

FROM IDEA TO MARKET: MATERIALIZING INNOVATION IN INFORMATION AND COMMUNICATION TECHNOLOGIES IN ACADEMIA THROUGH ENTREPRENEURSHIP AND COMMERCIALIZATION

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Abstract: *The path of an idea from the first moment it has been conceived to successful entry to the information and communication technology market has been veiled in mystery for years. Although bits and pieces of that path, along with the amazing stories of successful academic entrepreneurs, have been widely publicized, a coherent, comprehensive and organized description of how this can happen in the complex modern world of today is lacking. The purpose of this paper is to partially fill this void in a succinct, yet thorough manner.*

Keywords: *Information and Communication Technology, Entrepreneurship, Patents, Intellectual Property, Academia, Technology Transfer, Lean Start-up, Commercialization.*

ITHEA Keywords: *Information and Communication Technology*

Introduction

The complex world of materializing innovative ideas in information and communication technology has been the subject of numerous studies [Santangelo, 2002], [Etzkowitz, 2000], [Osterwalder, 2005]. Several books have been written to help aspiring entrepreneurs in the area succeed [Berker 2005], [Davenport 2013], [Unwin, 2009]. However, we have not seen a comprehensive and yet succinct guide into the kitchen of this process in academia. The aim of the present paper is to fill this void, offering a complete walk from the very inception of a possibly innovative idea, to its protection, its dissemination, its prototyping, the testing of the developed prototypes, actual product development, exit strategies etc. Our goal is to send an optimistic message to academics pondering commercialization pathways, that entrepreneurial success in this rapidly developing area is very possible, and to help them structure their own path to such success.

Conceiving the Idea

Generating a really innovative idea in the area of information and communication technologies requires first and foremost, intimate, and tirelessly pursued up-to-date knowledge of the cutting edge of such ideas generated by all other players in the narrow subfield to which such family of ideas would belong. One favorite analogy of ridiculously obvious idea that can convert even a respected scientist into the laughing stock of his or her colleagues is the discovery of the “wheel”, or the “hot water”. The context of the joke is clear – one can live in an oblivion that these have been discovered centuries ago, and seriously hope that he or she has actually invented them. We are not going to dwell here on the well-defined differences between discoveries and inventions [Myers 1995], but rather will discuss in the necessary details what we consider adequate work with the existing scientific and patent literature, which would prevent an inventor from the embarrassment of being padded on the shoulder with the condescending remark that in fact, they have invented the “hot water”. From our experience, we suggest the following approach in testing what you perceive to be a valuable innovative idea against the four pillars of successful modern patent protection: proper subject, novelty, inventive step, and industrial applicability.

Proper Subject

United States patent law has been considered a pivotal basis for defining the proper subject of a patent, first because it is the first to discuss it, second, because it is very well established and tested in numerous real court cases, and third, because successful patenting in the largest world economy is the most convincing argument of the seriousness of the invention. The United States Patent and Trademark Office (USPTO, www.uspto.gov) defines a proper subject if it belongs to 4 distinct categories: process, machine, manufacture, or composition of matter.

Process is defined as an act, or a series of acts or steps performed upon the subject-matter to be transformed and reduced to a different state or thing.

Machine is a concrete thing, consisting of parts, or of certain devices and combination of devices. This includes every mechanical device or combination of mechanical powers and devices to perform some function and produce a certain effect or result.

Manufacture (or manufacturing, or even manufacturability. i.e. being able to be manufactured) includes any article produced from raw or prepared materials by giving to these materials new forms, qualities, properties, or combinations, whether by hand labor or by machinery.

Composition of matter includes all compositions of two or more substances and all composite articles, whether they be the results of chemical union, or of mechanical mixture, or whether they be gases, fluids, powders or solids.

