Oh Patent, Shall I Compare Thee to a Journal Paper?

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Abstract: This essay argues that although patents and journal papers have equal status as contributions to "the edifice of knowledge," the full value of a patent as a credential is realized only when the patent is supplemented by other credentials that certify an inventor's ancillary skills. Such ancillary skills are those ideally taught in graduate school, and include conducting investigations according to accepted methodology, carrying written arguments logically from premises to conclusions, and relating new contributions to the existing body of knowledge.

Introduction

Tradition supports the notion that peer-reviewed journal papers are the fundamental unit of accomplishment for scientists and research engineers. But what about patents? Should patents be accepted as the equal of journal papers in the construction of the edifice of knowledge? Although the answers may be primarily of interest to philosophers and university tenure committees, such questions bring to mind something more general: to what extent are patents meaningful as credentials of competence and accomplishment? What do they say about their inventors?

The Scientist Writes a Journal Paper

In principle, scientific discovery comes from deliberate investigation conducted according to the scientific method. The theoretical essence of the scientific method, as described by Karl Popper, is the construction and refutation of hypotheses.

Hypotheses form in an investigator's mind as seemingly random permutations of relevant facts and principles. The investigator may reject most nascent hypotheses as being untenable, based on the outcomes of thought experiments. Those that survive the investigator's thought experiments are ready for further examination by model building, laboratory evaluation, mathematical analysis, computer simulation, and so forth. Those that pass this further examination graduate into the realm of tenable propositions developed according to the scientific method.

Hypotheses not refuted are not claimed to be proved; rather, they are admitted to the body of systematic knowledge through proper publication. Here, "proper" means subject to expert review, which certifies the contribution as being at least tentatively valid and original. This has practical importance, of course, because publication makes worthy findings available to other investigators, who may then incorporate the new knowledge into their own permutations in search of new hypotheses.

Systematic Knowledge

In a simple *ad hoc* model, the body of knowledge relevant to a field of investigation is *systematic* when:

(a) New facts and principles are developed according to accepted methods;

(b) Potential contributions are subject to expert review before being admitted, so that the body of knowledge may advance without the inclusion of errors and trivialities;

(c) The facts and principles are preserved by archive and made readily accessible; and

(d) The facts and principles are indexed and related amongst themselves to provide order.

The Inventor Works Much in the Same Way

Maslow[1] describes invention as *"the sudden integration of previously known bits of knowledge not yet suitably patterned. The flash of discovery is most frequently the closure of a gestalt rather than the creation of something out of nothing – this is the moment of a-ha!"* experienced by both scientist and inventor. The inventor's mind ponders seemingly random permutations of unrelated, unlikely, and sometimes seemingly contradictory facts, principles, and observations, sorting through the possibilities and testing them by thought experiment until a plausibility emerges. Once the limits of the inventor's thought experiments are reached, a proposition that cannot be refuted by thought alone may be tested further, again for example by model building, by laboratory evaluation, by computer simulation, or by mathematical analysis. Thus, like scientific work, invention can be viewed as the creation and testing of hypotheses.

Beyond inventors' testing of hypotheses by one means or another, inventions are subject to external review before they reach the stage of patents. The first stage of review is often driven by economics. In contrast to the minimal expense of publishing journal papers, the preparation and prosecution of patent applications can be quite burdensome. In the United States, the process from beginning to end typically costs more than $10,000. The cost of a multi-country, international filing can top $100,000. The point here is that whoever suffers these expenses will make a serious effort to ensure that the money is at least reasonably well spent.

The Examination of Patent Applications[2]

The journey leading to a patent starts with the conception of an invention, as outlined above. Usually, the next steps are for the inventors to write an *invention disclosure* – an informal document describing their work – and to engage a patent attorney[3] to prepare a formal *patent application* from the invention disclosure and file it with the U.S. Patent and Trademark Office (USPTO).

The Patent Office classifies each incoming application by its technological species, and assigns an *examiner*. Examiners are specialists. They know their fields of technology, and are presumed to be fully competent by courts of law. An important part of an examiner's job is to determine whether a purported invention clears several thresholds, two of which are (1) the invention must be novel, meaning that the same thing has not already been done, and (2) the invention must not be obvious to those of ordinary skill in the art. The test for obviousness is neither explicitly defined nor straightforward. Rather, the question of obviousness is considered with reference to the USPTO's *Manual of Patent Examining Procedure,* which incorporates the body of pertinent case law (court decisions) and regulations.

