Invention Quality Measurement (IQM)

1. Patent Valuation. The methods that TRIZ forgot

Barry Winkless, MSc.
AMT Ireland bwinkless@eircom.net
University College Cork

Dr. Barry O' Connor
AMT Ireland, Director
University College Cork

Dr. John Cooney
Researcher
School of Business and Governance
University College Cork

'The current emphasis on innovation as a source of industrial competitiveness and hence prosperity makes patents a natural focus-patents after all, are inherently about innovation'[1]

1.0 Introduction

This article is the first in a series of 6 that introduces an integrated statistical, patent valuation and TRIZ based invention analysis methodology. It represents a first step in the evolution of TRIZ in line with quantitative measurables that should eventually enable organisations to very rapidly measure invention quality of their own and indeed their competitor's intellectual property. This integrated approach is called Invention Quality Measurement (IQM).

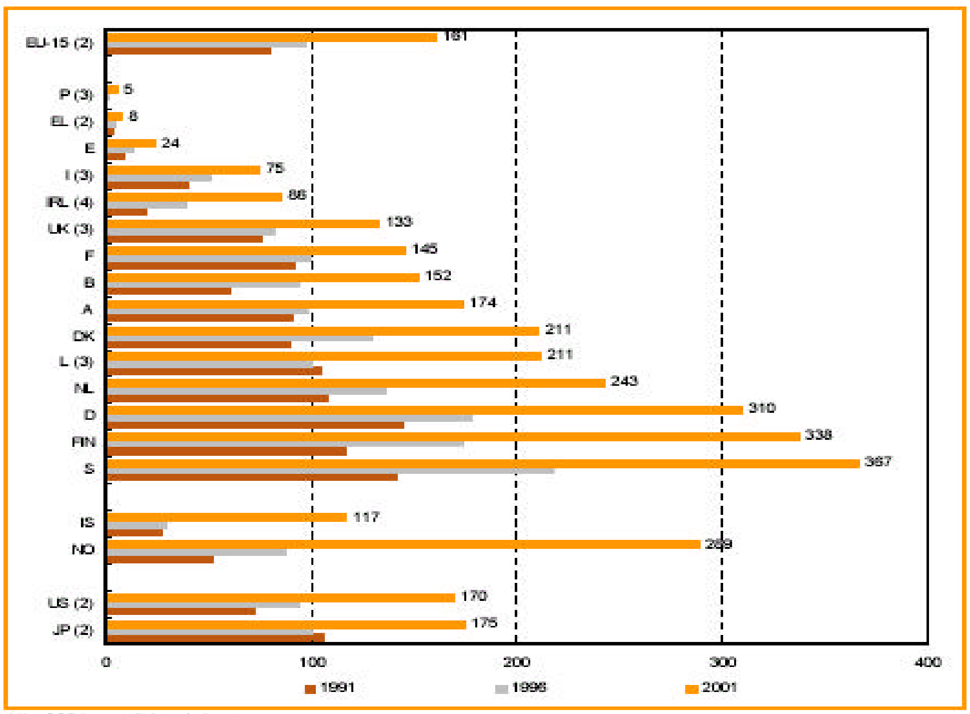
This preliminary article focuses on a presentation of past research carried out by economists and patent researchers in the development of patent valuation methods using counts such as patent citation frequency (backwards and forwards), patent maintenance levels, and patent claim length and breadth.

The article begins by highlighting the growth in patents and indeed their increased importance to competitive advantage in today's marketplace. The value and relative under-utilisation of patent information is also emphasised. A synopsis of patent valuation research and results are then presented. The article concludes by extolling the virtues of integrating patent valuation methods into a TRIZ-based innovation analysis methodology.

1.1 Growth in patents:

A Eurostat Report (2003) highlights the growth in patent applications world-wide over the past 10 years. A graph (Figure 1.0) extracted from that report is shown below, highlighting patent applications to the EPO per million habitants from the EEA, Japan and the United States. In the US, according to Technology Review (2002) the US patent office received 344,717 patent applications in 2001. Patents are also becoming important innovation indicators. The European Innovation Scoreboard (EIS) for example contains 17 main indicators, divided into 4 groups - one of these groups relates to the 'creation of new knowledge', which is based on EPO and USPTO patents.

Figure 1.0: Growth in European Patent applications and Patents granted.



(1) 2001: provisional data.
(2) EU-15, EL, JP and US 2001 population data: Eurostat estimation.
(3) I, L, P and UK 2001 population data: national estimation.
(4) IRL 2001 population data: provisional data.

Source: Frank, S (2003) 'Patent applications to the EPO continue an upward trend 1990 to 2001', in Statistics in Focus, Theme 9-4/2003. Eurostat. European Communities 2003.

