Problems) portion of TRIZ to help inventors resolve these contradictions. This algorithm is a flexible problem solving technique that involves analyzing problems to determine where the contradictory requirements lie, and explore potential solutions using an expanding database of known solution types that may be appropriate to various types of contradictions[61]. The goal of the algorithm is to guide the problem solver towards areas likely to hold solutions, thus minimizing the time and effort spent searching for a solution[62].

The Theory of NP-Completeness

Some problems are consistently hard to solve. For example, suppose you are a salesman. You need to visit your customers but, with today's high gas prices, you want to minimize how much you drive. You know where each customer is located and, because of MapQuest® and Google® Maps, you can easily determine how far it is between each pair of addresses. Even with all of this information, determining the shortest path that starts at your office, visits each customer once and then returns to your office turns out to be hard.

It turns out that there is no way to find the shortest path without simply adding up the length of every possible path. If you have 3 customers, you have 3 choices for your first stop, then 2 remaining choices for your next stop, then 1 for your last stop. This means there are 3! = 3*2*1 = 6 possible paths to check for just 3 customers[63]. For 4 customers, this numbers 4! = 4*3*2*1 = 24 possible paths. The number of possible paths grows increasingly quickly –a salesman with just 10 customers must check 3,628,800 possible paths!

A related problem, determining if there is a path shorter than some specified distance, is slightly easier – but only because checking an answer can be done quickly. In order to determine if a particular path is shorter than the specified distance, one need only add up the lengths of the individual segments. Note that finding the answer remains just as hard. This second problem falls

[59] *Id.* at 96-97.

[60] *Id.* at 95-96.

[61] *Id.* at 101.

[62] *See id.* at 108-116 for several early versions of ARIZ.

[63] "3!" Is read as "3 factorial". Generally, n!, or n factorial, is defined as n*(n-1)*(n-2)*…*3*2*1. This is the number of permutations of n objects taken 1 at a time.

into a group of decision problems[64] called "NP-Complete"[65]. These problems have the following common characteristics (among others)[66]:

1. There are currently no known polynomial time[67] solutions to these problems.
2. Any given solution to the problem can be **verified** in polynomial time.
3. Each of these problems is polynomial time reducible to the others. That is to say, each problem in this set can be transformed into one of the other problems in polynomial time. Thus, if a polynomial time algorithm is discovered that can solve one of these problems, then all of them can be solved in polynomial time.

There are a lot of known problems that exhibit these characteristics. "Computers and Intractability: A Guide to the Theory of NP-Completeness"[68], the classic work on this subject lists 320 general problems known to be NP-Complete in 1979. Since then, the list has continued to grow.

Problems verifiable in polynomial time, regardless of how the answer is obtained, fall into the class "NP"[69]. Problems solvable, not merely verifiable, in polynomial time fall into the class "P"[70]. Both P and NP-Complete are subsets of NP. It remains an open question whether or not P = NP. By definition, answers to NP problems may be obtained in a nondeterministic[71], or unpredictable, manner.

[64] A decision problem is a problem that asks a yes-no question.

[65] MICHEAL R GAREY & DAVID S. JOHNSON, COMPUTERS AND INTRACTABILITY: A GUIDE TO THE THEORY OF NP-COMPLETENESS 211-212 (W H Freeman and Company, 1979).

[66] NP-Complete, http://en.wikipedia.org/wiki/NP-complete (last visited Nov 18, 2008). Wikipedia provides a quick overview of the topic. See Garey and Johnson for an in depth treatment including proofs.

[67] Polynomial time, http://en.wikipedia.org/wiki/Polynomial_time (last visited Nov 18.2008). Polynomial time is one measure of the amount of time an algorithm takes to run as a function of the size of its input. Algorithms that run in polynomial time are generally considered tractable (solvable in a practical amount of time).

[68] GAREY & JOHNSON, *supra* note 66.

[69] *Id.* at 28.

[70] *Id.* at 27.