In order to determine whether the purported invention clears these two thresholds, the examiner searches for *prior art*. Prior art comprises relevant teachings – patents, journal papers, textbooks, commercial offerings, and so forth – that predate the application under examination. In other words, the examiner looks for earlier work along the same lines. Based on the results of the search, the examiner then determines the patentability of each claim of the application under review, and communicates this to the attorney in a *first office action*. The first office action may allow all of the inventors' claims, or allow only a subset of the claims, or reject all of the claims.

The attorney, with the advice of the inventors, then responds to the examiner, either accepting the examiner's judgement or presenting a reasoned argument as to why the examiner has erred. The examiner replies to the attorney with another office action. This process can iterate through further cycles of examination if need be. In essence, the patent examiner has the same role as the academic journal's editor and referees.

The Invention Becomes a Contribution to Knowledge

Once an invention clears the formal examination hurdle, a patent is granted, and the invention becomes a contribution to knowledge in the same way that the scientist's work becomes a contribution to knowledge upon its publication in a refereed journal. In particular, a granted patent satisfies the four criteria of the *ad hoc* model proposed earlier:

(a) The contribution to knowledge offered by the invention has been developed according to accepted methodology – the same methodology as that of science – as described above: random permutation, hypothesis, and attempted refutation;

(b) The contribution has been reviewed by an expert – a patent examiner – and normally by peers at the inventor's laboratory as well;

(c) Archived publication makes the invention available to others working in the field – the patent literature is public, as suggested by the etymology of the word *patent*; an abstract is published in the *Official Gazette of the United States Patent and Trademark Office* (or similar publications elsewhere); and

(d) Forward and backward citations are recorded by the USPTO as they are encountered, thereby providing order.

The Quality of Peer Review and Patent Examination

In practice, expert review of journal papers – peer review – has turned out to be rather porous. The present situation regarding low replication rates in many fields illustrates this. One problem is "forum shopping" – there are legions of academic journals, each with its own ideas about quality. Another is "p-hacking," or the torture of data until it confesses. Yet another is the simple carelessness and gullibility occasionally exhibited by those who review journal papers. Consequently, perhaps peer review should be thought of as necessary but not sufficient to ensure the integrity of the body of journal literature.

Perhaps the same may be said, but only to a lesser extent, of the patent literature. The issue of "forum shopping" does not apply to patent applications: there is only one USPTO. Moreover, Patent Office examiners are professionals who devote their full-time efforts to vetting patent applications. The same kind of involvement cannot be attributed to the volunteers who serve as referees for journals. Further, patent examiners are disinterested parties, whereas the uncompensated volunteers who review journal papers may be in professional alliance or competition with the authors whose work they vet.

Nevertheless, patents are occasionally granted for the trivial and even the absurd. There are, however, more than 11 million US patents extant. There will be outliers in any data set this large. These may be called "false positives," meaning that the examiners failed to weed-out some unworthy applications, and let them issue as patents.

It's difficult to determine what the fraction of false positives really is, because we can observe the characteristics of only the output of the end-to-end vetting process, without having adequate knowledge of the characteristics of the input. This is an example of survivor bias. We know only the cases that make it through the system; we have no knowledge of how many unworthy candidates were denied along the way. Suppose, for example, that 990 of 1000 unworthy candidates were to pass examination and issue as patents. This would clearly indicate a problem with examination. On the other hand, suppose that only one of the 1000 unworthy candidates makes it through to a patent. This "failure rate" of one-in-a-thousand would be excellent by reasonable human standards, yet would still result in about 11,000 "junk" patents. Unfortunately, junk patents inevitably draw the attention of the trade press, which sometimes leads uninformed observers to question the integrity of the examination process.

