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An A to X of patent citations for searching

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ABSTRACT

Patent citations have long been known as a useful source of information, especially in relation to trend and other analyses. This article discusses citations, but with particular emphasis on the value of citations as a regular search adjunct to conventional keyword and classification based search parameters. The different types of cited and citing references, their origins, in the jurisdictions of JP, US, EP, and WO, are described. Summaries of citation use and availability for search in the patent family databases from vendors and patent offices are provided along with example searches. Finally a section describes the value of visualisation tools, to show links between patents.

1. Introduction

Citation searching of scientific literature has been possible for over 50 years but search tools for patent citation searching have only more recently been developed. In this article I will look at how cited and citing references can be used to enhance both relevance and recall in patent searching and to review the sources available.

All citations in patents are not equal however, and an understanding of the different types of cited references which can be found on patents can further improve searching. For instance, references (citations) to previous work can be listed on patent applications by inventors prior to filing and by examiners during the examination process at the patent office. See Section 4, 'Citations in Depth' for an explanation. Does this matter to the patent searcher? I think it does and I hope to illustrate in this paper how to use citations for better searching.

The job of the patent searcher is not getting any easier, with increasing numbers of patent applications and Non-Patent Literature (NPL), and more patents filed in Asian countries. It is a greater challenge than ever to ensure all the relevant documents have been collected for analysis prior to filing a patent, filing an opposition or assessing freedom to operate in today's global market. Uncertainty is increased. Search engines based on text mining, semantic analysis and NLP (natural language processing) are entering the market of patent search (e.g. PatentCafe, SumoBrain). But today most patent searches are still carried out using a mixture of traditional techniques, based on combining fields and free text keyword searching using Boolean Operators, Positional (Proximity) Operators and Classification Codes.

It is well known that a citation provides a link between documents related by subject and some internet based patent databases[2] (e.g. Patbase, QPat, TotalPatent, USPTO, esp@cenet®) have integrated "clickable" links to show cited and citing references along with visualisation tools. These developments allow citations to be easily added into search strategies, see Section 3 for some search tips.

2. History of Patent Citation Indexing

To go back to the beginning of citation searching we must look to the 19th century and the legal profession when the idea of linking documents related to each other by subject started with '*Shepard's Citations*'. *Shepard's Citations* was first published in 1873 by the Frank Shepard Company [1] and citations soon proved an essential tool for secondary research for lawyers working on a brief. Firstly to verify that the located case was still in authority and second to find all subsequent cases quoting the original one. This provides the lawyer with an immediate link into the relevant case law. *Shepard's Citation's* also cited Statutes, Legal Reviews and the *Journal of the Patent Office Society*.

In scientific research the idea of citing earlier work–work which led the author to that described in an academic paper is of fundamental importance to the scientific tradition. In 1955 Eugene Garfield started the *Science Citation Index* as a means of linking

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[2] Some useful links are in Appendix A.

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scientific papers through these citations [2]. This was the first non-subject-index based tool for scientific literature searchers and was available only in print format until the mid 1970s. Later the *Science Citation Index* went online, and onto CD format, and expanded to other spheres of knowledge – Arts and Humanities, and Social Sciences – all of which now combine to form the Thomson Reuters' Web of Knowledge [3].

In the patenting world references have been listed on patents granted at the United States Patent Office (USPTO) from February 1947 when examiners began citing references considered during the patent examination process. Previously cited references were available in the 'File Wrapper 'held at the USPTO. Searching prior to examination was carried out at the patent office manually by examiners and other searchers using the US Patent Classification scheme. Lobeck described in this journal in 1981 the time new standards to be used when citing patents in other patents and in the literature [4].

Eugene Garfield was also the first to create a citation index for patents [5]. *The Patent Citation Index*, was published as part of the printed *Science Citation Index* in 1964. The original *Patent Citation Index* listed all references (patent and journal) cited by US patents granted in 1964. *Science Citation Index* had always listed citations of patents by journal articles. However the complexity of the indexing required and the lack of commercial viability led *The Patent Citation Index* to cease publication after just two years.