[71] Nondeterministic algorithm, http://en.wikipedia.org/wiki/Nondeterministic_algorithm (last visited Nov 18, 2008).

Two Proposed Objective Standards:

The Non-Polynomial Time Problem Solution Standard

Current standards for obviousness focus on the predictability of the result. However, predictability has, up to this point, been informally applied. While patent offices will reject inventions when the number of choices is small, it isn't clear what they will do when the number of choices is large, even though the end result can also be computed. So far, it appears that the standard has been based on the ability of humans to predict the result. However, if humans aren't doing the work, then using that standard can be seen as arbitrary and inappropriate.

Objectively, there are two forms of unpredictability: true unpredictability based on randomness or rules not yet understood and practical unpredictability due to the computational complexity of relevant algorithms. Note that it is possible to have both in a single event: unpredictability, such as the radioactive decay of a particular nucleus, and statistical predictability of the half-life of a lump of radioactive material containing that nucleus.

Problems with no known polynomial time solution are practically unpredictable. They are practically unpredictable because there is no guarantee of finding a solution to a version of the problem of any practical size in a reasonable amount of time. Therefore, obtaining a solution, regardless of how it is obtained, is significant. While devising a polynomial time solution to a problem may or may not be nonobvious, finding a solution to a problem with no known polynomial time solution, because it is practically unpredictable, must be nonobvious. Since that any problem to which an NP-hard problem[72] can be reduced[73] does not have answers that are practically predictable, it makes sense to define an objective standard that a showing that the solution at the core of an invention is the result of such a problem establishes a prima facie case for nonobviousness for the invention itself.

For example, staff scheduling is an NP-Complete problem[74]. If I create a generalized staff scheduling tool that works for any number of workers and any kind of on/off schedule and does so in a practical amount of time, I've solved the general staff scheduling problem. Given the known complexity of the problem, the general solution should be considered objectively nonobvious. In addition, a tool that does not solve the general problem but instead relies on

[72] A problem is NP-hard if it is at least as hard to solve as an NP-complete problem. See Garey & Johnson, *supra* note 66, at 109.

[73] The NP-hard problem must be polynomially reducible to the problem in question because that implies that either the NP-hard problem is polynomially solvable (in which case P=NP) or the problem in question is not polynomially solvable, in which case its solution is practically unpredictable.

[74] Problem SS20, Garey & Johnson, *supra* note 66, at 243.

predetermined solutions to the problem, where those particular solutions could not be obtained using a polynomial time algorithm should also be considered objectively nonobvious because the particular solutions at the core of the invention are practically unpredictable.

There may be concerns that this standard would encourage inventors to create end products, but not reveal how they were obtained. However, setting this standard will have no additional impact on behavior. If inventors don't reveal enough, they risk problems with inadequate disclosure, failure to describe best mode, or inequitable conduct. Returning to the staff scheduling example, the inventor of the generalized solution must reveal the generalized solution in order to make broad claims covering the generalized solution. Failure to do so would violate both enablement and the best mode requirement. In addition, the inventor whose invention relies on a subset of predetermined solutions must still reveal those predetermined solutions in order to claim against them. Failure to do so would be inadequate disclosure at a minimum.

The Contradiction Resolution Standard

Even if something is "predictable", there are still some problem solutions that are more significant than others. Problems that are resolved by the removal of contradictions require a qualitatively different level of effort than those that do not. If there are no contradictory requirements, the problem simply becomes one of engineering – it requires mere calculation to optimize all the relevant parameters using existing rules. Such problem solutions are practically predictable even if they aren't humanly predictable. However, a problem that turns on contradictory requirements is hard because contradictions don't tell the observer what to do – they only tell the observer what cannot be done. Contradictions leave open ended choices. They can require tradeoffs – some that may make it seem impossible to solve. The person who can correctly determine how to transcend the contradictions has indeed done something worthwhile, even if they do it mechanically – because it would be, by definition, difficult to do intuitively.