The Analyst and the Synthesist

In his famous 1959 Rede Lecture at Cambridge University, C. P. Snow identified two cultures – the literary and the scientific – and remarked:[4]

> *"I believe the intellectual life of the whole of Western society is increasingly being split into two polar groups. . . . Literary intellectuals at one pole – at the other scientists, and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension – sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding."*

The same might be said, although clearly to a lesser extent, about inventors and journal authors. There is an inherent cultural difference between the patent literature, which describes mostly the results of industrial research, and the journal literature, which describes mostly the results of academic research.[5] To some extent, journal papers may be thought of as being driven by analysis, whereas patents may be thought of as being driven by educated intuition.

Given this difference, the analyst might view the work of the synthesist as being somehow lesser, mistaking intuitive linkage with obviousness or triviality, especially when a product of intuition is not readily amenable to analysis. In the world of inventions and patents, however, the word "obvious" has particular meaning based on regulatory rulings and case law. Thus, as a practical matter, synthesists may have a stronger argument than analysts in defending their work against accusations of obviousness.

In either camp, to transcend obviousness does not mean to transcend the process of creating and testing random permutations. Nor does the question of obviousness have anything to do with the greater or lesser separation of a permutation from its nearest neighbor in the body of knowledge. An invention in a crowded field is unavoidably near its neighbors, but may nonetheless be a respectable or even astonishing contribution to knowledge. Some might argue, plausibly, that a significant contribution in a crowded space carries all the more weight.

Inevitability and Obviousness

Over the long run, most advances are inevitable, and sometimes even occur simultaneously among independent investigators. A nihilistic view might hold that the work of scientists and inventors is therefore largely obvious, and is simply a consequence of the background. The question here turns on the word "obvious." In casual use, the word "obvious" means "easily perceived." Most facts and principles, *once discovered and explained*, are indeed easily perceived by an intelligent audience. This does not mean that they are easily wrought, or that they are timely wrought, or that the contribution to knowledge is somehow diminished.

What a Patent is Not

A post-graduate student who is a candidate for a research degree is required to submit an academic thesis. The thesis may be thought of as an extended journal paper or a "stapled" collection of journal papers of ordinary length. In this realm, *a contribution to knowledge* is the sometimes-elusive attribute that separates a doctor's thesis from a master's. Beyond this, however, an academic thesis has other purposes: to demonstrate the candidate's ability to

carry a written argument logically from premises to conclusions, command of the field of inquiry and its academic literature, skill in the use of scholarly apparatus, and so forth.[6]

The academic thesis thereby serves as a metaphor to illustrate what a journal paper is, and what a patent is not. A patent is not a demonstration of an inventor's ability to write or to carry an argument logically, as the manuscript itself is written and organized by an attorney. Further, a patent does not show that the inventor is aware of the prior art, or that the inventor can search the literature and place his or her work in context. This is done by the patent examiner. Finally, a patent does not certify that the inventor is capable of testing hypotheses by experiment, mathematical analysis, or computer simulation, as the hypothesis may have been tested by thought alone, especially in predictable fields.[7]

In other words, although a patent certifies an inventor's creativity and contribution to knowledge, it is not necessarily an overarching credential, whereas an academic thesis – and by extension a refereed journal paper – is both a contribution to knowledge and a demonstration of the investigator's several other skills.

So Which is Better – A Patent or a Journal Paper?

This is a silly question, of course, whose answer hinges on which particular patent and which particular journal paper. The question, however, is intended to be rhetorical, and to draw attention to the important but immeasurable quality of *gravitas*. Clearly, patents such as Edison's on the light bulb or Bell's on the telephone far outweigh papers such as the one now at hand. Conversely, Einstein's brief paper on the photoelectric effect surely outweighs any number of patents on potato peelers and bottle-cap openers.

In this context, patents and journal papers may be said to serve essentially the same purpose, although in different ways – to claim and defend turf. A journal paper brings its authors reputational credit by certifying that *their* efforts have added a particular brick to the edifice of knowledge. Any economic reward likely comes by way of career advancement. A patent, on the other hand, stakes-out economic territory through the control of licensing rights. A byproduct of the patent is its contribution of another brick to the edifice, and the commensurate credit that such brings to the reputation of the inventors.

A Few Thoughts from Academia

As mentioned earlier, university tenure-and-promotion committees often consider questions of the kind examined here. Some have published guidelines that put patents into perspective. Four such examples are discussed below, followed by a fifth from a different kind of organization.