It has been argued successfully, that some specific software is in fact a form of a software process, i.e. a prescribed procedural way of making a certain process materialize. In these circumstances, software based patents have been recently allowed [Geiger, 2005]. However, because of the many ways to achieve a certain programming results by using a huge variety of different processes, the strength of such patents in real court proceedings has been questionable. Therefore, an argument persists that some software processes could bring more commercial benefits if they are copyrighted, rather than patented. Future legal and court practices will undoubtedly demonstrate which approach will be gaining or losing value.

Novelty

In a brilliant graduation thesis entitled "Novelty in Patent Law" defended as early as 1896 [Ryan, 1896], Michael L. Ryan characterizes the concept of novelty in the context of U.S. patent law not only as consisting in the substantial variation of the invention in question from all inventions, which, in contemplation of law, are already open to the public, but also, as the subject of various practical court-defined tests. Since then, these tests have substantially evolved, and the matter has become so legalistically complex, that our suggestion is not to sink into the deep waters of the legal evolution of this subject, but rather, to concentrate on a single, simple test, which we would define as follows:

Can you formulate a major claim for your invention that will contain a detail or details making your proposal functionally better compared to the closest similar inventions that have been already published (as disseminated scientific articles, internet pages, issued patents or published patent applications), or of their combinations? And, vice versa, if the closest inventions to yours that have been already published, or their combinations, lack this detail or details that are pivotal to your invention, will they be functionally inferior?

Of course, this test is very broad and rough, but it can be considered a good starting point. How well this initial test will serve you depends on two important factors: (1) How well (meaning, how mercilessly) will you search the abundant world of any possible publications, product brochures, issued patents, and published patent applications to discover as extensive as possible list of already published inventions that are close to yours; and (2) will your invention be replicated if you simply combine two or several of the already published inventions that you discovered. The most prevalent problem in defining novelty, in

our opinion, is the poor preliminary work with the existing published literature, resulting in the inability to define a comprehensive enough list of prior art related to your invention. This creates an aura of false hope for some imaginary value in your invention, which, if not properly controlled can result in an almost religious belief that you have come up with something really "big". Several years into prototype development and testing, and deep into the patenting process, a diligent and professional patent examiner will send you the devastating message, that in fact, you have been one of the many "mad inventors", pretending that they have discovered the "wheel". By then, you would have probably invested lots of time and money in developing your "invention". More importantly, you could have even misled not only yourself, but external partners, collaborators, investors, and even relatives to support you in your quest to fame. Second, the lack of mercilessly combining the set of previously published inventions in order to make sure that such combinations do not result in replicating your invention, can be equally embarrassing. Moreover, the later into the invention and patent developing process the failure of this simple novelty test is discovered, the greater will be the potential damages to your professional reputation, your reliability, and your finances. It is harder to recover from such damage the later you are in the process. Therefore, our recommendation can be only one: have no mercy in your data mining, and in combining the already published inventions close to yours in the quest to determine whether they would not replicate, alone or in combinations, what you claim as novel.

Inventive Step

Inventive Step, or non-obviousness of an invention is defined in the US and international patent law as an invention, which, if regarded with respect to the prior art, is not, at the prescribed relevant date, obvious to a person skilled in the art. There are three tricky points here:

First, the prior art includes public domain publications (journal and conference papers, public presentations, Internet articles and publications, and even a conversation between two or more persons. In addition, issued patents and published patent applications with earlier priority dates compared to yours. If a party that contests your invention can demonstrate that any of the priority dates preceded your provisional patent application priority date (or regular patent application priority date, should you decide not to file a provisional patent application), your invention, even if the patent has been issued, can be invalidated.

Second, the prior art includes any possible combinations of single prior art items in any possible order, i.e. public domain publication(s) combined with other public domain publication(s), public domain

publication(s) combined with patent application(s), patent publication(s) combined with other patent application(s), etc.

Third, the definition of an invention becoming obvious to a person skilled in the art familiar with the cited prior art can be truly based on the subjective assessment of the patent examiner, who often plays the role of such person himself or herself. In cases of dispute expert witnesses are requested to define, for the relevant patent in question what defines "a person skilled in the art" for that domain.