Germany accounts for the largest proportion of total EU patent applications to the EPO. However if population is taken into account both Sweden and

---

[1] Form: 'Patents for innovation and profit' July 1997. www.cordis.lu/itt/itt-en9/-4/dossier.htm

Finland exhibit the highest rates of patent applications. World-wide and again taking population into account the highest ratio of patent applications per million (ppm) inhabitants was Japan (175) followed by the US (170) and the EU lagging behind at 161 ppm. Overwhelmingly most European patent applications were in the 'performing operations/transporting sections, whereas Japan specialised in 'Electricity' and the US in Physics.

The European trend chart on innovation (2002:12), however, does show the increasing importance being placed on IPR due to the fact that 'innovation, legal protection of IPR and competition are strongly linked'. The report shows there are some trends recently established by most European countries, namely the increased importance of promoting and disseminating information on IPR and the diversification of methods used to promote information on IPR.

Interestingly, and something rarely commented on in the literature, is the fact that only 50% and less of patent applications are granted as full patents. This could be for a number of reasons. However it does point to the fact that many patent applications are infringing on previously granted patents again highlighting an under utilisation of the patent databases, and indeed a lack of systematic mechanisms that can assist in using patent data as a stepping stone to further invention.

Arundel (2000) highlights a higher patent propensity rate for large American firms as compared to their European counterparts- patents on product innovations by European firms amounts to 44% compared with a 52% rate by American firms. In relation to process innovations that have been patented American firms have patented 44% compared with the European figure of 26%. Obviously lower patent propensity rates do not equate to American firms being more innovative than their European counterparts.
According to Arundel (2000) three factors are thought to lie behind the increase in value of patents – changes in legislation to strengthen patents, changes in firm IPR strategies, and a shift in innovative activities to knowledge based activities. In addition Arundel notes (2000:2) notes that

‘small firms have been one of the drivers of innovation in several new technologies….These small firms partly rely on patents to signal expertise either to attract research partners or investment’.

1.2. Need for more use of the patent system

A recent study carried out by the European Patent Office (EPO 1997) found that only 59,000 companies in Europe have made any use of the patent system in the last five years, a further 111,000 innovative companies are estimated to be in a position to benefit from the patent system but fail to do so. This is an interesting situation, as around 80% of all publicly available technical information is published in patent documentation. A study carried out by PriceWaterhouseCoopers (1999)[2] noted that most technology businesses were not fully utilising their own IP assets. Even more surprising was the fact that only 66% of the companies surveyed had a formal internal process in place for identifying and managing IP resources there is an obvious under utilisation of probably the best innovation information system available to organisations today

1.3. Negative aspects of patents:

Cole (2001) highlights a number of negative aspects and problems caused by patents. He notes that ‘the existence of patents also induces wasteful expenditure of resources by competitors trying to “invent around the patent”’. He also argues that technological innovation is often stimulated when patents are not effective, and that inventive activity is often diverted toward more easily ‘patentable’ products. Although Cole offers an interesting critique, patents do stimulate invention. Of course they are not the only mechanism that do so, however in order to ‘design around’ a patent another inventive step is generally required and as such patents actually encourage inventive thinking. Cole also fails to highlight the real value of patents as an information resource that contains huge amounts of scientific and technical descriptions, diagrams and experimental results.

[2] Quarterly ‘Technology Barometer’ 1999 - views of 365 top industry executives.

1.4.The value of patent information

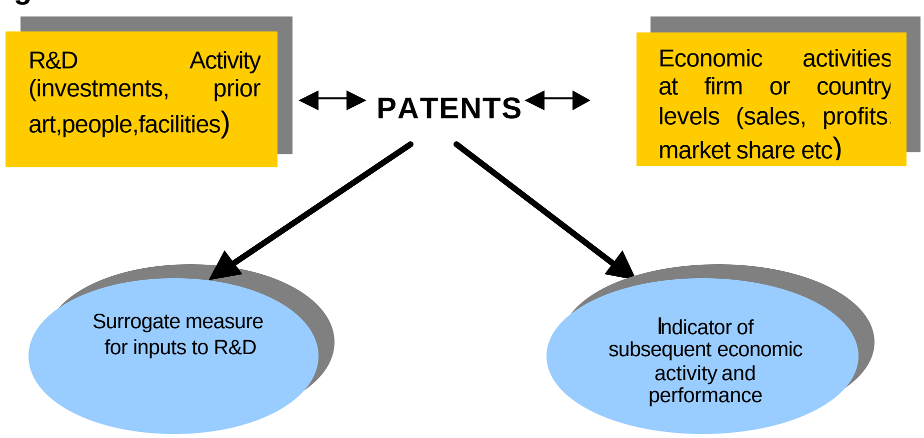
'I have often heard the theory that researchers are more creative if they are not hindered by knowledge of previous research. That is a fairy tale. Nowadays no company can afford to ignore the information available in technical literature, mainly in patent literature. No company can afford to ignore the tools needed to transform this information into useful knowledge, knowledge required to keep a leading edge in the race against one's competitors'.