The first example comes from Washington State University's Voiland College of Engineering.[8] Their approach is to divide accomplishments of research into two tiers. The higher tier includes peer-reviewed research papers and issued patents, with papers accorded the highest status

within this tier. The lower tier includes books, book chapters, and invited presentations. Thus, patents are "ranked" a below journal papers, but clearly above books and chapters.

The second example comes from Louisiana Tech University, which has the following to say about patents:[9]

> *"The filing of a patent resulting from an engineering or scientific research project is certainly evidence of a candidate's* [for promotion or tenure] *creativity. Patents are often the result of an extensive applied research effort, and in some cases, basic research. The patent is evidence that the candidate was able to successfully apply scientific and engineering principles to the solution of a problem or to satisfy a societal need. Due to proprietary and legal restrictions, the candidate is often prohibited from immediately publishing the work which led to the development of the patent. In such cases, the patent may serve as the only evidence of the candidate's scholarly activity in this regard. The candidate should include in the dossier evidence of the scientific quality of a patent, perhaps in a letter from independent outside sources."*

Note four aspects of this example: (1) the inventive process is referred to as "scholarly activity," (2) a patent may exhibit "scientific quality," (3) evidence of "the scientific quality of a patent" is solicited, presumably to weed-out the patents on potato peelers and bottle-cap openers, and (4) a patent is acceptable as a stand-in for a delayed journal publication.

The third example comes from West Texas A&M University.[10] Their approach is to assign numerical points to various kinds of intellectual contributions [their term], and to use a candidate's point total as a metric for judging promotion or tenure. In the A&M system, the following are assigned four points each: "Major contributor to a peer reviewed publication in a discipline appropriate journal," and "Major contributor to a respectable discipline appropriate patent award." Here, the patent and the journal paper are treated as equals.

The fourth example comes from a small, liberal arts college in Massachusetts, Stonehill College. Their chemistry department simply notes that "We consider peer-reviewed publications and patents to be the final measure of successful scholarship."[11]

The final example comes from a different kind of organization – *Sigma Xi, The Scientific Research Honor Society*. Their criteria are:[12]

> *"An individual who has shown noteworthy achievement as an original investigator in a field of pure or applied science is eligible for election to Full Membership. / This noteworthy achievement must be evidenced by publication as the primary author (defined in the manner appropriate to the discipline) on at least two different articles published in a refereed journal, patents, or refereed monographs. / Dissertations and theses alone are not considered sufficient for demonstration of this achievement and must be accompanied by at least two other publications."*

Note here that an applicant's portfolio is evaluated holistically rather than its individual components, wherein patents and journal papers are assumed *a priori* to be equals. Full membership, however, further requires sponsorship and election by members (vetting). One trusts that the vetting weeds-out any potato-peeler patents offered by candidates for admission.

Multiple Authors and Inventors

Further complicating the situation, multi-author papers and multi-inventor patents have become commonplace. A seemingly routine practice is for a journal paper to list a plethora of authors, of which only a few may have actually contributed anything of intellectual substance. Various ways have been proposed to apportion credit realistically in these situations. Some assign more credit to sole-author papers than to multi-author papers. In the case of multi-author papers, credit is sometimes awarded in what might be called "fractional units," with the first author receiving the lion's share. In some cases, citation counts and journal prestige are also taken into consideration.

The situation for patents is more straightforward. Inventors may as well be listed alphabetically as in any other order. As required by law, each person listed as an inventor on a granted patent must have contributed to the intellectual conception of the invention – there is no endorsement of a "first inventor" in any meaningful sense. Conversely, someone who works solely as a technician who reduces an invention to practice or works only as a scribe to "write things up" cannot legitimately claim inventorship. Getting this right is important, because a patent reporting spurious inventorship can be found invalid in litigation.

Concluding Remarks

Inventors and scientists work in much the same way, developing and testing hypotheses, looking for a sound hypothesis that withstands refutation, subjecting the result to expert review, and publishing in an open, cumulative literature. Although they differ significantly in many ways, the patent and the journal paper are equally contributions to systematic knowledge.