Interestingly, even an issued patent can be later invalidated by the courts if upon judicial examination any of the requirements for Inventive Step are not met. Thus, vigorous and maximally comprehensive and broad self-testing before actual patent filing (provisional or not) is a must. In this process, of extreme importance become three factors – (a) the flexible and broad selection of combinations of searching keywords; (b) the correct identification of the numerical patent category and subcategory to which your invention belongs; and (c) the rigorousness of your data mining in both the patent and patent application databases, as well as in all possible corners of the public domain. Practically, your work on these three factors should exceed the rigorousness of the same work performed by the patent examiner who would be determining the merit of your patent application at one point of the process. It is not only embarrassing to recognize late that your critical analysis of the state-of-the-art closely related to your invention had not been adequate. It will cost you. It will cost you, first of all, money. Very often – lots of it. As we are going to discuss later, one of the best approaches in patenting is to have patent protection as early as possible, but procrastinate the associated patent costs as much as possible. However long this procrastination might be, the associated costs will be piling. Perhaps you will not notice them, because they might be distributed in time. However, at one point, the moment of truth will come, and you will face the assessment of your patent application by a qualified and very well trained patent examiner. One of the most devastating ways to defeat a patent application and throw it into oblivion is to find it already replicated in prior state-of-the-art. Then you can really feel that your investment, both in terms of time and money, and your hopes go down the drain. "From the great to the ridiculous there is only but a step", said once Napoleon Bonaparte, and this immortal wisdom applies in full swing to the patenting process.

Finally, we would like to mention, that the US patent law allows you to patent a previously published work of yours in the form of a journal article, conference article, or public presentation, as long as the patent application filing is done within one year after such publication. However, many other patent jurisdictions across the globe are not that generous.

Industrial Applicability

The onus is on you to demonstrate that your invention, for which you seek from the government exclusive patent protection, has some direct utility in the industry as the latter is defined about the priority filing date of your patent application. Otherwise, the invention remains an abstract intellectual contribution without any practical value, and although it could very well be a major discovery, it cannot be protected as an invention. Thus, for example, Albert Einstein could not have patented any process, machine, manufacturing, or composition of matter, based on his Theory of Relativity [Einstein, 1922], because this theory belongs to the realm of the major discoveries in the area of physics, rather than being possibly associated with something that can be directly and immediately utilized by any industry while he (Einstein) as alive and productive. Of course, a machine that can achieve the speed of light, for example, the design of which could be based on this theory, could be patentable, if its practical implementability could be convincingly demonstrated to a patent examiner at the time of such eventual patent application filing and examination.

Worthy of note is that a patent lifetime is 17 years. The inventors receive the protection of the USPTO for this time frame, while after it lapses the patent is available for public use. This means that time is of essence and commercial benefits from your successful invention would be limited in time as well.

Writing and Filing a Patent Application

It is widely believed that to write and file a competitive and serious patent application, you need the help of a lawyer. This, of course, poses a major obstacle for individual inventors and small company startups, particularly if located outside the USA. In our opinion, engagement of a lawyer is not necessary, particularly in early stages of patent application writing and even filing. Patent writing is not significantly different in its logistics than writing a scientific journal or conference paper. However, it does have a specific logistic that is quite unique and different.

The best start is to define how broad the invention is. Can it involve all three major components of a technological innovation: apparatus, system and method (not necessarily in this order)? If so, you need to protect all these major components, and learn how to write such a patent application. The most appropriate approach is to examine a successfully issued patent, preferably in the area of your invention, which very clearly and distinctly describes these three aspects and the claims of which are very clearly separated into them. For example, pretend that your invention is in the area of information management. A rigorous search of the state-of-the-art in the area satisfies you that you have something