Ilmaier-Campi (1999:121)

The nature of competition is changing. Innovation and intellectual property are the new 'buzzwords' of the 21st century. Competitive advantages, according to Bosworth (1997) 'which were once based primarily on low labour cost, access to raw materials or abundant capital, now turn on access to intellectual property'.

According to Kiesbauer (1999) patent information plays an essential role for developing technological expertise in Europe and for the evaluation of future R and D programmes. The successful retrieval of important information is the lifeblood of any product or process innovative endeavour. Kiesbauer also notes that about DEM 30,000 million are wasted in Europe every year because of duplicate research and development. Geisler (2000:204) diagrammatically illustrates (Figure 1.1) patents as a link between R&D and economic outcomes.

Figure 1.1: Patents as link between R&D and economic outcomes.



Source: Geisler E. (2000), The metrics of science and technology. Wesport CT and London: Quorum. Figure 10.1. (p. 204).

Scott (1997)[3] referring to the 'real value of patents' sees them as a means to stimulate innovation, to disseminate scientific information and, crucially, to control the exploitation of new ideas'. Durvy (1999), in a presentation made at Patinnova 1999, highlights the importance of patent information as a knowledge base. He notes that patents encourage investment in research and that the publication of patent information is intended to encourage the dissemination of knowledge and technologies.

Brady (1999) sees patents as an essential component of the 'innovation wheel'. She notes that the disclosure of patent information brings new information and data into the public domain, this in turn leads to further innovation and research building on previous invention. Durvy et al (1999) pinpoints the importance of patent scanning activities as an important part of the research process in organisations.

Cohen (2002) noted the importance Japanese firms place on patents as an information resource (as compared to US firms). For both countries Cohen noted a positive effect of R and D information flows (large proportion of R and D information flows relate to patents) on industry R&D. However Japan's R&D intensity is greater than the US on average. Cohen found that overall there was a positive effect of patenting on R&D- even in industries where patents were less effective than other mechanisms.

According to Derwent (1999), patents over a number of advantages as an information resource:

-Currency of data- the publication of a patent is often the first time the invention has ever been made known

-Exclusivity of information- 70-90% of the information in patents is never published anywhere else.

-Citations intelligence- the cited patents in a patent application can be used to provide more background on the development of a particular technology.

-Full and practical descriptions- highly detailed diagrams and descriptions of the patent must be given so that an expert in the same field can re-create the invention.

---

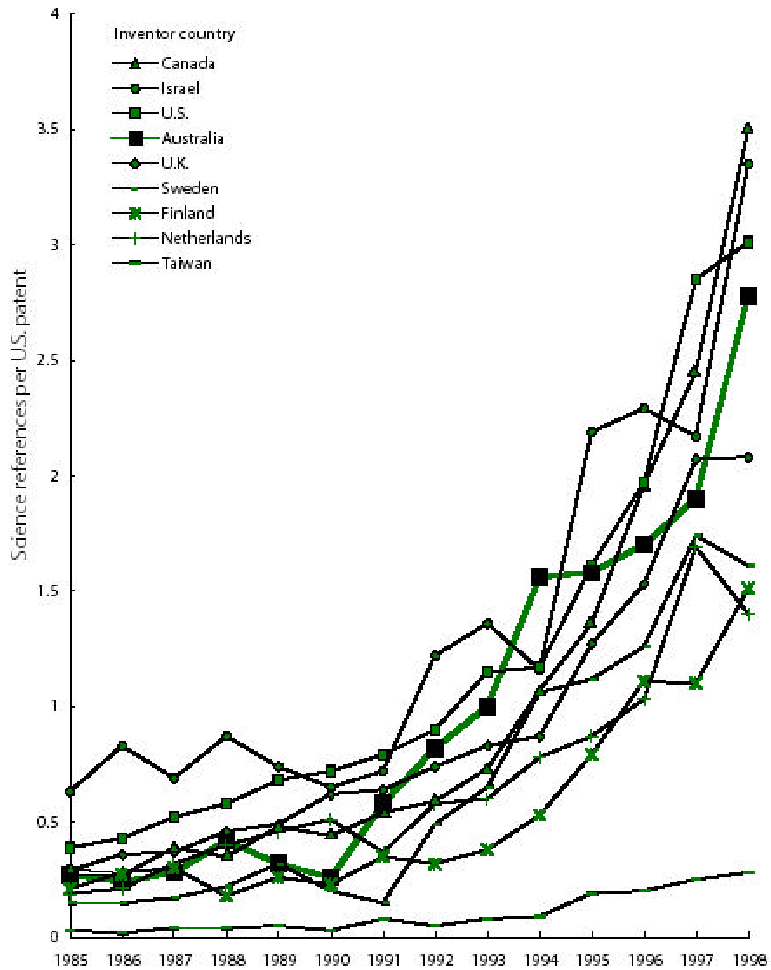
[3] Scott, Sue (1997) 'The value of patent information in the innovation process', paper presented at Patinnova 1997.