It was to be another 30 years before Derwent began the *Patent Citation Index* database as a companion to the World Patent Index. The technology needed to keep the links updated between patents proved cumbersome and time consuming, requiring whole file updates to add new links. When the internet era truly took off in the late 1990s and the Web embraced the hyperlink as the key for linking documents, citation searching took on a new lease of life. Citations are now easily accessible for searching and analysis of patents, and I am sure will become a major search method for patent searchers particularly to assist with finding patents in difficult languages. In the next section, I will illustrate this with some search examples and look at the difference between databases, before going into depth about the different types of citation.

3. Searching with citations

One reason citation searching can be a powerful supplement to a keyword and classification based search is that citations introduce a language independent link between documents. A search using this link will almost certainly add relevant documents to the retrieved set [11]. This can be very useful for increasing recall for prior art, and competitive intelligence searches including patent landscaping and state of the art analysis.

Using citations is of less use for rapidly developing or very new technical fields. It takes 18 months for an application to be published. Only then once it is in the public domain can an examiner use this patent application in a Search report. However, an inventor who cites this patent must then apply for his own patent leaving a wait of another 18 months minimum.

Table 1 gives a summary of fields for searching cited references in the major patent family databases. Using the patent family approach is important because patent examiners tend to cite patents from their own collections and language [10,12], and see Section 4.3. Table 2 gives analogous information for citing patent information. Both of these Tables will I hope be useful for deciding in which database to perform a particular search using citations. In Table 1 I have indicated the field label to be used, those squares containing a Y indicate a click-link. For instance TotalPatent has links for 'Cited references' (Table 1) and 'Citing References' (Table 2) only, but from these links has built powerful visualisation tools (see Fig. 2). Other databases have more fields which allow searchers to build specialist searches, e.g. PCI and INPADOC. For ranking and analysis on citations PCI should still be the first choice database. The PCI database is available on several database aggregators (STN, Questel and Dialog). But for searching individual patents and finding their citations either as an exercise in itself or as part of a larger search strategy there are now many options; and some search examples are provided.

Patbase, TotalPatent, and QPat take their coverage of Cited references from the INPADOC REFI database. Patent Citations Index (PCI) from ThomsonReuters, and esp@cenet from the EPO, use their own unique sources and methods. esp@cenet shows cited references and citing references for each family member separately and only provides citations made by EPO examiners.

PCI and INPADOC have the most functionality for cited reference searching. PCI was relaunched in 2007 and now provides the most sophisticated search options for citing references and for setting up alerts or watches for patents which cite a particular patent assignee or inventor.

3.1. Prior art searching

One of the most frequently performed patent searches is the 'Prior Art' search. Using citations for this type of search can (a) reveal new terms (b) locate older patents where no text is available to search (Fig. 3).

Using the above iterative search recall can be improved. This type of strategy can be developed with ease using the web-based databases which give links to both cited and citing patent references for each patent family record.

The CleanTech industry is expanding, but many of the techniques are built on older technology. For instance reviewing citations from patents found during a search for prior art on '*down draft gasification of wood chips*', revealed a new term – '*DOWN DRAUGHT*' (e.g. GB2183249, US1821263) in older patents which could be used to improve the search strategy and increase recall.

Additionally, cited references can take the search back further than text searching would allow (because there may be no abstracts available), and may also suggest additional keywords. Terminology usage changes with time and also with geographical location.

Another useful technique to build a prior art search is to find a heavily cited patent (also called a 'key' or a 'grandfather' patent)

Table 1
Which database for which type of citation search?

SEARCH FIELDS	PCI	INPADOC	PATBASE	CAS	QPAT FAMPAT	TOTAL PATENT	ESP@CENET	USPTO
CITED PATENT COUNT	CDPC, PNC.D (OSC.D)	REP	Y					
CITED PATENT SEARCH	PN.D	RPN	Y	RPN	CITB	Y	Y	/REF, /FREF
CITED CATEGORY	CAT.D, CAT.G	SRT			Y		A3, EPOLINE	
NPL	REN, CRC	REN, REXP		REC			XP, A3, EPOLINE	/OREF
TOTAL CITED COUNT	REC	REC						
CITED ASSIGNEE	PA.D				Y			
CITED INVENTOR	IN.D			RIN	Y			/REF
CITED PUBLICATION YEAR				RPY				

Table 2
Which database for which type of citing patent search?