really innovative and unique. However, it should also acquaint you with many already issued patents that describe innovations in this area. One of them is the US Patent No. 7,599,983 issued on Oct 6, 2009 by Harper et al, entitled "Method, apparatus and system for management of information content for enhanced accessibility over wireless communication networks" [Harper, 2009]. This prior art is a great example of patent writing covering all three aspects of a broad patent, it is professionally written, and the assignee is a really existing US corporation, indicating its seriousness. Structurally, it has everything that you need to learn from it how to write your application. Moreover, its claims are divided into all three major components (method, system and apparatus). If your invention is not that broad, and involves only an apparatus, a system, or a method, or any combination of two rather than all three of these components, your writing should be in fact easier, since you would need to cover only a subset of the three components. If you really have the motivation to be successful as an entrepreneur in information and communication technologies, you can start by writing your own patent application draft, and performing your thorough state-of-the-art data mining to convince yourself that your idea is really a patentable invention. If this is done relatively well, a professional and experienced patent lawyer's review can be done with reasonable funds and hence be cost effective.

Patent Application Is Written and Ready. So, Now What?

As we mentioned earlier, in our opinion the best approach in patent pursuit is to have protection as early as possible, while procrastinating the patenting costs as long as possible. Thus, it seems that filing the ready patent application as a provisional patent application with the USPTO is the cheapest possible approach to take. At the time of writing of this article, the cost for such application is only 130USD for a small entity, and the necessary form is available online. An even cheaper option is to claim a micro entity status, which, however, has some more stringent restrictions that should be carefully observed. The filing of a US provisional patent application, particularly if it is done online, gives you an immediate protection date for a period of 1 year, without the provisional application being examined at all, i.e. this protection is unconditional. As mentioned earlier, a patent lawyer can be consulted in relation to this filing, with initial costs not beyond \$2500. Within this one full year of protection, you should be able to do many important things in order to test the value of your invention.

First, you can design and test a working prototype of the invention. The closer your working prototype would be to an actual commercial product, the better, of course.

Second, you can contact the top executives of various companies that might be interested in your invention. Very often, top executives of such companies would not communicate with individual inventors, because they have been overexposed to sufficient number of "mad inventors" trying to convince them that their invention is "the next big thing" in the area. Therefore, and particularly if you have a working prototype of your invention, it might be prudent to consider opening a start-up company and assigning the filed provisional patent application to it. Thus, contacting the CEO even of a large corporation could become a CEO-CEO communication, rather than a "mad inventor" bother. In addition, if your invention truly has some merit, negotiations between corporations, including licensing and/or acquisition, could be far better handled.

Third, you can start writing scientific conference papers and present the invention at major scientific forums in the area, and in particular the ones that are integrated with large technological exhibit. In fact, you can have both scientific presentation related to your invention, and rent a booth to present your working prototype at the associated technological exhibit. In some situations, large technological exhibits are separate from any scientific conference forums, but renting a booth on them might be financially prohibitive. In such situations, preference given to scientific conferences in order to spread the word about your invention is an obvious choice.

Fourth, you can publish your research associated with the invention in a major journal in the area that is normally read by the industry. You will have to assess the impact factor of the journal, and probably look for evidence of some industrial involvement in it.

In addition, in this time span, you need to do some market research to understand if your invention solves a real "pain". We will point this out later when we discuss exit strategies and going all the way on your own by creating a start-up company.

If within the first 9 months after the filing of your provisional patent application you have successfully walked all of the above four avenues to disseminate the news about your invention, and you have not heard any positive feedback as a result, and on the other hand you cannot point out where your invention solves a "real pain", the time has come for you to reassess its merit and decide what to do next. More often than not, cutting your losses by abandoning the provisional application and re-directing or perfecting your efforts by re-focusing would be a wise choice.