-Availability of translations- the technical content of a patent will generally be available in at least one familiar language.

-Ease of comparison- the organisation of patent contents make them relatively easy to compare and contrast.

A highly in-depth patent analysis paper from an economics perspective (Hall et al 2001) also highlights the numerous advantages due to the use of patent data that are in broad agreement with those detailed in the Derwent report.

Figure 1.2: Patents referencing scientific publications.



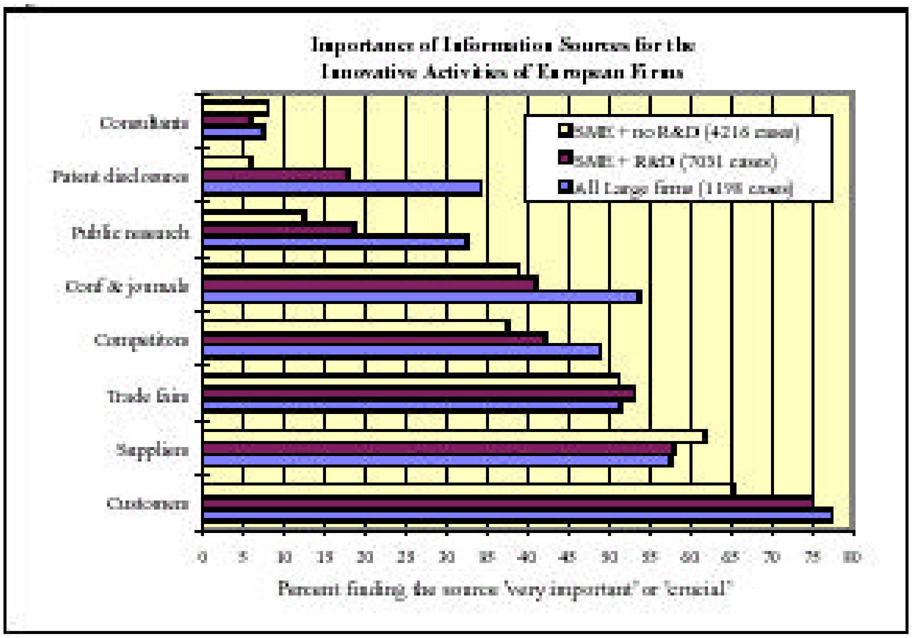
Source: Australian Research Council (2000) 'Inventing our future', Union Offset Printers. Pp. 40.

According to Hall et al (2001) each patent contains highly detailed information on the innovation itself and have very wide coverage as well as becoming an increasingly accurate reflection of inventive activity not just in the US but world-wide. They also note the huge wealth of data available as well as the

‘100 years of consistently reported data’ (pg4). They also stress however the limitations to patent data- most notably that not all inventions are patented. However with the obvious increase in patent applications over the past 10 years this is a situation that could be changing. Another traditional problem associated with patent as a data and information means has been the difficulty in actually getting relevant patent data- this is a situation that has changed only relatively recently with online availability of the US, JP, European, and WTO patent texts.

Amazingly, Scott (1997:2) notes that researchers often ignore patents and indeed view patent information in some way as second rate. On examination of most patents however a different picture emerges- detailed descriptions and experimental figures of invention that can be used as a springboard to further innovation. Some full text patents exceed 100 pages. As previously stated patents also need to have some form of novelty or non-obviousness. As a result patents often supersede academic articles in their depth and scope of invention. Research carried out by CHI (2000) for the Australian Research Council also highlights that patents are increasingly referencing

Figure 1.3: Importance of information sources for the innovative activities of European firms.



Public research: Based on the highest score given to separate questions on universities, government laboratories, and technical institutes. *Suppliers:* Based on the highest score given to separate questions on equipment and material suppliers.

Source: Arundel, A (2000) 'Patents-the Viagra of innovation policy?', MERIT. Pg. 15