FIELDS	PCI	PATBASE	QPAT FAMPAT	TOTAL PATENT	ESP@ CENET	USPTO
CITING PATENT COUNT	PNC.G					
CITING PATENT SEARCH	PN.G	Y	CITF	Y	Y	Y
CITING ASSIGNEE	PA.G		Y			
CITING INVENTOR	IN.G		Y			

and review these patents first. One early critique of this approach [11] looked at patent and scientific literature citations in the field of X-ray tomography, used recycling and stressed the importance of assessing relevance. Today it is easy to locate a 'key' or heavily cited reference using the PCI 'Citing Reference Count' to rank results, caution over relevance is still encouraged according to the type of search undertaken.

Chemical Abstracts Service database (CAS), is the premier source for prior art searching in chemistry with the combined resources of patents and literature. The functionality for searching and linking citations could be made a lot more powerful.

3.2. Competitive intelligence

Another frequently performed patent search is to find all patents by an individual inventor or an individual assignee. This may be an exercise on its own or part of a broader patent landscape. Using citations this type of search can also be expanded to review not only the target Assignee, but also those who have Cited their patents.

Again using the PCI database, it is possible to carry out a simple search on a patent assignee, then remove occurrences where Konarka have cited their own patents, i.e. self-citations from the result set. For example:

KONARKA/PA.D (finds Konarka patents as cited).
NOT KONARKA/PA (self-citations).

Further refinement of this set using the EPO/PCT Search Report categories (*see* Section 4) will find Assignees developing similar technologies.

(P) (X/CAT.D or Y/CAT.D).

Relevant assignees here were found to be Du Pont, NanoLedge, NanoCrystal Lighting, and several Universities. These companies may be considered direct competitors to Konarka for the technology of Organic light emitting polymers.

One note of caution – limiting the search in PCI to 'X, and Y' category citations only will have removed US and other patents from the set. Only EP and PCT search reports show these categories (*see* Section 4). It is to be hoped that techniques to isolate the examiner citations on US patents can also be developed.

Reviewing all citing patents will show competitors working on similar applications (but probably using different technology) and those using similar technology (but probably for different applications).

LexisNexis have developed for TotalPatent links between patent families which have two or more citations in common. Using these A–B–C type relationships to indicate similarity between patent families can lead to further potential competitors (or partners), and can be used to rapidly build a set for a patent landscape. (*see* Section 5). For an example of a statistical citation study of this type see Sternitzke's [13] technology review of top optoelectronics firms. No attempts were made to qualify the citations, and self-citations were considered of value in this case.

3.3. What is a citing reference?

A citing reference link in a database joins the cited patent to the one where it was cited. Citing links are added by patent offices for examiners to use and by database providers to facilitate citation searches. The power of using forward citation searching was demonstrated by Kaback in 1983 [14], one original Italian patent linked to 54 later citing patents.

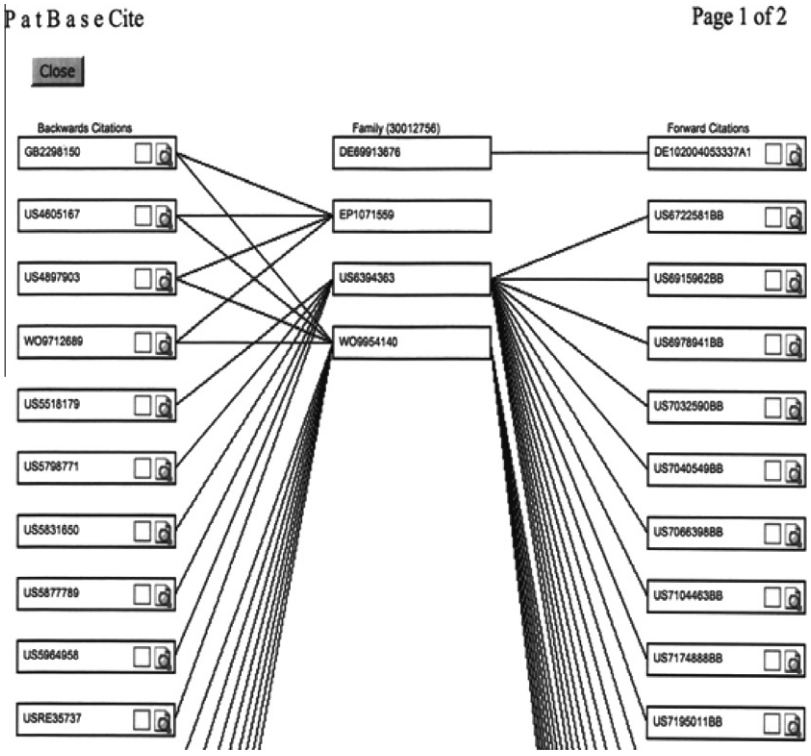

Fig. 1. Patbase cite – snap shot of a partial citation tree.