One way or the other, if you decide to continue with your application, in our opinion your best choice is to convert the provisional patent application into an international patent application according to the so-called Patent Cooperation Treaty (PCT) administered under the auspices of the World Intellectual Property Organization (WIPO, www.wipo.int). The signatories of the PCT are all major economies of the

world, and such an application can later be converted into a national patent application in any, several or all countries that has signed the treaty. This will give you not only a time extension to perfect your work in the above four invention dissemination avenues, but also a non-binding professional examination by a patent examiner working for the patent office of the country in which the international patent application is filed. This preliminary examination process by the WIPO is approximately 18 months. After the International Search Authority issues its professional opinion about your invention, you will have another chance to cut your losses and call it quits. This time, however, the international PCT application filing and the process of preliminary non-binding examination will cost you over a thousand dollars (see e.g. <http://www.wipo.int/export/sites/www/pct/en/fees.pdf>). If, therefore, after 30 months (2 ½ years) of continuous patent protection, and in the presence of genuine dissemination attempts and search for real “pain” your invention solves, no external indications have been received of the merit of the invention, the only asset that can be of potential future value would be a very positive opinion by the International Search Authority in the three major aspects of any invention (novelty, inventive step and utility). If you feel pushed back by the lack of any positive feedback about your invention resulting from your dissemination efforts and market research, would you be prepared for yet another round of such efforts based on this positive opinion of the International Search Authority? At this point, the decision is critical, but it is yours, and yours alone. If you decide to continue with the patenting process, you will need to consider converting the PCT application into a “national phase”. Very often, and considering the fact that the US economy is the biggest in the world, and to reduce costs, a conversion to a full-blown US patent application only is the preferred choice. A second and broader choice would be to convert it also to the national phases of English-speaking countries or the ones accepting and processing patent applications in English (e.g., the UK, Ireland, Canada, Australia, Switzerland, the Netherlands, Sweden, Norway, Finland, or a subset of these). Practice shows that patenting in Latin America, China, Japan, in the rest Asia and in Africa do not add much value, as the level of governmental protection to foreign inventors could be questionable, if not because of other issues, due to language barriers and the associated costs. At the point of conversion of your PCT patent application to a full-blown US patent application we recommend the engagement of patent agents in order for the logistics of the filing and the patent processing and prosecution to be handled properly. Indeed, by the time of the PCT conversion, the inventor should be already very clear whether a more substantial financial investment in the invention is warranted.

Dissemination of the Protected Invention Was Successful. Now What?

Well, enough with the possible negative scenarios! Let us assume that you followed the 4 dissemination avenues described above and your invention generated the long anticipated industrial interest or that you have found real “pain” that your invention solves, to an extent that you firmly believe it is worth your investment in a start-up. From this point on, and depending on the seriousness of this interest, you have exactly 4 options in front of you.

1. Licensing Agreement.

Although engaging a contract specialist (a lawyer or not) is recommended, do not forget that licensing agreements are made by people like you and for people like you. You need to understand very clearly what is offered, is it exclusive or non-exclusive, and never forget one simple principle in business negotiations: whoever talks numbers first during the (often informal) start of these negotiations, usually demonstrates eagerness and loses. So, patience is a virtue, but in the information and communication technology asking for more than 300-400K USD down payment and 4% royalty on sales can often mean overestimating your invention. However, who knows – may be your invention is really a major innovative step in the area! So, our recommendation is – stay cool and wait for the other party to talk numbers first.

2. Right-of-First-Refusal Agreement (ROFR).

This is a possible avenue for collaboration with an industrial partner who is willing to fund you to perfect your prototype, make it closer to a commercial product, test mass production, test the market at arm's length from this partner, etc. The onus will be on you to present a good business model as to how will you propose to collaborate with the partner. At the end of the duration of the collaboration, the funding partner will have the exclusive right to license the invention, and you will resort to Option 1 above. Keep in mind that if at this point the partner refuses to exercise its right to license, this could be the “kiss of death” for you, since in the due diligence process in any future licensing or acquisition negotiations with other potential partners, you need to disclose what has happened with this ROFR.

3. Acquisition.

This, of course, could be the sweetest possible outcome of your inventive effort, resulting in you selling your start-up company to a bigger fish and putting a period to your inventive effort on this file altogether. However, keep in mind that history has seen many bitter inventors that have done just that, and for what they believed to be very good money at the time, only to observe their invention making it tremendously

big, to an extent that the money they received for it now start looking to them like small cramps from the big feast that their invention has become. On this feast, however, the guests are now others, not the original inventor.