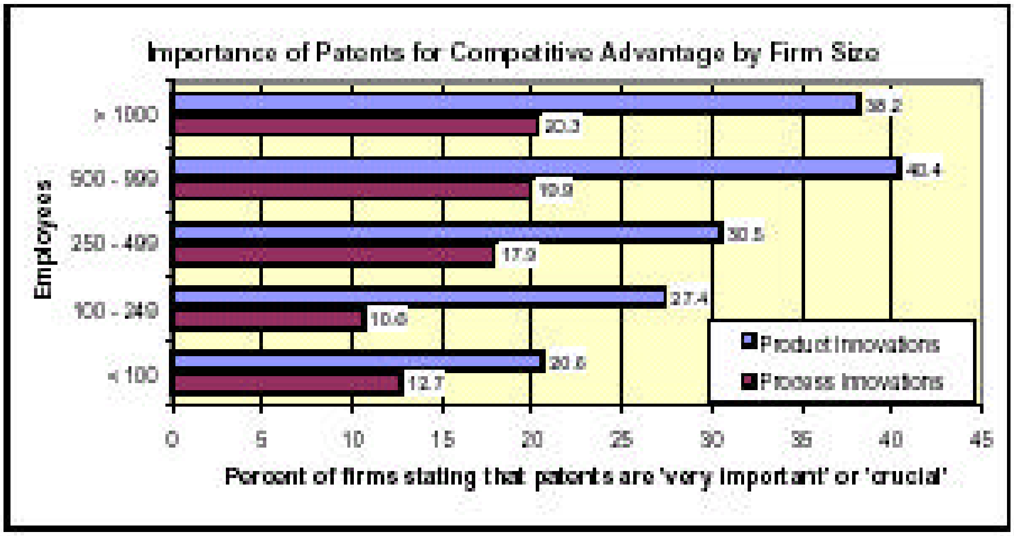
scientific papers, Figure 1.2, extracted form the research report illustrates this increase- again another indicator that patent disclosures and databases are a highly valuable and often multi-informational resource base. According to research conducted by Arundel (2000) only a relatively small percentage of firms at present view patent information as very important or crucial. The figure (Figure 1.3) relating to important information sources is reproduced from Arundel's survey article.

There is an obvious under utilisation of the patent database as a source of information and as a stepping-stone to invention. The Figure 1.4 has been extracted from a CIS survey (Arundel 2000), where 5,147 innovative firms were surveyed. It highlights a higher importance level accrued to patents the larger the firm size. It is interesting to note, however that even in relation to smaller firms the % importance of patents for product innovations is still relatively high at 20.6%. According to Willows (1999), a survey carried out by Derwent highlighted that the main reason for using patent information (51% of respondents) was as an important source of information on competitors. The other main reason was as a means to protect intellectual property. The third major reason, and a long way behind the first two, was the use of patent information to support R&D activities- this again highlights the need for a re-evaluation of how organisations patents in their innovation procedures. It also highlights a need for tools and methods that can be utilised in disseminating patent information and pinpointing optimal directions for new product and process development.

Knudsen (1997) notes that patent information can be useful to a scientist in three ways, namely: 1) To improve his general knowledge base. 2) To establish the state-of –the-art within a specific scientific field, and to 3) clarify the novelty of a potential invention. He also highlights the fact that 'the rapid development within the information technology sector has in many ways facilitated the use of patent information'.

Robert Vernue (1999) director of the European Patent Organisation, quoting from the Green Paper on innovation, highlighted the fact that 2/3's of the 170,000 SME's which generate inventions in Europe do not have access to patents. Also, many firms are unaware of the profits they could make from granting licences. He also notes that 'very few researchers and engineers use patent data as a source from literature reviews, to analyse technological trends to survey the competition, or to analyse alternative technical solutions'. Klaila and Hall (2000: 47) note that intellectual capital 'is an asset that is often ignored once it has been put to its initial use and "catalogued"' Rivette and Kline (2000) view is that patents should be required to generate returns.

Figure 1.4: Importance of patents for competitive advantage by firm size



Source: CIS survey (Arundel, 1996; Arundel 1997). Results are for 5,147 innovative firms and are weighted to reflect the distribution of firms across sectors, firm size classes, and country.

Source: Arundel, A (2000) 'Patents-the Viagra of innovation policy?', MERIT. Pg. 15

1.5 Patent Valuation methods

a) Introduction

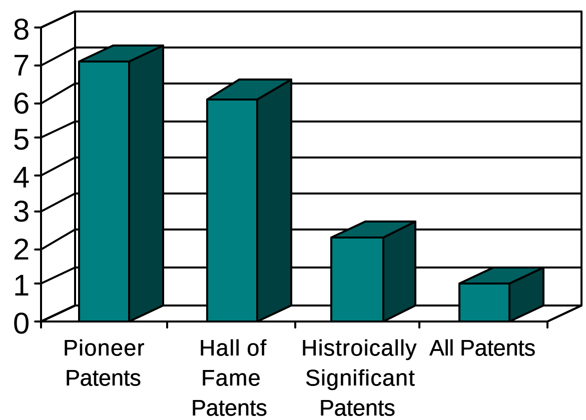
The following section focuses on quantitative patent valuation methods that have been developed by a number of economics and legal researchers, and encompass a range of measures that can be used to ascertain patent 'importance' and quality. As yet these methods have not been integrated into a TRIZ based patent evaluation system.