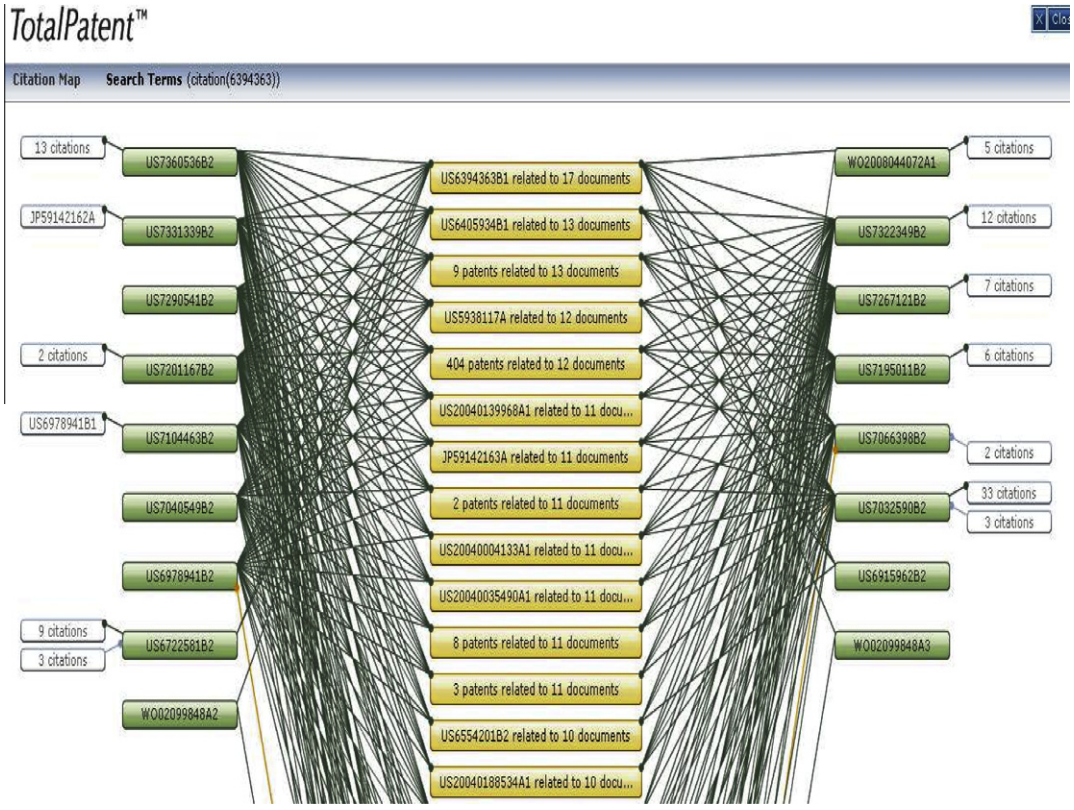

Fig. 2. Total patent citation map.

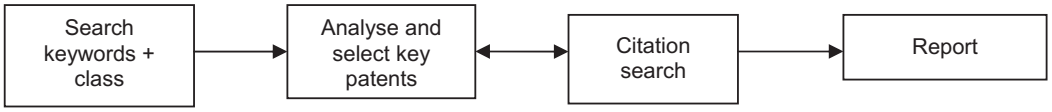

Fig. 3. Iterative prior art search procedure.

Table 3
Sources for Citing References.

Source patent	ESPACENET 'Citing documents'	USPTO 'Referenced by'	PATBASE	PCI	QPAT 'Forward'
US4143355	28	41	43 documents in 20 patent families	46 citing documents: 2 by inventors. 46 by examiners At 3 patenting authorities	36
US5670791	16	30	50 documents in 35 patent families	60 documents. 12 by examiners.	42

Table 3 compares Citing Patent Counts from different sources for two patents US4143355 'Character Recognition System' and US5670791 'Photoresponsive Device'. There are differences between all databases for both families. The differences reflect both the coverage of the databases and also the methodology used for counting citations. I make no suggestion as to which is the 'best' source, only to suggest caution and that all information should be verified ideally form more than one source for citation searching as for keyword and classification searching.