Choosing this as a standard also makes sense in a world where machines can do unlimited calculation. Even if machines can apply the ARIZ algorithm to resolve contradictions, these problems still rely on an appropriate requirements statement, the creation of which is in itself often difficult. Stating requirements is difficult because it often requires identifying key contradictions that stand in the way of success.

Implications of These Standards

How these standards differ

These standards differ from prior standards in two important ways: First, it should be noted that all prior standards are effectively negative standards. Instead of indicating what is nonobvious, they cordon off solutions that are known to be obvious. While useful, this still leaves large areas of grey. The addition of these standards will cordon off areas known to be nonobvious, reducing the grey from the other side. Second, note that the prior negative standards are highly subjective whereas these are objective standards. They turn on the definition of a PHOSITA and what s/he "would" do. Contradictions are apparent on their face. Similarly, reducing an NP problem to the core problem overcome by an invention is effectively an algorithmic exercise, with the result clear in the description.

Direct Implications of these standards:

The most obvious effect of these standards will be the rapid disposition of patent applications. Because these standards are objective, it will be simply enough for examiners to evaluate applications against them. So simple, in fact, that patent agents and lawyers will also be able to analyze their applications against these standards prior to submission. This could result in a substantial clearing of the patent application backlog. Clearly stating the contradiction in the requirements and its resolution OR the NP-Hard problem whose solution is at the core of the invention means that the nonobviousness evaluation can be done almost mechanically.

The pier and the screw posts from earlier is an example of contradiction resolution. If a patentee were to clearly state the core contradiction(s) to be overcome – in that case, that a pier vertical movement must be both easy and hard – and then show how the invention resolves the contradiction – a screw can screw in easily but won't pull out easily, then the patent examiner, in evaluating nonobviousness/ inventive step, need only look at the contradiction to see 1) is the contradiction real? Does it actually describe the problem to be solved? 2) Does the solution actually resolve the conflict? And 3) Does it resolve it in a way that is not obvious in light of the prior art?

The staff scheduling tool from earlier is an example of the NP-hard invention solution. If the patentee in this case were to clearly show that the general invention solves a problem to which an NP-complete problem is reducible, then clearly the patentee has accomplished something significant and nonobvious. If the patentee were to show that the limited invention depends at its core on solutions to NP-hard problems, the patent examiner need ask: 1) Is the NPC reduction proof correct?; 2) Is the target problem to which the NPC problem was reduced actually the problem that needs to be solved?; 3) Is the target problem actually solved with this invention? In the case of the limited solution, question 2 can look at the actual problem solutions on which the invention claims to depend or the general problem as a whole.

In addition, this will raise the quality of the patents granted. Solving problems based on contradictions or NP problems is significant – so much so that it is worth the "embarrassment of an exclusive patent"[75]. Granting patents to reward those who simply grind through the

[75] Jefferson, *supra* note 1.

possibilities will become increasingly unjustifiable as improved compute power brings more and more of that capability to the masses. A 20 year exclusive grant on something discovered today by someone doing “serious, focused research” is hardly justifiable when the same solution could be reached 3 years from now by a 12 year old running a screen saver.

Third, it would make it possible to have some consistent worldwide standards. While different jurisdictions may have a lower bar for nonobviousness, this standard could provide a guaranteed minimum standard – a standard that, if reached, would be guaranteed to meet or exceed the requirement for nonobviousness / inventive step in every jurisdiction. In effect, this could be the maximum minimum standard – no minimum standard would be higher. Such a standard would insure that, for those inventions meeting this standard, that no further review for obviousness / inventive step would be required. Patent issuance would then depend primarily on the issue of novelty in the relevant jurisdiction. Additional reviews for adequate disclosure might be required in some close cases but it is likely that issues with that and best mode will be fixed as part of the original examination process. This, of course, would lower the cost of patent prosecution. It might even impact the speed of publication if the backlogs start to clear.