A number of patent valuation methods or indicators have been proposed as a means to evaluate patents. The analysis of citations (Albert et al 1991), forward/backward citations (Trajitenberg 1990, Jaffe, Trajtenberg and Fogarty 2000), claim length and breadth and 'family size' (Putnam 1996) represent the most validated, and indeed accessible examples of valuation indicators. Recently Reitzig (2002:29), has recently identified some new indicators of patent value (see section (b)). To put Patent Valuation methods into context, simple patent counts are already being integrated into European policy. For example the European Trend Chart- a monitor of inventive activity in Europe uses two patent based indicators. The use of patent valuation methodologies is also becoming commercialised. CHI, a research and analysis organisation, use a range of highly patent centric analysis measures to examine science and technology trends-for example exploring the links between patenting and basic science ('Inventing Our Future' (2000) commissioned by the Australian Research Council and CSIRO).

b) Valuation Quantitative Measures

In 1976 the US Patent and Trademark Office, in their Sixth Technology Assessment and Forecast Report, highlighted that the number of times a patent is cited may be a measure of its technological significance. Since this report, a number of citation studies have been carried out, for example Carpenter, Narin and Woolf 1981, Narin and Noma 1987, Albert et al 1991 further developing the citation/patent importance link.

Figure 1.5: CHI Pioneer/Hall of Fame/Significant/All patents results

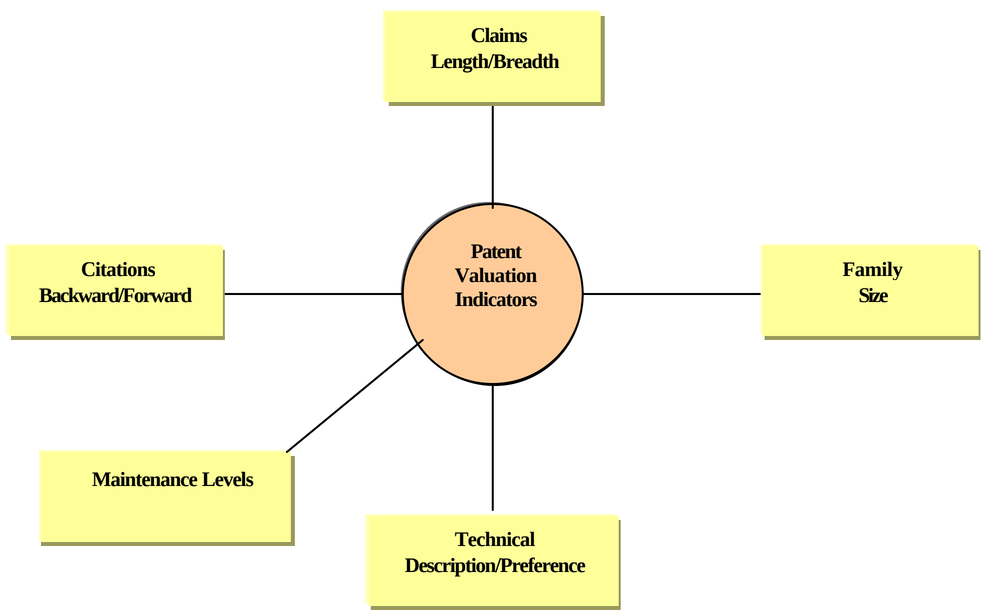


Source: Narin, F (2000) Tech-Line Report. www.chi.com

Probably the clearest example of the linkages between highly cited patents and their technological importance was illustrated in a study carried out by CHI that examined patents listed in the National Inventor's Hall of Fame and patents of Historical Significance (U.S. Department of Commerce), and patents that were viewed as 'pioneering patents' by the Federal District Court. As can be seen in Figure 1.5, the results highlight the obvious link between citation frequency (averaged by year) and patent importance.

There are two types of citations- citations made and citations received. (Hall et al 2001:14) notes that 'citations made may constitute a paper trail for spill-overs i.e. the fact that patent B cites patent A may be indicative of knowledge flowing from A to B, second, citations received may be telling of the importance of the cited patent'. In other words the number of citations made highlights the development path of a particular invention and citations received is an important indicator of quality of the patent. It is imperative to that the use of citations as an indicator is used carefully. For example, as highlighted by Hall et al (2001) is a 1990 patent that received 5 citations by 1999 regarded as more or less cited than a 1985 patent that received 10 citation by 1999. Hall et al (2001) recommend two approaches in order to minimise this problem- one is to use a fixed-effect approach- i.e. averaging citation frequency over citation mean per year for a particular product or technology segment.

Figure 1.3: Patent Valuation (Validated factors) Spectrum



The other method is 'quasi-structural' approach, which uses economic estimation in order to distinguish multiple effects. The fixed effect approach offers the developer the best method for citation analysis but only if it is product or technology specific - for example an analysis of centrifuges is highly specific and as a result the fixed-effect approach is highly applicable. Other citation based measures that have been proposed by Trajtenberg, Jaffe and

Henderson (1997) which focus on the originality, generality and science base of the selected patent.