4. Cited references in-depth

To really get the best out of citation searching, understanding a little more about how they are added to a patent will help. In this section I describe different types of citations, who adds them, and why they might do so.

4.1. What is a cited reference?

References to the prior art listed on a patent application may be to any form of 'published' literature, not only to other patents. Cited references may be found, usually on the front page of a patent specification, in a field denoted by INID code 56. INID is an Acronym standing for Internationally Agreed Numbers for the Identification of (bibliographic) Data and 56 is the common field label used by all jurisdictions to facilitate understanding of patent specifications.

References may be trade catalogues, internet- or electronic-only published documents, patents, directories, journals, books, conference report, product specification, an entry in a scientific dictionary or encyclopedia [6]. The reference may be in any language.

Non-Patent Literature (NPL) references are often neglected by the database producers, and even where they are displayed,

searching is not always possible except in the full text (see Table 1). Many databases do not display NPL references at all. In esp@cenet NPL references are given an 'XP' number and may have a record on the esp@cenet database, with citing/cited links. This practice varies with subject area.

Vendors unfortunately treat Patent Abstracts of Japan (PAJ) cited references as NPL making them difficult to include in searches. This practise arose because examiners needed to clarify that their citation is to the English abstract supplied by JAPIO (Patent Abstracts of Japan).

Inventor references are usually listed in the patent specification, in the first part of the description, and are therefore also only searchable within the full text.

4.2. Who can add a cited reference to a patent?

Unlike in scientific literature, cited references in patents may be added to the document for different reasons, at different times and by different people. A cited reference can be added by the inventor before filing, or by the examiner during the patent examination process. [7–9,12]. Citations may also be added at other times during the life time of a patent by third parties either prior to grant or during the nine month post grant opposition period at the EPO.

Inventor references appear in the body of the patent specification either in the 'Background to the Invention', 'Prior Art' or 'State of the Art' section where the applicant outlines how his invention *is different* to that of the prior art. These references are chosen to illustrate the difference between earlier patents and show the novelty of the present invention.

The patent examiner on the other hand is looking for prior art which will limit the claims of the invention for which a patent is sought. Examiner citations represent the closest prior art to the technical aspects of the invention as claimed.

The examiner does not need to find all related art, he usually stops searching after finding a number of references which prevent or restrict the granting of the invention. In fact it is the stated policy of the EPO to cite the minimum number of references needed for the argument [10].

Examiner added references can be considered as added value from the patent office for searchers. Classifications whether IPC, ECLA, USCLA or JP FI terms are added to the patent application following a brief survey of the subject matter. Cited references are added after an in-depth search by the examiner. The search may take one or two days and in some subject areas such as biotechnology which are more complex up to four days.

4.3. Cited references: variety of approaches in different patenting authorities

The treatment of patent citations varies in the patent offices around the world, and an awareness of these differences could help in formulating searches and understanding differences in the results. For example: taking a patent family from a PCT application with GB priority and look at the references cited during examination and grant at EP, US and JP.

US5670791: '*Photo responsive device with a photo responsive zone comprising a polymer blend*'. This family has four direct members WO, EP, US, JP applications. The inventors cite in the description – US5247190 and five NPL references (four journal articles and one book chapter).
US5670791 has two patents referenced (US5247190, US5350459), and six NPL references.
JP4053590 (granted) has three patents referenced (US5350459, US5247190, US5331183).
WO/EP A1 (WO9616449) application has one patent cited reference (US5350459 with an 'X' to claims 1, 15, 17) and two NPL cited references one 'X' and one 'A'.

Table 4 focuses on databases which take a patent family approach with the exception of USPTO and esp@cenet because these are important patent office sources of citations and file histories. Examiners often cite from their own patent collections and in their own language, which is one reason that using patent families for citation search and analysis is best.

Esp@cenet lists the cited references for the document viewed, the citations from all family members are not displayed together. For example, looking at US5670791 the Bibliographic data page shows only the two patent references (US5247190, US5350459), and no NPL citations, but when viewing WO9616449 then the cited references show one patent cited reference (US5350459), and the two NPL references cited by the EPO as XPs (XP000578123, XP000578122). The Japanese document cannot be viewed.