Fourth, it will position patent authorities to deal with the soon coming onslaught of computationally generated or aided inventions. While it is not necessary that patent standards be raised to include only those inventions meeting these objective nonobviousness standards[76], for those inventions that do, a PHOSITA will no longer be required, and thus determining what capability a PHOSITA would be expected to have needn’t be done in every case. For jurisdictions that choose to maintain a lower nonobviousness/ inventive step standard, a PHOSITA will still be relevant for dealing with patent applications that may fall into the gap between this objective standard and the subjective PHOSITA standard. Note that this only affects nonobviousness – inventions may remain unpatentable on other grounds such as prior art.

Other Potential Implications

There will also be implications if jurisdictions choose to deny patents to inventions that do not meet either of these criteria. By making the objective standard the minimum standard, a jurisdiction effectively eliminates any remaining nonobviousness grey area.

Is this desirable? While we want ideas in the public domain, what we really want is progress. Just because ideas end up in the public domain doesn’t mean they will actually benefit anyone. A country without patents is no different from a country that ignores patent laws – while it may be easy to discover new ideas, the incentive to discover them can fade quickly. Even if the discoveries are cheap, someone still has to make the investment. While we could simply put

[76] Different jurisdictions may have policy reasons for lower standards of non obviousness. I make no attempt to address what those reasons might be or how they affect nonobviousness standards in this paper.

government resources behind the core research (ex: Human Genome Project), we have to be careful about this. Government funded research that increases the public domain will rapidly drive away competing private investment. Private investors may use that information, but they can't compete in its creation. And if you want society to actually benefit from new ideas, someone must move past idea discovery to implementation.

An additional impact comes from the compute power advantage of larger organizations. If automated searches can lead to patentable results, the incentive for those with idle resource to devote to those searches may be overwhelming. However, because organizations typically have limited resources to invest in actually reducing these inventions to practice, it may be that they are able to discover and patent much more than they can actually exploit. This can have a significant negative impact on the market by destroying incentive for secondary invention, while simultaneously stopping the public from taking advantage of the original invention.

One possible solution to this problem is the addition of a time limit on "working the invention" in order to retain the patent[77]. Any patents not worked within that time period would automatically go into the public domain. Obviously, this time limit must be significantly shorter than the standard patent lifespan. Practicality may require it begin at the date of issue rather than the date of filing. It may be necessary for the PTO to establish the lengths of these periods, with different periods for different technologies. This would make US rules similar to the rules in other countries such as India.

On the flip side, if inventions obtained via automated searches are not patentable, a different problem results. Even if ideas are free, implementation isn't. And, particularly if ideas are free and implementation is costly, who has the incentive to invest? The first mover takes the risk of market creation. The second mover need only invest in proven markets – and if there is no way to prevent the second mover from entering the market – there will be little or no monopoly rent incentive for the first mover. Instead, the first mover will have only an "implementation window" – the time it takes the second mover to understand the value of the market and ramp up production – in which to recoup its risk capital. A good example of this is pharmaceuticals. Given the cost of developing a successful drug - $100MM or more – there must be some protection of that investment or there will be no incentive to take the risk. If the discovery process is automated discovery by exhaustion and is deemed obvious as a result, that only lowers the discovery cost. It doesn't eliminate the clinical trial costs – which are significant. However, once the clinical data is obtained, under the current regime, generic makers needn't repeat the same costly trials. If there is no protection of the discovery, the risk from investing may be too high.

[77] While the details of this are the subject of a subsequent paper, the Paris and TRIPS standards provide examples of how this might be done.

Conclusion

The approach described above establishes a "maximum minimum" standard for non-obviousness. By defining these objective standards, patent offices say to inventors: "If you do this, you are guaranteed to meet the nonobviousness requirement". This approach doesn't preclude granting patents at lower thresholds of nonobviousness – there may be policy reasons unexplored in this paper for doing so. However, because these proposed standards are objective, they enable patent offices to avoid what would otherwise be unavoidable political criticism from both advocates and critics of patents for new inventions developed in an automated fashion. Further, they provide that, because they are tied to core issues involved in creative problem solving, will be stable even in the face of rapid change in both technology and our ability to access it.

For these reasons, I recommend these standards be adopted worldwide.