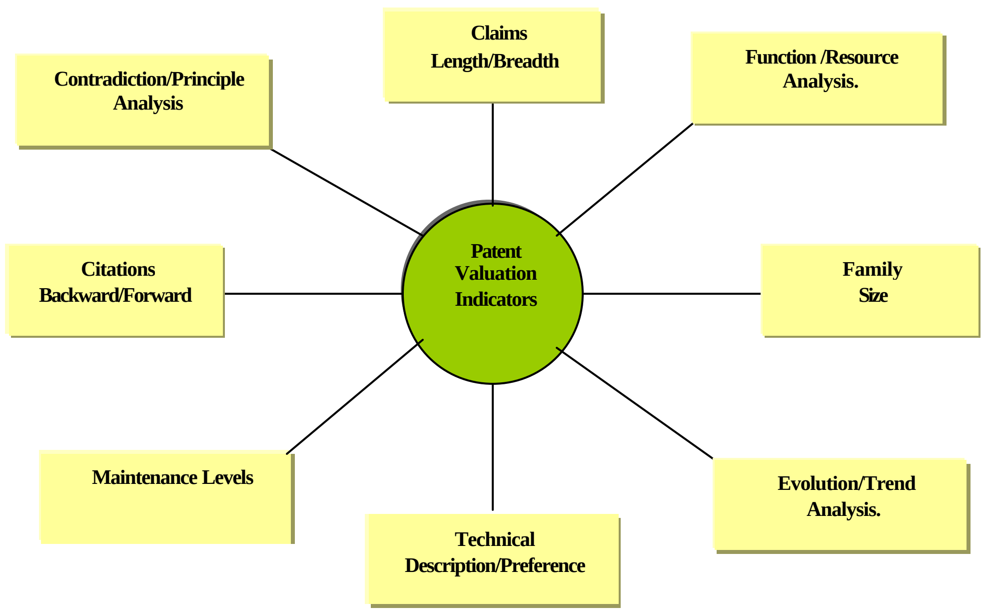
In general, maintenance rates of patents - that is the length of time the patent is enforced through the payment of a maintenance fee, is a good indicator of patent quality. Barney (2001:12) highlighted that 'higher maintenance rates correspond generally to higher implied values'. In an extremely insightful paper Barney (2001) discovered that patent maintenance rates generally increased with the number of claims, with shorter claims, with longer written specifications and more priority claims to related cases. Exploratory research carried out by Reitzig (2001/2) focusing on possible factors that may or may not have an effect on patent value identified that the number of words describing the technical problem, the number of technical preferences, independent and dependent product claims and application claims all had an effect on patent value. The patent valuation spectrum is illustrated in Figure 1.3, highlighting the numerous quantitative measures that can be used to ascertain patent quality.

1.6 TRIZ- The other side of the invention analysis coin

Any inventive analysis approach-patent based or otherwise, requires the use of TRIZ. TRIZ still represents the only systematic innovation methodology available today and as such is a key tenet of the Invention Quality Measurement approach. Analysing patents through traditional TRIZ based means such as use of resources, functionality, contradictions/principles and inventive levels are well known and as such do not need much discussion here. Suffice to say that these tools give a clear picture of the inventive side of any selected patent or group of patents.

With the development of Mann's (2001/2) Triz based Evolutionary Potential © Methodology the quantification of the quality of an invention (product, process or business) is getting closer to realisation. However, the approach is still predominantly qualitative and at it's early stages of methodological development. It does however to some extent attempt a form of invention quantification through the use of 'radar' plots and the pinpointing of a selected product or processes' current evolutionary state with regard to the TRIZ trends. It is therefore included as another key aspect of an integrated approach to patent valuation. Figure 1.4 highlights the patent valuation spectrum with the TRIZ methods of Trend/Evolutionary Potential Analysis, Resource Analysis, Function Analysis and Contradiction/Principle Analysis added- representing a more rounded approach to patent valuation- utilising both qualitative and quantitative measures.

Figure 1.4: Integrated Invention Quality spectrum of patent/invention valuation



As can be seen from figure 1.4 the integration TRIZ and Patent Valuation methodologies represent a more robust and indeed universal approach to the overall classification of a selected patent or group of patents.

Patent valuation methods and TRIZ are essentially about identifying and disseminating important patents. Patent valuation methods identify the most important and indeed most valuable patents through quantitative analysis. TRIZ tools identify what makes an important patent important- i.e. what inventive step was taken by a particular patent to make it important. This inventive step may have involved the innovative use of resources, or

functions, or the solution of contradiction, or the evolution of the system along one of more evolutionary trends (or a combination of these innovative steps).
In order for both approaches to grow and evolve it is important that they are integrated. The integration of both approaches will minimise current methodological weaknesses and maximise current methodological strengths.