4.4. Cited references on US patents

The USA was the first authority to cite references found during examination of the prior art leading to the grant of a patent. The US publishes two types of cited references, inventor cited references and examiner cited references. Since February 1947 references cited have been listed on the front page of US granted patents (INID 56). In 2001 the US began to publish applications. Applicants must provide a complete disclosure (in the IDS) of all known prior art leading to their invention. This is intended to assist the search and examination process. However, often very long lists of references are disclosed by applicants [11], and this may make it more difficult to determine the closest prior art. It is possible that applicants are providing long lists of citations to ensure full compliance with the legal requirement, or it's possible that this practise is intended to disguise the true prior art, and to make the job of the examiner (and of competitors) more difficult.

For Example:

US6554088 'Hybrid Vehicles' 29th April 2003 lists 214 US patents, twelve NPL references, and six Foreign patent references. Of these only four of the US patents are cited by the examiner.

Table 4
Start dates for the addition of Cited References by Patenting Authority in databases worldwide.

Patenting authority	YR Started	PCI	INPAFAMDB	PATBASE	CAS	QPAT FAMPAT	ESP@CENET	USPTO
US	1947	1973	1947	1950	1997	2001		1973
JP	1970	1994	1970	In prep.		Y		
WO, EP	1978	1978	1978	1978	1997	1978	1978	
CA	1948							
DE	1957	1994	1941	Y	1997			
FR	1968	2007	1970?	1978	2003			
GB	1978	1994	1978	1978	2003			
NL, BE, ES		2007	Y					

US applications are not published with the applicant's cited references. Citations are only published when the patent is granted ('issued'). Examiner citations are identified by an asterix (*) on the front page of the granted patent specification. These cited references represent those found to be close, to the invention, but still sufficiently different to allow the patent to be granted. It is hoped that the database providers will find a method to facilitate searching of US examiner citations and US application citations.

It is possible to view cited references for US applications using the PAIR database. Here transactional information relating to all patents in the US system can be found including the examiners search and report. For instance, crossed out references are ones which the examiner found were not relevant. Unlike with European patents, even after grant it is only by looking in PAIR that we can find out to which aspect of the invention the US examiner felt the references related.

The many databases which now carry US cited references do not distinguish between examiner and inventor cited references. Inventor cited references from US Applications are not held in searchable databases until grant either. But for search and IP assessment it would be helpful to have more direct means to view these citations. Since 2001 the inventor citations on US patents are probably closer to a 'state of the art' review similar to that found in the scientific literature, than to the EP and US examiner citations.

4.5. Cited references on EP and PCT patents

The European patent system began in 1978, and from the beginning patent applications have generally been published after 18 months as an A1 document with a search report. This search report, summarized at the end of the patent document, gives the cited references added to the patent application by the examiner during the initial search which precedes the examination process with an indication of the type of citation against which claims. European patent documents are published again, if granted as a B document with the same number. The EPO Search Report is published with patent applications with Kind Codes: A1 specification with search report, as an A3 as a separate document. In the search report cited references ('Documents considered to be Relevant') are listed in a table giving the associated claim numbers for which they are most relevant. Each citation is also given a category which shows how close the reference cited is to the current application. The categories used are listed in Table 5 below:

It will be clear that 'X and Y' citations will be particularly useful when performing a novelty search, as they provide a link between technologically related documents. Citations denoted with an 'A' may be more useful for a broader 'state of the art' analysis.

The WO applications are searched similarly to EP patents with an International Search Report (ISR) published using the same reporting system for cited references. Three types of WO documents can carry cited references A1, A3 and the recently introduced document type A9 which means the application and or search report have been republished with changes. The WO documents will all be applications and progress may be followed on PatentScope up to entry into the National Phase.

Table 5
Citation categories in EP and WO search reports.

&	Corresponding document (from the same family)
A	Technological background
D	Document cited in the application
E	Earlier patent document, but published on or after the filing date
L	Document cited for other reasons (miscellaneous category)
O	Non-written disclosure
P	Intermediate document
T	Theory or principle underlying the invention
X	Particularly relevant
Y	Particularly relevant, when combined with another document

4.6. Cited references on JP patents

In Japan Cited references are published at the end of granted patent specifications only (INID 56). They are carried by PCI and INPADOC for searching.