On the other hand, a journal paper might be viewed as a more valuable credential than a patent for at least two reasons: (1) a journal paper is primarily the work of its authors, whereas a patent is the work of the inventors, a patent attorney, and a patent examiner, and (2) because of the involvement of these other parties, a patent *per se* does not certify an inventor's broader competence with written expression, logical argument, the tools of scholarship, command of the related art or literature, and so forth.

This leads to a final "it all depends" situation. If an inventor has published peer-reviewed journal papers, these papers certify the inventor's competence in the academic skills mentioned above. In other words, the inventor has already "checked this box." Thus, for an inventor who has a record of refereed publications, *and only for such an inventor*, a patent may

be accorded full status as the equal of a journal paper in a holistic evaluation of his or her portfolio, based on the patent's contribution to knowledge combined with the journal papers' certification of the inventor's other skills.

In other words, what a patent says about an inventor – its value as a credential – depends on what else the inventor brings to the table, whereas a journal paper stands independently as an overarching credential.

Biographical Note: David Rand Irvin was admitted to practice before the United States Patent Office as an agent in 1998. In recognition of his earlier work as a research engineer, he was honored by the Ericsson laboratory at Research Triangle Park, NC, with the Master Inventor's Award, having received 44 US patents with numerous foreign counterparts. David is a graduate of Johns Hopkins University (*Phi Beta Kappa*), North Carolina State University (National Science Foundation trainee), and the University of Wisconsin at Madison.

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[1] Abraham H. Maslow, *Maslow on Management*; John Wiley & Sons, Inc.; New York, 1998; p.231

[2] This section is derived in part from: David Rand Irvin*; "Analysis of Hedy Lamarr's Contribution to Spread-Spectrum Communication,"* researchers.one/articles/24.01.00001 (pre-print)

[3] Patent attorneys are required to have earned at least the educational equivalent of a bachelor's degree in engineering or science in addition to a law degree. Many have earned advanced degrees in technical fields; more than a few have earned doctorates. Further, patent attorneys often acquire significant technical competence over the course of specialized practice. Thus, they are able to help an inventor focus on the nub of an invention, and sometimes contribute (without recognition) to its technical aspects. Additionally, ethical attorneys discuss the likelihood of gaining a patent with their clients, thereby providing a stage of vetting, albeit quite informal.

[4] C. P. Snow, *The Two Cultures and the Scientific Revolution*, Cambridge University Press, New York, 1961 pp. 4-5

[5] J. J. Gilman in "Research management today," *Physics Today,* March 1991, pp.42-48

[6] As proposed by Paul E. Koefod throughout *The Writing Requirements for Graduate Degrees*, Prentice-Hall, Inc., Englewood Hills, NJ, 1964

[7] American jurisprudence admits the possibility that an invention, particularly an uncomplicated one, may indeed be fully understood by thought alone. These fields are called *predictable*, meaning that anyone with relevant skill would be able to understand and predict the behavior of the inventive configuration, *in retrospect*, by applying known principles. In this sense, mechanical and electrical inventions may be predictable, whereas biological and chemical are generally not.

[8] *Supplementary Procedures and Criteria for Tenure and Promotion*, Voiland College of Engineering and Architecture, Washington State University, 27 Oct. 2015; https://vcea.wsu.edu/faculty-staff/documents/2016/01/tenure-and-promotion-guidelines-vcea.pdf/

[9] *Tenure and Promotion Guidelines*, College of Engineering and Science, Louisiana Tech University, July 2021; https://coes.latech.edu/documents/2022/08/tenure-and-promotion-guidelines.pdf/

[10] *Standards for Tenure and Promotion*, College of Engineering, West Texas A&M University; revised 1 June 2021; https://www.wtamu.edu/_files/docs/academics/academic-affairs/TP%20Standards%20COE66.pdf

[11] *Scholarship Criteria for Tenure and Promotion*," Chemistry Department, Stonehill College; https://stonehill-website.s3.amazonaws.com/files/resources/scholarship-criteria-booklet-august-2020-ac.pdf

[12] *Becoming a Member*; Sigma Xi, The Scientific Research Honor Society; https://www.sigmaxi.org/members/becoming-a-member