Conclusion

This article has introduced the concept of integrating patent valuation methods with TRIZ methodologies. It has highlighted the growth of patents, their value and relative under-utilisation by organisations. It has also introduced patent valuation methods developed by economic and legal researchers. Article 2 in this series will further discuss patent valuation methods and through worked examples describe how these methods can be used in a TRIZ/Patent centric invention analysis approach. Article 3 will focus on the TRIZ side of the method and how current methods can be improved through the use of simple statistical and sampling procedures. Articles 4 and 5 will focus on the use of the IQM method in selected patent analysis

References

Albert, M.B, Avery, D, McAllister, P and Narin, F (1991) 'Direct validation of citation counts as indicators of industrially important patents', in Research Policy 20 (1991) pp.251-259.

Arundel, A (2000) 'Patents- the Viagra of innovation policy?', Internal Report to the Expert Group, MERIT 2000.

Barney, J (2001) 'Comparative patent quality analysis: A statistical approach for rating and valuing patents'. Patent Ratings, LLC 2001.

Bosworth, D (1997) 'The economic value of patents', in Proceedings of PATTINNOVA 97,Vienna, 5th-7th May. CORDIS Pubs.

Brady, A (1997) 'The use of patent information in the research process-examples of good practice', in Proceedings of PATTINNOVA 97,Vienna, 5th-7th May CORDIS Pubs.

Carpenter, M.P, Narin, F and Woolf, P (1981) 'Citation rates to technologically important patents, in World Patent Information 4 (1981) pp.60-163

Cohen, W (2002) 'Patents: Their effectiveness and role', Presentation prepared for the FTC/DOJ Hearings on Competition and Intellectual Property Law in the Knowledge-Based Economy February 20, 2002

Cole, J.H (2001) 'Patents and Copyrights: Do the benefits exceed the cost?', in Journal of Libertarian Studies, Volume 15, no.4 (Fall 2001) pp. 79-105.

Commission Staff Working Paper (2002) '2002 European Innovation Scoreboard', Brussels 9.12.2002, SEC (2002) 1349. European Communities 2002.

Derwent Information (1999) Global Patent Sources. Pub: Derwent Information 1999.

Durvy, J, Kutt, W, and Schmiemann, M (1997) 'The use of patent information in the research process: Examples of good practice-Quick Scan', in Proceedings of PATTINNOVA 97,Vienna, 5th-7th May. CORDIS Pubs.

Frank, S (2003) 'Patent applications to the EPO continue an upward trend 1990 to 2001', in Statistics in Focus, Theme 9-4/2003. Eurostat. European Communities 2003.

Geisler E. (2000), The metrics of science and technology. Wesport CT and London Quorom. Fig 10.1. Pp 204.

Hall, B, Jaffe, A and Trajtenberg, M (2001) 'The NBER Patent citations file: Lessons, Insights and Methodological tools', NBER publications, 2001.

Ilmaier-Campi, E (1999) 'Use of patent information in a major multinational company', in Proceedings of PATTINNOVA 99, Thessaloniki, Greece, 18-20th October. CORDIS Pubs.

Kiesbauer, H (1999) 'Patent Information- the EPO perspective', in Proceedings of PATTINNOVA 99, Thessaloniki, Greece, 18-20th October. CORDIS Pubs.

Klaila, D and Hall, L (2000) 'Using intellectual assets as a success strategy' Journal of Intellectual Capital, Vol.1 No.1 (2000) 47-63.

Knudsen, F (1997) 'The strategic use of patent information', in Proceedings of PATTINNOVA 97,Vienna, 5th-7th May. CORDIS Pubs.
London: Quorum. Figure 10.1. (p. 204).

Mann, D (2002) Hands on Systematic Innovation. CREAX Press 2002.

Michel, J and Bettels, B (2001) 'Patent citation analysis: A closer look at the basic input data from patent search reports', Scientometrics, Vol. 51, No.1 (2001) 185-201

Narin, F (2000) Tech-Line Background Paper. Web source: www.chi.com.

Narin, F and Noma (1987) 'Patents as indicators of corporate technological strength', in Research Policy 16 (1987) pp.143-155.

Narin, F, Albert, M and Hicks, D (2000) 'Inventing our future: The link between Australian patenting and basic research', Australian Research Council, Union Offset printers.

Patent and Trademark Office. U.S. Department of Commerce, Technology Assessment and Forecast. 6th Report, June 1976.

Reitzig, M (2002) 'Improving patent valuation methods for management', LEFIC Working paper, LEFIC2002.

Scott, S (1997) 'The value of patent information in the innovation process', in Proceedings of PATTINNOVA 97,Vienna, 5th-7th May. CORDIS Pubs.
Verrue, R (1997) 'The economic value of patents', in Proceedings of PATTINNOVA 97,Vienna, 5th-7th May. CORDIS Pubs.

Willows, R (1999) 'Commercial information- how the market is changing', in Proceedings of PATTINNOVA 99, Thessaloniki, Greece, 18-20th October. CORDIS Pubs.