5. Visualisation of patent citation trees or networks

Visualisation tools can assist the searcher in understanding the relationships between patents and how they are linked, especially when using the patent family approach. Two internet databases which make available these tools are PatBase (see Fig. 1) and LexisNexis TotalPatent (see Fig. 2). For direct comparison of the two approaches the same patent US6394363 'Liquid Projection Apparatus' was used to form the Maps. In the Patbase patent family chart a direct link between a patent application and it's granted equivalent is shown as a citation (e.g. This is potentially misleading as these are not true citations and this 1:1 relationship gives rise to the over counting of citations. In the Patbase visualisation you can choose to see only the patents in the family which have citations. Looking at the Tree it can be seen that the EP and WO cited references are common, but the US references are not.

TotalPatent citation maps are more complex as the relationships between not only patents in the same family, but also patents in related families are shown. TotalPatent uses the 'ABC approach' which shows links between multiple patent families which have two or more citations in common. The logic here is that patents which have cited two or more of the same citations must also be technically related. Using this approach the number of patents for analysis may rapidly be increased and this could be very useful for a State of the Art or competitive gap analysis, but caution must be used in interpretation.

In TotalPatent's Map each box represents a patent family, e.g. The box for US6394363 contains 17 family members. Clicking on this family box reveals further detail on these patents in the family itself. The complete patent list may be used for further searching, and more precise keyword and or classification searching may be performed to ensure relevance is maintained.

6. Conclusions

In this article I have described how to use citations in a search and also how the citations arrive on patents. Citations represent added value from the patent office which we can use to help formulate better patent searches. Importantly, citations provide a language-independent search tool. This is of increasing importance in our global economy where applications are published around the world in many different languages. Links between cited references are now available in many databases free and fee-based and those links between patents related by subject can be exploited in a search to improve both relevance and recall. And visualisation tools are being developed which should further aid in the analysis of the cited links. Cited references can provide access to older documents, which cannot be keyword searched or where terminology has changed.

There are still many improvements which could be made by patent offices and by database providers before we can fully utilize the power of citations. Suggestions for instance would be utilizing the examiner categories, adding US application cited references, increasing the availability of JP cited references, and cleaning up the JAPIO NPLs; all would all be welcomed. Searchable NPL citations and integrated links between patent and scientific literature

would be valuable, CAS, Thomson Innovation and google/scholar are forerunners in this field. All of these improvements could enable more thorough searching and therefore more certainty for patent applicants and better applications for patent offices.

Citation indexing was initiated over 50 years ago as an aid to information retrieval. In the world of patents, until recently bibliometrics – citation counting and analysis for economic evaluations – has been the major use of patent citations. I look forward to seeing patent citations once again becoming an important tool for finding relevant information.

7. Editor's note

The following related disclosures may also be of interest to readers of this article:

- Criscuolo P, Verspagen B. Does it matter where patent citations come from? Inventor vs. examiner citations in European patents. Res Policy 2008;37(10):1892–1908.
- Fujii A. Enhancing patent retrieval by citation analysis. In: Proceedings of the 30th annual international ACM SIGIR conference on research and development in information retrieval, SIGIR'07; 2007. p. 793–4.
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Appendix A

Some useful database internet links:

A.1. Patent office databases

http://ep.espacenet.com
http://www.epoline.org/portal/public
http://www.epo.org/patents/law/legal-texts/guidelines.html
www.uspto.gov
http://uspto.pair.gov
Handling of Prior Art Citations [R-5] 2206–2200, MPEP, www.uspto.gov
http://www.ipdl.inpit.go.jp/homepg_e.ipdl
http://www.wipo.int/patentscope/en/

A.2. Other free websites

www.depatisnet.dpma.de (citation searching in Expert mode).
http://www.freepatentsonline.com/search.html
www.google/patents

A.3. Proprietary patent family databases

INPADOCDB/INPAFAMDB: http://www.stn-international.com/details_inpadocdb.html
www.patbase.com
PCI (Patent Citation Index):
Patents Citation Index on STN Reference Manual 2008. http://www.stn-international.de/training_center/patents/pciman.pdf
http://www.qpat.com/index.htm
http://corporate.lexisnexis.com/totalpatent/

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