4. Going All the Way on Your Own.

This is the most difficult, but also, the most rewarding path to entrepreneurial success. It, however, requires an entirely new discussion, ranging from your ability to attract governmental support for your first steps, to attracting investors, and further to manufacture, market and sell the product based on the invention. We believe in the "Lean Start-up" methodology as presented by Steve Blank [Blank, 2013]. The idea is that a start-up looks for a business model, so it needs to come up with the minimal viable product as soon as possible. What we mean is that we encourage young entrepreneurs to do a basic prototype of their invention, go out and test it and improve it with feedback gotten from the potential customers. In essence, we extend this methodology to the patenting realm as well, and see a provisional and PCT filing as a "Lean patenting" way available to academics. Following our proposal of doing the patenting in such a way, we embrace the idea of prototype buildup and checking with potential customers their real needs (for example in forums, or in web based product reviews) to have assurance that this invention answers a real need or solves a real problem that is worthy of pursuit. For instance, while researching compact food allergen detection devices in our lab, we have noticed that many customers currently complain in forums on a newly marketed product for gluten detection that fails to detect the gluten in beer, soy sauce or other fermented foods. Hence, we understood that solving the invariability to different pH levels in our product in development is addressing a real unresolved "pain" and we focus our efforts on solving this. As outlined by Blank, lean start-ups don't begin with a business plan; they begin with the search for a business model. Only after quick rounds of experimentation and feedback reveal a model that works do lean founders focus on execution.

Conclusion

In this article we tried to outline possible avenues to add an entrepreneurial twist to routine academic endeavors in the area of information and communication technologies, with the message that this is not tremendously difficult, nor it is tremendously expensive, as long as there are inventive ideas to be protected and developed. We basically offer an extension to the "Lean Start-up" methodology to include patent filing as part of the minimum viable product and to be done in such a way to be cost effective.

Bibliography

- [Santangelo, 2002] Santangelo, Grazia D. The regional geography of corporate patenting in information and communications technology (ICT): domestic and foreign dimensions. *Regional Studies* 36.5: 495-514, 2002.
- [Etzkowitz, 2000] Etzkowitz, Henry, and Loet Leydesdorff. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research policy* 29.2: 109-123, 2000.
- [Osterwalder, 2005] Osterwalder, Alexander, Yves Pigneur, and Christopher L. Tucci. Clarifying business models: Origins, present, and future of the concept. *Communications of the association for Information Systems* 16.1: 1, 2006
- [Berker 2005] Berker, Thomas, Maren Hartmann, and Yves Punie. *Domestication of media and technology*. McGraw-Hill Education (UK), 2005
- [Davenport 2013] Davenport, Thomas H. *Process innovation: reengineering work through information technology*. Harvard Business Press, 2013.
- [Unwin 2009] Unwin, P. T. H., ed. *ICT4D: Information and communication technology for development*. Cambridge University Press, 2009.
- [Myers 1995] Myers, Greg. From discovery to invention: The writing and rewriting of two patents. *Social Studies of Science* 25.1: 57-105, 1995.
- [Geiger 2005] Geiger, Christophe, and Reto M. Hilty. Patenting Software?-A Judicial and Socio-Economic Analysis. *IIC-international review of intellectual property and competition law* 36.6: 615-647, 2005.
- [Ryan, 1896] Ryan, Michael L. *Novelty in patent law*, 1896
- [Einstein, 1922] Einstein, Albert. *The general theory of relativity. The Meaning of Relativity*. Springer Netherlands, 1922. 54-75.
- [Harper 2009] Harper, David Walker, Jason James Sabella, and William Henry Munch. *Method, apparatus and system for management of information content for enhanced accessibility over wireless communication networks*. U.S. Patent No. 7,599,983. 6 Oct. 2009.
- [Blank 2013] Blank Steve. *Why the Lean Start-Up Changes Everything*, Harvard Business Review, 2013.

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